ARTI REFRIGERANT DATABASE
DATA SUMMARIES - VOLUME 2:
BLENDs (ZEOTROPES AND AZEOTROPES)

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prepared by

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Introduction

This report provides data summaries from the ARTI Refrigerant Database. Volumes 1 and 2 present refrigerant profiles for single-compound refrigerants and refrigerant profiles, respectively. Volume 3 presents data summaries for compatibility and toxicity. They are part of a series to provide a record of the database entries in printed form.

Purpose

The Refrigerant Database is an information system on alternative refrigerants, associated lubricants, and their use in air conditioning and refrigeration. It consolidates and facilitates access to property, compatibility, environmental, safety, application, and other information. It provides corresponding information on older refrigerants, to assist manufacturers and those using alternative refrigerants to make comparisons and determine differences. The underlying purpose is to accelerate phase out of chemical compounds of environmental concern.

Contents


The database provides bibliographic citations and abstracts for publications that may be useful in research and design of air-conditioning and refrigeration equipment. The complete docu-
ments are not included, though some may be added at a later date. Incomplete citations or abstracts are provided for some documents. They are included to accelerate availability of the information and will be completed or replaced in future updates.

**Limitations**

The Refrigerant Database is intended as a means to assist users in locating sources of information on alternative refrigerants. But, the database is:

- neither a comprehensive nor authoritative reference source,
- not a substitute for independent data collection by users,
- not a substitute for examination of the data, information on how they were arrived at, assumptions, and caveats in the cited documents, and
- not an endorsement of suitability or accuracy of the referenced publications.

The information in the database was obtained from published and unpublished sources, or calculated from them, without verification. Some of the data may be imprecise or incorrect, as manifested - in some cases - by inclusion of conflicting data based on disagreement among identified sources. Similarly, errors may have occurred in assembling and processing the database. Users are cautioned to check the data and associated limitations and caveats in the referenced documents and other sources before use, particularly if such use might risk harm to life or property. Newer or more complete data may be available from refrigerant suppliers or elsewhere.

Materials compatibility, properties, safety considerations, and other characteristics affecting suitability or desirability may be influenced by a number of factors. Among them are specific application conditions, preparation such as drying before use, additives including fillers, impurities, catalytic interactions with other materials used, and changes in compounding between one source or batch and another. Similarly, new findings or corrections may supersede previously published data. The database is an aid in locating data that may be pertinent; it is not and should not be viewed as the source of data for research, design, analysis, or other purposes.

**Database Form**

The database is available in both computerized ("electronic") and report ("manual" or "listing") versions.
Computerized Version

The computerized version includes both data summaries and bibliographic citations organized into a number of segments ("files"). These segments can be searched individually or together, in any combination.

The computerized database provides 606 specially-prepared data summaries, including refrigerant (single compound and blend) profiles, tabular compatibility summaries for plastics and

### Distribution of the Refrigerant Database

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a Data summaries, citations, and synopses may be printed with the computerized version.
b The Copper Development Association (CDA) sponsored supplement provides additional citations and synopses, most of which address compatibility with or use of copper in air-conditioning and refrigeration systems. The supplement is included and searchable with the computerized version, but published as a separate report.
c Use of the search and retrieval software is subject to acceptance of the license agreement for it; both accompany the computerized version.
d Distribution is limited to documents in the public domain or for which authorization has been obtained. Others may be ordered from their publishers, which are identified in the bibliographic citations.
elastomers, and toxicity reviews for refrigerants. The refrigerant profiles cover designations, common uses, chemical and trade names, other identifiers, molecular mass, critical properties (pressure, temperature, specific volume, and density at the critical point), physical and thermophysical properties for selected conditions, safety classifications, toxicity and flammability data, exposure limits, atmospheric lifetime, ozone depletion potential, global warming potential, halogen global warming potential, commercialization, phaseout, and other data.

The computerized version also provides more than 6,100 citations. They are organized into a primary file that includes recently added and key references, a supplement on copper in air conditioning and refrigeration, and an archival group covering historical and superseded documents.

The search and retrieval software provided with the computerized version enables very fast searches for user-selected terms or combinations of terms. The search program offers several automated features to simplify use. They include optional prompting by search category, an automated "thesaurus" of synonyms and related terms, chain searches to broaden or narrow prior searches, a "wildcard" capability to allow entry of word segments, and a configuration capability to customize a number of options. The program also allows printing of selected portions of the database. Printing the entire database would yield more than 8,000 pages, so a printed version is available for those who prefer to use the database manually.

**Report Version**

A listing of the recent and key citations is provided in report form. The citations are grouped under the primary or first subject addressed; they are not cross-referenced under other topics. The computerized version, therefore, is better suited to search for information by subject.

Citations and summaries from the supplement on copper in air conditioning and refrigeration are published separately. They also are arranged by subject.

Archival and historic citations are included in a third report. They are presented in reverse chronological order, beginning with the most recent. These citations remain accessible through the computerized version.

**Documents**

The database also includes a collection of published and unpublished documents, copies of which can be ordered individually. Approximately one third of the documents cited in the database are included in this collection. They include documents that are not protected by copyright or proprietary restrictions. They also include documents for which the authors or copyright owners granted permission for reproduction and distribution. Documents that are not dis-
tributed through the database can be obtained from their publishers, libraries, and other sources (please refer to the database User's Manual for suggestions).

**Ordering Information**

The computerized version of the database and the report version for recently added and key references can be ordered along with a subscription for updates. The report versions of the copper supplement, archival citations, and data summaries are available as separate documents distributed through the database.

An order form for the Refrigerant Database, which indicates the pricing, accepted methods of payment, and applicable terms and conditions, may be downloaded from the Internet from [http://www.arti-21cr.org/db](http://www.arti-21cr.org/db). Alternatively, a copy may be obtained by mail or fax by calling +1-703/524-8800 or faxing +1-703/522-2349. Questions should be sent by e-mail to database@spectrum-internet.com. Please note that the same form may be used to obtain the computerized database and remaining scheduled updates, the report version and remaining scheduled updates for primary and key references, and database documents by completing the corresponding portions of the form.

**Additions**

Future updates and expansions to the database are planned. Please help in making it more useful, and facilitating use of alternative refrigerants, by submitting the following:

- corrections to errors identified in the database,
- copies of helpful papers - whether your own or written by others - for citation, and
- suggestions for improving the database.

Authors or those holding rights to published or unpublished works pertinent to the database are invited - and encouraged - to authorize their reproduction and unrestricted distribution through the database. Product literature normally is not included, but technical bulletins and papers providing relevant information, whether on proprietary or generic substances, will be considered.

Please send your inputs to: James M. Calm
   Engineering Consultant
   10887 Woodleaf Lane
   Great Falls, VA 22066-3003 USA
   jmc@spectrum-internet.com
Thank you for your help with and use of the database. Its objective is to accelerate phase out of chemical compounds of environmental concern by sharing the information needed to do so.
ARTI Refrigerant Database - Data Summaries

The parameter descriptions that follow summarize the information included in data summaries for refrigerants, also referred to as refrigerant profiles. Each entry consists of the following parts:

- a label to identify and/or explain the data,

- a data value, typically rounded to common representation or limits of precision, generally expressed metric units or dimensionless form (metric units conform to the International System, SI, modified to use the Celsius scale for temperatures in place of the Kelvin scale),

- units of measure if applicable,

- converted data and units in the inch-pound (IP) system for data expressed in metric units,

- qualifying information on the data such as the animal species, exposure duration, and fraction of responses for toxicity test results, exposure periods, or manufacturer identity where the source is a safety data sheet, and

- four-digit alphanumeric Refrigerant Database ("RDB") number (discussed below).

The specific data included for each single-compound refrigerant or blend depend upon availability. Multiple values are cited for the same or related parameters in some cases, for example when conflicting data were published by multiple credible sources. The purpose of the database is to assist users in locating data rather than to endorse or verify specific data or to resolve inconsistencies and conflicts. Older data generally are deleted for simplification when the original source reports later results or when scientific consensus is reported, but that does not suggest endorsement of the newer data. Please refer to the discussion of data limitations on page 2. The data values shown are included to assist users, but the primary information for each entry is the four alphanumeric digit "RDB" number in the right-most column, which indicates the document or other source from which the data were taken. Those sources may be located by searching for the number prefixed by "RDB" (for example RDB9901) in the database.
Identifiers

The refrigerant number shown in the heading is the standard designation based on those assigned by or recommended for addition to ANSI/ASHRAE Standard 34-1997, *Designation and Safety Classification of Refrigerants*, as well as pending addenda and common industry extensions thereto. These familiar designations are used almost universally, usually preceded by "R-", "R", the word "Refrigerant", composition-designating prefixes (for example "CFC-", "HCFC-", "HFC-", or "HC-"), or manufacturer trade names. Nonstandard and pending designations generally are flagged as such or identified in notes included with the common uses.

The chemical formula indicates the molecular makeup of the single-compound refrigerants, namely those consisting of a single chemical substance. The blend composition is substituted for refrigerant blends, namely those consisting of two or more chemicals that are mixed to obtain desired characteristics. The composition consists of two parts. The first identifies the components, in order of increasing normal boiling points and separated by slashes. The second part, which is enclosed in parentheses, indicates the mass fractions (as percentages) of those components in the same order. The profiles also indicate alternative chemical names, the common and historic names, index numbers for common reference databases, empirical and structural chemical formulae, and standard container colors. Among the identifiers shown are the:

- standard designation following American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), Standard 34-1997 (*Designation and Safety Classification of Refrigerants*) as well as addenda, pending addenda (flagged), and common industry extensions to it (flagged),
- variants using the "R-", "R", "R ", composition-designating prefixes (for example "CFC-", "HCFC-", or "HFC-")
- common fluorochemical number and variants,
- halon number for chemicals also used or considered as fire suppressants,
- chemical name following the International Union of Pure and Applied Chemistry (IUPAC) convention,
- chemical name following other common conventions,
- common names,
- structural formula following the IUPAC convention,
- structural formula following other common conventions,
- empirical formula following the Hill convention,
- other formulae including some flagged as "not recommended" to enable location by them
• Chemical Abstracts Service (CAS) registry number,
• Beilstein registry number,
• European Inventory of Existing Chemical Substances (EINECS) number,
• Merck index (volume and number),
• National Institute of Occupational Safety and Health (NIOSH) Registry of Toxic Effects of Chemical Substances (RTECS) index number,
• trade name(s),
• historical name(s),
• names used for rule making notices for proprietary refrigerants in U.S. Environmental Protection Agency (EPA) Significant New Alternatives Program (SNAP) notices,
• standard container color name and Pantone number as assigned by Air-Conditioning and Refrigeration Institute (ARI) Guideline N (Assignment of Refrigeration Container Colors),
• composition for blends
• both mass and mole formulations for blends, and
• standard mass formulation tolerances for blends with ASHRAE safety classifications.

In some cases, primarily for proprietary blends, additional identifying information is included in the description of common uses.

**Common Uses**

The uses focus on application as refrigerants followed, if applicable, by terse indications of other applications if known. Limiting considerations such as toxicity, flammability, reactivity, or environmental concerns are cited for some substances.

This section also includes notes on pending changes in standard designations and safety classifications.

**Physical Properties**

The refrigerant profiles indicate key physical, thermodynamic, and transport properties at representative conditions, including the normal boiling point, 20 °C (68 °F), 60 °C (140 °F), and the critical point.
The molecular mass is a calculated value based on the atomic weights recognized by International Union of Pure and Applied Chemists (IUPAC). It indicates the mass in grams of a mole of the refrigerant or, for blends, the mass-weighted average of a mole of the mixture.

The normal boiling point (NBP) is the temperature at which liquid refrigerant will boil at standard atmospheric pressure, namely 101.325 kPa (14.6959 psia). The NBP and most dimensional units in the tables are shown in both metric (SI) and inch-pound units of measure. Both the bubble point (temperature at which a bubble first appears, hence the temperature at which boiling begins, for a blend) and dew point typically are shown for blends.

The critical temperature (T_c) is the temperature at the critical point of the refrigerant. The T_c values shown for blends are the mass weighted averages of the component T_c's unless actual values have been determined.

The critical pressure (P_c) is the pressure at the critical point.

The NBP and critical properties suggest the application range for which an individual refrigerant might be suitable. Those with extremely low NBP lend themselves to ultra-low temperature refrigeration, for example in cryogenic applications. Those with high NBPs generally are limited to high-temperature applications, such as for use in chillers or high-temperature heat pumps. Both capacity and efficiency decline in a typical vapor-compression (reverse Rankine) cycle, the one most commonly used, when condensing temperatures approach the T_c. The P_c will exceed the operating pressure, except in transcritical cycles, which are uncommon except for R-744 (carbon dioxide).

**Environmental Data**

The atmospheric lifetime (τ_atm) is an indication of the average persistence of the refrigerant, if released into the atmosphere, until it decomposes or reacts with other chemicals. The values shown are composite atmospheric lifetimes. Separate lifetimes also are shown if known for the tropospheric (lower atmosphere where we live), stratospheric (next layer where global depletion of ozone is a concern), and higher layers, since the atmospheric chemistry changes between layers.

The ozone depletion potential (ODP) is a normalized indicator, based on a value of 1.000 for R-11, of the ability of refrigerants (and other chemicals) to destroy stratospheric ozone molecules. The data shown are the modeled values adopted by the international scientific assessment. The ODPS shown for blends are mass-weighted averages. The values shown typically are modeled ODP values, the most indicative of environmental impacts. Semi-empirical ODP and regulatory values adopted in the Montreal Protocol also are indicated for some refrigerants.
The semi-empirical ODPs are calculated values that incorporate adjustments for observed atmospheric measurements. The concept is conceptually more accurate, but it is difficult to measure the data needed for representative adjustments accurately.

The regulatory values generally are required for specific purposes, but may not be updated with newer findings after adoption. The ODP values listed in the annexes to the Montreal Protocol, for example, have not been updated since 1987 for chlorofluorocarbons (CFCs) and 1992 for hydrochlorofluorocarbons (HCFCs). A note in the Protocol indicates that the values "are estimates based on existing knowledge and will be reviewed and revised periodically."

The global warming potential (GWP) is a similar indicator of the potency to warm the planet by action as a greenhouse gas. The values shown are relative to carbon dioxide (CO2) for an integration period of 100 yr. Both the ODP and GWP are calculated from the $\tau_{\text{atm}}$, measured chemical properties, and other atmospheric data. The GWPs shown for blends are mass-weighted averages.

The $\tau_{\text{atm}}$, ODP, and GWP values indicated for blends were calculated for the nominal blend compositions.

The database also indicates halocarbon global warming potential (HGWP) and photochemical reactivity at ground level if known.

**Safety Data**

The safety section is subdivided into classifications, recommended exposure limits, acute (short-term, single exposure) and chronic (long-term, repeated exposure) toxicity data, flammability data, and detection (appearance and odor) information. The exposure limits are further separated into short-term occupational, long-term occupational, and emergency exposures. Depending on the refrigerant, more than 100 parameters - some with differing values for species or exposure durations in toxicity tests - are reported. The following brief summary addresses only the chronic toxicity and flammability indices used to determine standard refrigerant safety classifications.

The first value is an occupational exposure limit, namely the Threshold Limit Value - Time Weighted Average (TLV-TWA) or a consistent measure. It is an indication of chronic (long-term, repeat exposure) toxicity of the refrigerant. Some of the consistent toxicity indices are the workplace Environmental Exposure Level (WEEL) guides and the Permissible Exposure Limit (PEL). These measures indicate adopted limits for workplace exposures for trained personnel for typical workdays and work weeks.
The Lower Flammability Limit (LFL) is the lowest concentration at which the refrigerant will burn in air under prescribed test conditions. It is an indication of flammability. The absence of an LFL or even an indication of nonflammable does not assure that a substance will not burn or exacerbate an existing fire under some conditions, such as when mixed with other fuels (such as lubricants) or at elevated pressures and temperatures.

The Heat of Combustion (HOC) is an indicator of how much energy the refrigerant will release when it burns in air, assuming complete reaction to the most stable products in their vapor state. Negative values indicate endothermic reactions (those that require heat to proceed) while positive values indicate exothermic reactions (those that liberate heat).

The ASHRAE Standard 34 safety group is an assigned classification that is based on the TLV-TWA (or consistent measure), LFL, and HOC. It comprises a letter (A or B) that indicates relative toxicity followed by a number (1, 2, or 3) that indicates relative flammability. These classifications are widely used in mechanical and fire construction codes, to determine requirements to promote safe use. Most of these code provisions are based on ASHRAE Standard 15, *Safety Code for Mechanical Refrigeration*.

**Production Data**

The final section of the refrigerant profiles indicates initial commercialization if known and the last year production is allowed in developed countries under the Montreal Protocol.
Refrigerant Profiles: Zeotropic Blends with Assigned Designations
R-400

R-400 R-12/114 (formulation must be indicated) see RDB#
zeotrope binary blend

COMMON USE(S)
industrial air conditioners usually for high-condensing temperatures such as crane-cab air conditioning in foundries; composition must be specified to determine properties

IDENTIFIERS

common name(s): R-400; R400; or R 400 (?/??) 2909
formulation must be indicated 2909
CFC/CFC-400 (?/??) 8601
not CFC-400 (?/??) 8601
CFC-12/CFC-114 (?/??) 8601
not CFC-12/114 (?/??) 8601
trade name(s): Allied Genetron(R) 12/114 mix MSDS
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

nominal blend formulation R-12/114 2909
composition: R-12/114 2909
component weight fractions: formulation must be indicated 2909
%

SAFETY

safety group (ASHRAE Standard 34): Al/Al 8601
NFPA 704 degrees of hazard (H-F-R-S): AlliedSignal: 2-0-0 MSDS
NPCA HMIS hazard ratings (H-F-R): health-flammability-reactivity
[-special]: 0=no, 4=severe
AlliedSignal: 2-0-0 MSDS
health-flammability-reactivity
0=insignificant, 4=extreme

long-term occupational limit none, components 1,000/1,000
OSHA PEL (permissible exposure limit): ppm v/v TWA for 8 hr/day and 3904
ppm v/v TWA for 8 hr/day and 40 hr/wk

flammability none (nonflammable as tested)
LFL-UFL (flammability limits in air): AlliedSignal: no flash point MSDS
flash point: AlliedSignal: not applicable MSDS
autodecomposition temperature: AlliedSignal: >250°C (>482°F) MSDS

detection
appearance: AlliedSignal: clear, colorless MSDS
odor: AlliedSignal: faint ethereal MSDS

PRODUCTION

last year production allowed: 1995 by components in developed countries under the Montreal Protocol 8C01
**R-400 (50.0/50.0)**

--- REFRIERANT DATA SUMMARY ---

**R-400(50/50) R-12/114 (50.0/50.0)**

<table>
<thead>
<tr>
<th>Zeretrope</th>
<th>Binary blend</th>
</tr>
</thead>
</table>

**COMMON USE(S)**

formerly used in industrial heat pumps with high-condensing temperatures

**IDENTIFIERS**

<table>
<thead>
<tr>
<th>common name(s):</th>
<th>R-400 (50.0/50.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R400 (50.0/50.0)</td>
</tr>
<tr>
<td></td>
<td>R 400 (50.0/50.0)</td>
</tr>
<tr>
<td></td>
<td>CFC/CFC-400 (50/50)</td>
</tr>
<tr>
<td></td>
<td>not CFC-400 (50/50)</td>
</tr>
<tr>
<td></td>
<td>CFC-12/CFC-114 (50/50)</td>
</tr>
<tr>
<td></td>
<td>not CFC-12/114 (50/50)</td>
</tr>
<tr>
<td></td>
<td>&quot;R-50/50&quot; (not a standard designation)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>trade name(s):</th>
<th>Allied Genetron(R) 12/114 mix</th>
</tr>
</thead>
</table>

**ARI container color / Pantone number:**

none, use light green grey/413 6601

**PHYSICAL**

- nominal blend formulation -------

<table>
<thead>
<tr>
<th>composition</th>
<th>R-12/114</th>
</tr>
</thead>
</table>

  | component weight fractions: | 50.0 / 50.0 % |
  | component mole fractions: | 58.568 / 41.432 % |

<table>
<thead>
<tr>
<th>molar mass:</th>
<th>141.63211 g/mol (0.312245 lb/mol)</th>
</tr>
</thead>
</table>

  | normal boiling point -----------
  | bubble point temperature: | -20.8 °C (-5.5 °F) |
  | dew point temperature: | -10.9 °C (12.4 °F) |
  | maximum temperature glide: | 9.95 °C (17.9 °F) |
  | density, saturated liquid: | 1517 kg/m3 (94.68 lb/cf) |
  | density, saturated vapor: | 6.82 kg/m3 (0.426 lb/cf) |
  | specific volume, saturated liquid: | 0.659 L/kg (0.0106 cf/lb) |
  | specific volume, saturated vapor: | 146.5 L/kg (2.3473 cf/lb) |
  | heat of vaporization: | 158.3 kJ/kg (68.0 Btu/lb) |
  | velocity of sound, saturated liquid: | 696 m/s (2284 ft/s) |
  | velocity of sound, saturated vapor: | 127 m/s (416 ft/s) |
  | viscosity, saturated liquid: | 371 µPa·s (0.371 cp) |
  | viscosity, saturated vapor: | 9.97 µPa·s (0.00997 cp) |
  | thermal conductivity, liquid: | 0.0772 W/m·K (0.0446 Btu/hr·ft°F) |
  | thermal conductivity, vapor: | 0.0083 W/m·K (0.0048 Btu/hr·ft°F) |

  | normal pressure, 20 °C (68 °F) ------
  | density, vapor: | 6.038 kg/m3 (0.3769 lb/cf) |

  | normal pressure, 21.1 °C (70 °F) ---
  | density, vapor: | 6.013 kg/m3 (0.3754 lb/cf) |

  | 20 °C (68 °F) ----------------------
  | pressure, liquid (bubble point): | 405.3 kPa (58.79 psia) |
  | pressure, vapor (dew point): | 310.3 kPa (45.00 psia) |

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
density, saturated liquid: 1392 kg/m³ (86.87 lb/ft³) 8401
density, saturated vapor: 19.63 kg/m³ (1.225 lb/ft³) 8401
specific volume, saturated liquid: 0.719 L/kg (0.0115 cf/lb) 8401
specific volume, saturated vapor: 51.0 L/kg (0.8162 cf/lb) 8401
velocity of sound, saturated liquid: 539 m/s (1770 ft/s) 8401
velocity of sound, saturated vapor: 128 m/s (421 ft/s) 8401
viscosity, saturated liquid: 234 μPa·s (0.234 cp) 8401
viscosity, saturated vapor: 11.1 μPa·s (0.0111 cp) 8401
thermal conductivity, saturated liquid: 0.0654 W/m·K (0.0378 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.00988 W/m·K (0.00571 Btu/hr·ft·°F) 8401

60 °C (140 °F) ---------------
power, liquid (bubble point): 1111 kPa (161.1 psia) 8401
pressure, vapor (dew point): 939 kPa (136.2 psia) 8401
heat of vaporization: 114.7 kJ/kg for liquid and 8401
vapor both at nominal 8401
composition (49.3 Btu/lb) 8401
94.0 kJ/kg coexisting liquid 8401
and vapor at bubble-point 8401
pressure (40.4 Btu/lb) 8401

critical point ---------------
temperature: 128.9 °C (264.0 °F) 8401
pressure: 3919 kPa (566.4 psia) 8401
density: 565 kg/m³ (35.3 lb/ft³) 8401
specific volume: 1.77 L/kg (0.0283 cf/lb) 8401

ENVIRONMENTAL
ODP (ozone depletion potential): 0.835 mass-weighted average 9501
(model-derived relative to R 11) 9501
0.875 mass-weighted average 9501
(semi-empirical relative to R 11) 9501
GWP (global warming potential): 10,200 mass-weighted average 9501
relative to CO₂ for 100 yr 9501
integration
HGWP (halocarbon GWP): 5.1 mass-weighted average DW
relative to R 11 for infinite 8401
integration period

SAFETY

- classification ------------
safety group (ASHRAE Standard 34): A1/A1 8601
NFPA 704 degrees of hazard (H-F-R-S): AlliedSignal: 2-0-0 8401
NFPA (halocarbon GWP):
NPCA HMIS hazard ratings (H-F-R): MSDS
health-flammability-reactivity
[-special]: 0=no, 4=severe
AlliedSignal: 2-0-0 8401
health-flammability-reactivity
0=insignificant, 4=extreme

- long-term occupational limit ------
OSHA PEL (permissible exposure limit): none, components 1,000/1,000 3904
ppm v/v TWA for 8 hr/day and 40 hr/wk

- emergency exposure limit --------
Refrigerant Concentration Limit (RCL): 28,000 ppm v/v (preliminary 8401
value under review, based on draft ASHRAE 34aa)
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFL-UFL (flammability limits in air)</td>
<td>none (nonflammable as tested)</td>
</tr>
<tr>
<td>Flash point</td>
<td>AlliedSignal: no flash point MSDS</td>
</tr>
<tr>
<td>Autodecomposition temperature</td>
<td>AlliedSignal: not applicable MSDS</td>
</tr>
<tr>
<td>• detection</td>
<td>AlliedSignal: &gt;250°C (&gt;482°F) MSDS</td>
</tr>
<tr>
<td>Appearance</td>
<td>AlliedSignal: clear, colorless MSDS</td>
</tr>
<tr>
<td>Odor</td>
<td>AlliedSignal: faint ethereal MSDS</td>
</tr>
</tbody>
</table>

**Production**

Last year production allowed: 1995 by components in developed countries under the Montreal Protocol.

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-400 (60.0/40.0)

**REFRIGERANT DATA SUMMARY**

- R-400 (60.0/40.0)
- R400 (60.0/40.0)
- R 400 (60.0/40.0)
- CFC/CFC-400 (60/40)
- not CFC-400 (60/40)
- CFC-12/CFC-114 (60/40)
- not CFC-12/114 (60/40)
- "R-60/40" (not a standard designation)

**COMMON USE(S)**

Industrial air conditioners usually for high-condensing temperatures such as crane-cab air conditioning in foundries.

**IDENTIFIERS**

- **common name(s):** R-400 (60.0/40.0), R400 (60.0/40.0), R 400 (60.0/40.0), CFC/CFC-400 (60/40), not CFC-400 (60/40), CFC-12/CFC-114 (60/40), not CFC-12/114 (60/40), "R-60/40" (not a standard designation)
- **trade name(s):** Allied Genetron(R) 12/114 mix
- **MSDS**
- **ARI container color / Pantone number:** none, use light green grey/413 6601

**PHYSICAL**

- **nominal blend formulation ---------**
  - **composition:** R-12/114
  - **component weight fractions:** 60.0 / 40.0 %
  - **component mole fractions:** 67.953 / 32.047 %
- **properties ------------------------**
  - **molar mass:** 136.93903 g/mol (0.301899 lb/mol)
- **normal boiling point ---------------**
  - **bubble point temperature:** -23.2 °C (-9.7 °F)
  - **dew point temperature:** -14.1 °C (6.7 °F)
  - **maximum temperature glide:** 9.08 °C (16.3 °F)
  - **density, saturated liquid:** 1511 kg/m³ (94.34 lb/ft³)
  - **density, saturated vapor:** 6.68 kg/m³ (0.417 lb/ft³)
  - **specific volume, saturated liquid:** 0.662 L/kg (0.0106 cf/lb)
  - **specific volume, saturated vapor:** 149.7 L/kg (2.3983 cf/lb)
  - **heat of vaporization:** 160.5 kJ/kg (69.0 Btu/lb)
  - **velocity of sound, saturated liquid:** 704 m/s (2308 ft/s)
  - **velocity of sound, saturated vapor:** 133 m/s (435 ft/s)
  - **viscosity, saturated liquid:** 366 µPa·s (0.336 cp)
  - **viscosity, saturated vapor:** 9.93 µPa·s (0.00993 cp)
  - **thermal conductivity, liquid:** 0.0792 W/m·K (0.0457 Btu/hr·ft·°F)
  - **thermal conductivity, vapor:** 0.0081 W/m·K (0.0047 Btu/hr·ft·°F)
- **normal pressure, 20 °C (68 °F) -------**
  - **density, vapor:** 5.831 kg/m³ (0.3640 lb/ft³)
- **normal pressure, 21.1 °C (70 °F) ---**
  - **density, vapor:** 5.807 kg/m³ (0.3625 lb/ft³)
- **20 °C (68 °F) ------------------------**
  - **pressure, liquid (bubble point):** 441.0 kPa (63.96 psia)
  - **pressure, vapor (dew point):** 347.9 kPa (50.45 psia)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>density, saturated liquid</td>
<td>1378 kg/m³ (86.03 lb/cf)</td>
<td></td>
</tr>
<tr>
<td>density, saturated vapor</td>
<td>21.42 kg/m³ (1.337 lb/cf)</td>
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<tr>
<td>specific volume, saturated liquid</td>
<td>0.726 L/kg (0.0116 cf/lb)</td>
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<tr>
<td>specific volume, saturated vapor</td>
<td>46.7 L/kg (0.7479 cf/lb)</td>
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<tr>
<td>velocity of sound, saturated liquid</td>
<td>536 m/s (1760 ft/s)</td>
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<tr>
<td>velocity of sound, saturated vapor</td>
<td>130 m/s (427 ft/s)</td>
<td></td>
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<tr>
<td>viscosity, saturated liquid</td>
<td>226 μPa·s (0.226 cp)</td>
<td></td>
</tr>
<tr>
<td>viscosity, saturated vapor</td>
<td>11.2 μPa·s (0.0112 cp)</td>
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<tr>
<td>thermal conductivity, saturated liquid</td>
<td>0.0661 W/m·K (0.0382 Btu/hr·ft·°F)</td>
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<tr>
<td>thermal conductivity, saturated vapor</td>
<td>0.00988 W/m·K (0.00571 Btu/hr·ft·°F)</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure, liquid (bubble point)</td>
<td>1200 kPa (174.0 psia)</td>
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</tr>
<tr>
<td>Pressure, vapor (dew point)</td>
<td>1035 kPa (150.2 psia)</td>
<td></td>
</tr>
<tr>
<td>Heat of vaporization</td>
<td>114.9 kJ/kg for liquid and vapor</td>
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</tr>
<tr>
<td>composition (49.4 Btu/lb)</td>
<td>96.9 kJ/kg coexisting liquid and</td>
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<tr>
<td>vapor at bubble-point pressure (41.7 Btu/lb)</td>
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<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Critical point</td>
<td></td>
<td></td>
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<tr>
<td>Temperature</td>
<td>125.4 °C (257.7 °F)</td>
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<tr>
<td>Pressure</td>
<td>3993 kPa (579.1 psia)</td>
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<tr>
<td>Density</td>
<td>564 kg/m³ (35.2 lb/cf)</td>
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**ENVIRONMENTAL**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
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<tbody>
<tr>
<td>ODF (ozone depletion potential)</td>
<td>0.832 mass-weighted average</td>
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<tr>
<td>model-derived relative to R 11</td>
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<tr>
<td>GWP (global warming potential)</td>
<td>10,280 mass-weighted average</td>
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<tr>
<td>relative to CO₂ for 100 yr integration</td>
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<tr>
<td>HGWP (halocarbon GWP)</td>
<td>4.7 mass-weighted average</td>
<td>DW</td>
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<tr>
<td>relative to R 11 for infinite integration period</td>
<td></td>
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**SAFETY**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Classification</td>
<td>Al/Al</td>
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<tr>
<td>Safety group (ASHRAE Standard 34)</td>
<td>AlliedSignal: 2-0-0</td>
<td>MSDS</td>
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<tr>
<td>NFPA 704 degrees of hazard (H-F-R-S)</td>
<td>health-flammability-reactivity</td>
<td></td>
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<tr>
<td>NPCA HMIS hazard ratings (H-F-R)</td>
<td>[-special]: 0=no, 4=severe</td>
<td></td>
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<td></td>
<td>AlliedSignal: 2-0-0</td>
<td>MSDS</td>
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<tr>
<td></td>
<td>health-flammability-reactivity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0=insignificant, 4=extreme</td>
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<tr>
<td>Long-term occupational limit</td>
<td>none, components 1,000/1,000 ppm v/v</td>
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<tr>
<td>OSHA PEL (permissible exposure limit)</td>
<td>TWA for 8 hr/day and 40  hr/wk</td>
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<tr>
<td>Emergency exposure limit</td>
<td>30,000 ppm v/v (preliminary</td>
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<tr>
<td>Refrigerant Concentration Limit (RCL)</td>
<td>value under review, based on</td>
<td></td>
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<tr>
<td></td>
<td>draft ASHRAE 34aa)</td>
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<tr>
<td>Flammability</td>
<td>Elf Atochem: nonflammable</td>
<td></td>
</tr>
<tr>
<td>LFL-UFL (flammability limits in air)</td>
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</table>

**SEE DATA LIMITATIONS AND NOTES ON PAGE 2**
<table>
<thead>
<tr>
<th>Property</th>
<th>AlliedSignal:</th>
<th>Elf Atochem:</th>
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<tbody>
<tr>
<td>flash point</td>
<td>no flash point</td>
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</tr>
<tr>
<td>autodecomposition temperature</td>
<td>not applicable</td>
<td>&gt;427 °C (&gt;800 °F)</td>
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<tr>
<td>detection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>appearance</td>
<td>clear, colorless</td>
<td></td>
</tr>
<tr>
<td>odor</td>
<td>Elf Atochem: faint ether-like</td>
<td></td>
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</table>

**PRODUCTION**

last year production allowed: 1995 by components in developed countries under the Montreal Protocol
R-401A

--- REFRIGERANT DATA SUMMARY ---

R-401A  R-22/152a/124 (53.0/13.0/34.0)  see RDB#
zeotrope  ternary blend  ----

COMMON USE(S)
medium-temperature refrigeration systems, including commercial refrigeration and home refrigerators, primarily for aftermarket use to service or retrofit existing equipment as an alternative for refrigerant 12; comparable capacities and efficiencies are expected at evaporator temperatures of -23 °C (-10 °F) and above

IDENTIFIERS

common name(s):  R-401A; R401A; R 401A  3B01
not HCFC-401A  3B01
trade name(s):  AlliedSignal Genetron[R] MP39  MSDS
DuPont Suva(R) MP39  3441
ICI R-401A  CSDS
ARI container color / Pantone number:  pinkish-red (coral) / 177  6601

PHYSICAL

nominal blend formulation --------
composition:  R-22/152a/124  3B01
component weight fractions:  53.0 / 13.0 / 34.0 %  3B01
component weight tolerances:  ±2.0 / ±0.5,-1.5 / ±1.0  3B01
component mole fractions:  57.885 / 18.587 / 23.527 %  8820

properties ---------------
molar mass:  94.43835 g/mol (0.208201 lb/mol)  8820

normal boiling point --------
bubble point temperature:  -34.4 °C (-30.0 °F)  8401
dew point temperature:  -28.8 °C (-19.9 °F)  8401
maximum temperature glide:  5.58 °C (10.0 °F)  8401
density, saturated liquid:  1367 kg/m³ (85.33 lb/cf)  8401
density, saturated vapor:  4.89 kg/m³ (0.306 lb/cf)  8401
specific volume, saturated liquid:  0.732 L/kg (0.0117 cf/lb)  8401
specific volume, saturated vapor:  204.3 L/kg (3.2731 cf/lb)  8401
heat of vaporization:  226.6 kJ/kg (97.4 Btu/lb)  8401
velocity of sound, saturated liquid:  807 m/s (2647 ft/s)  8401
velocity of sound, saturated vapor:  154 m/s (504 ft/s)  8401
viscosity, saturated liquid:  353 μPa·s (0.353 cp)  8401
viscosity, saturated vapor:  9.87 μPa·s (0.00987 cp)  8401
thermal conductivity, liquid:  0.1042 W/m·K (0.0602 Btu/hr·ft·°F)  8401
thermal conductivity, vapor:  0.0079 W/m·K (0.0046 Btu/hr·ft·°F)  8401

normal pressure, 20 °C (68 °F) -----
density, vapor:  4.003 kg/m³ (0.2499 lb/cf)  8401

normal pressure, 21.1 °C (70 °F) ---
density, vapor:  3.987 kg/m³ (0.2489 lb/cf)  8401

20 °C (68 °F) ------------------------
pressure, liquid (bubble point):  707.6 kPa (102.63 psia)  8401
pressure, vapor (dew point):  618.8 kPa (89.75 psia)  8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
density, saturated liquid: 1199 kg/m³ (74.85 lb/cf) 8401
density, saturated vapor: 27.57 kg/m³ (1.721 lb/cf) 8401
specific volume, saturated liquid: 0.834 L/kg (0.0134 cf/lb) 8401
specific volume, saturated vapor: 36.3 L/kg (0.5810 cf/lb) 8401
velocity of sound, saturated liquid: 560 m/s (1837 ft/s) 8401
velocity of sound, saturated vapor: 155 m/s (508 ft/s) 8401
viscosity, saturated liquid: 186 μPa·s (0.186 cp) 8401
viscosity, saturated vapor: 11.9 μPa·s (0.0119 cp) 8401
thermal conductivity, saturated liquid: 0.0818 W/m·K (0.0472 Btu/hr·ft²°F) 8401
thermal conductivity, saturated vapor: 0.01138 W/m·K (0.00657 Btu/hr·ft²°F) 8401

・60 °C (140 °F) --------------------
pressure, liquid (bubble point): 1918 kPa (278.2 psia) 8401
pressure, vapor (dew point): 1772 kPa (257.1 psia) 8401
heat of vaporization:

・critical point -------------------
temperature: 105.3 °C (221.5 °F) 8401
pressure: 4613 kPa (669.1 psia) 8401
density: 495 kg/m³ (30.9 lb/cf) 8401
specific volume: 2.02 L/kg (0.0324 cf/lb) 8401

ENVIRONMENTAL
ODP (ozone depletion potential): 0.027 mass-weighted average (model-derived relative to R 11) 9501
GWP (global warming potential): 1240 mass-weighted average relative to CO₂ for 100 yr integration 9501
HGWP (halocarbon GWP): 0.20 mass-weighted average relative to R 11 for infinite integration period 7214

SAFETY
・classification -------------------
safety group (ASHRAE Standard 34): A1/A1 8601
NFPA 704 degrees of hazard (H-F-R-S): AlliedSignal: 2-0-1
NPCA HMIS hazard ratings (H-F-R): DuPont: 1-0-1
health-flammability-reactivity
[−special]: 0=no, 4=severe
AlliedSignal: 1-0-1
DuPont: 1-0-1
health-flammability-reactivity
0=insignificant, 4=extreme

・long-term occupational limit -------
exposure limit consistent to OSHA PEL: DuPont estimated AEL: 1000 ppm MSDS
refrigerant concentration limit (RCL): v/v TWA for 8 hr/day and 40 hr/wk

・emergency exposure limit -------
Refrigerant Concentration Limit (RCL): 20,000 ppm v/v (preliminary
· flammability ---------------------
  LFL-UFL (flammability limits in air):
  flash point:
  autoignition temperature:
  autodecomposition temperature:
  former UL Classification:

  value under review, based on
  draft ASHRAE 34aa)

  none (nonflammable as tested) 3441
  AlliedSignal: not applicable   MSDS
  TOC, DuPont: will not burn     MSDS
  681 °C (1258 °F)               5931
  AlliedSignal: >250°C (>482°F)  MSDS
  practically nonflammable       5931

  (withdrawn for revision of the
  classification system,
  category SBQT2)

· detection -----------------------
  appearance:
  odor:

  DuPont: clear, colorless       MSDS
  AlliedSignal: faint ethereal   MSDS

PRODUCTION

  first commercial use as a refrigerant: 1992
  last year production allowed: 2029 by refrigerants 22, 124 8C01

  in developed countries under
  the Montreal Protocol
R-401B

--- REFRIGERANT DATA SUMMARY ---

- R-401B R-22/152a/124 (61.0/11.0/28.0) see RDB#
- zeotrope ternary blend

COMMON USE(S)
- low-temperature refrigeration systems with evaporator temperatures below -23 °C (-10 °F), including commercial and transport refrigeration as well as home freezers, primarily for aftermarket use to service or retrofit existing equipment as an alternative for refrigerants 12 and 500

IDENTIFIERS
- common name(s): R-401B; R401B; R 401B 3B01
- HCFC/HFC/HCFC-401B 3B01
- not HCFC-401B 3B01
- trade name(s): AlliedSignal Genetron(R) MP66 MSDS
- DuPont Suva(R) MP66 3441
- ARI container color / Pantone number: yellow-brown (mustard) / 124 6601

PHYSICAL
- nominal blend formulation -------
  - composition: R-22/152a/124 3B01
  - component weight fractions: 61.0 / 11.0 / 28.0 % 3B01
  - component weight tolerances: ±2.0 / ±0.5, -1.5 / ±1.0 3B01
  - component mole fractions: 65.492 / 15.461 / 19.047 % 8820
- properties ------------------------
  - molar mass: 92.83607 g/mol (0.204668 lb/mol) 8820

  - normal boiling point ----------
    - bubble point temperature: -35.7 °C ( -32.3 °F) 8401
    - dew point temperature: -30.8 °C ( -23.4 °F) 8401
    - maximum temperature glide: 4.94 °C (8.9 °F) 8401
    - density, saturated liquid: 1373 kg/m3 (85.69 lb/cf) 8401
    - density, saturated vapor: 4.85 kg/m3 (0.303 lb/cf) 8401
    - specific volume, saturated liquid: 0.728 L/kg (0.0117 cf/lb) 8401
    - specific volume, saturated vapor: 206.3 L/kg (3.3044 cf/lb) 8401
    - heat of vaporization: 228.3 kJ/kg (98.1 Btu/lb) 8401
    - velocity of sound, saturated liquid: 815 m/s (2672 ft/s) 8401
    - velocity of sound, saturated vapor: 158 m/s (518 ft/s) 8401
    - viscosity, saturated liquid: 352 µPa·s (0.352 cp) 8401
    - viscosity, saturated vapor: 9.81 µPa·s (0.00981 cp) 8401
    - thermal conductivity, liquid: 0.1058 W/m·K (0.0611 Btu/hr·ft·°F) 8401
    - thermal conductivity, vapor: 0.0077 W/m·K (0.0045 Btu/hr·ft·°F) 8401

- normal pressure, 20 °C (68 °F) ----- density, vapor:
  - normal pressure, 21.1 °C (70 °F) --- density, vapor:
  - 20 °C (68 °F) ---------------------
    - pressure, liquid (bubble point): 744.2 kPa (107.93 psia) 8401
    - pressure, vapor (dew point): 662.2 kPa (96.04 psia) 8401
    - density, saturated liquid: 1199 kg/m3 (74.86 lb/cf) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
density, saturated vapor: 29.16 kg/m³ (1.820 lb/ft³) 8401
specific volume, saturated liquid: 0.834 L/kg (0.0134 cf/lb) 8401
specific volume, saturated vapor: 34.3 L/kg (0.5494 cf/lb) 8401
velocity of sound, saturated liquid: 560 m/s (1838 ft/s) 8401
velocity of sound, saturated vapor: 156 m/s (512 ft/s) 8401
viscosity, saturated liquid: 184 µPa·s (0.184 cp) 8401
viscosity, saturated vapor: 12.0 µPa·s (0.0120 cp) 8401
thermal conductivity, saturated liquid: 0.0824 W/m·K (0.0476 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01128 W/m·K (0.00652 Btu/hr·ft·°F) 8401

- 60 °C (140 °F) ---------------------
power, liquid (bubble point): 2009 kPa (291.4 psia) 8401
pressure, vapor (dew point): 1876 kPa (272.1 psia) 8401
heat of vaporization: 144.3 kJ/kg for liquid and vapor both at nominal composition (62.0 Btu/lb) 8401
133.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (57.5 Btu/lb) 8401

critical point ---------------------
temperature: 103.5 °C (218.3 °F) 8401
pressure: 4682 kPa (679.1 psia) 8401
density: 498 kg/m³ (31.1 lb/cf) 8401
specific volume: 2.01 L/kg (0.0322 cf/lb) 8401

ENVIRONMENTAL
ODP (ozone depletion potential): 0.028 mass-weighted average (model-derived relative to R 11) 5301
0.038 mass-weighted average (semi-empirical relative to R 11) 9501

GWP (global warming potential): 1350 mass-weighted average relative to CO₂ for 100 yr integration 9501
HGWP (halocarbon GWP): 0.22 mass-weighted average relative to R 11 for infinite integration period 7214
0.24 relative to R 11 for infinite integration period 7214

SAFETY
- classification ---------------------
safety group (ASHRAE Standard 34): Al/A1 8601
NFPA 704 degrees of hazard (H-F-R-S): AlliedSignal: 2-0-1 MSDS
health-flammability-reactivity [-special]: 0=no, 4=severe AlliedSignal: 1-0-1 MSDS
0=insignificant, 4=extreme DuPont: 1-0-1 MSDS
health-flammability-reactivity 0=insignificant, 4=extreme 8601
NPCA HMIS hazard ratings (H-F-R): DuPont estimated AEL: 1000 ppm MSDS v/v TWA for 8 hr/day and 40 hr/wk

- long-term occupational limit -------
exposure limit consistent to OSHA PEL: DuPont estimated AEL: 1000 ppm MSDS v/v TWA for 8 hr/day and 40 hr/wk

- emergency exposure limit ----------

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
Refrigerant Concentration Limit (RCL): 21,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

flammability ------------------------
LFL-UFL (flammability limits in air): none (nonflammable as tested) 3441
heat of combustion (by ASHRAE 34-92): -2.7 MJ/kg (~1170 Btu/lb) UL
flash point: AlliedSignal: not applicable MSDS
autoignition temperature: TOC, DuPont: will not burn MSDS
685 °C (1265 °F) 5931
autodecomposition temperature: AlliedSignal: >250°C (>482°F) MSDS
former UL Classification: practically nonflammable 5931
(withdrawn for revision of the classification system, category SBQT2)

detection -------------------------
appearance: DuPont: clear, colorless MSDS
odor: AlliedSignal: faint ethereal MSDS

PRODUCTION
first commercial use as a refrigerant: 1992
last year production allowed: 2029 by refrigerants 22, 124 8C01
in developed countries under the Montreal Protocol
### R-401C

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**R-401C**

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**REFRIGERANT DATA SUMMARY**

<table>
<thead>
<tr>
<th>R-401C</th>
<th>R-22/152a/124 (33.0/15.0/52.0)</th>
<th>see</th>
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</thead>
<tbody>
<tr>
<td>zeotrope</td>
<td>ternary blend</td>
<td>RDB#</td>
</tr>
</tbody>
</table>

**COMMON USE(S)**

- automobile air conditioners and other mobile air-conditioning (MAC) systems, primarily for aftermarket use to service or retrofit existing equipment as an alternative for refrigerant 12

**IDENTIFIERS**

- common name(s): R-401C; R401C; R 401C 3B01
- HCFC/HFC/HCFC-401C 3B01
- not HCFC-401C 3B01
- trade name(s): DuPont Suva(R) MP52 3441
- ARI container color / Pantone number: blue-green (aqua) / 3268 6601

**PHYSICAL**

**nominal blend formulation**

- composition: R-22/152a/124 3B01
- component weight fractions: 33.0 / 15.0 / 52.0 % 3B01
- component weight tolerances: ±2.0 / +0.5, -1.5 / ±1.0 3B01
- component mole fractions: 38.559 / 22.945 / 38.496 % 8820

**properties**

- molar mass: 101.03413 g/mol (0.222742 lb/mol) 8820
- normal boiling point
  - bubble point temperature: -30.5 °C (-23.0 °F) 8401
  - dew point temperature: -23.8 °C (-10.9 °F) 8401
  - maximum temperature glide: 6.70 °C (12.1 °F) 8401
  - density, saturated liquid: 1369 kg/m³ (85.49 lb/cf) 8401
  - density, saturated vapor: 5.14 kg/m³ (0.321 lb/cf) 8401
  - specific volume, saturated liquid: 0.730 L/kg (0.0117 cf/lb) 8401
  - specific volume, saturated vapor: 194.6 L/kg (3.1177 cf/lb) 8401
  - heat of vaporization: 217.3 kJ/kg (93.4 Btu/lb) 8401
  - velocity of sound, saturated liquid: 781 m/s (2561 ft/s) 8401
  - velocity of sound, saturated vapor: 155 m/s (508 ft/s) 8401
  - viscosity, saturated liquid: 359 μPa·s (0.359 cp) 8401
  - viscosity, saturated vapor: 9.92 μPa·s (0.00992 cp) 8401
  - thermal conductivity, liquid: 0.0989 W/m·K (0.0572 Btu/hr·ft°F) 8401
  - thermal conductivity, vapor: 0.0084 W/m·K (0.0049 Btu/hr·ft°F) 8401
- normal pressure, 20 °C (68 °F) density, vapor: 4.291 kg/m³ (0.2679 lb/cf) 8401
- normal pressure, 21.1 °C (70 °F) density, vapor: 4.274 kg/m³ (0.2668 lb/cf) 8401
- 20 °C (68 °F) pressure, liquid (bubble point): 611.1 kPa (88.63 psia) 8401
- pressure, vapor (dew point): 516.5 kPa (74.91 psia) 8401
- density, saturated liquid: 1216 kg/m³ (75.89 lb/cf) 8401
- density, saturated vapor: 24.31 kg/m³ (1.517 lb/cf) 8401
- specific volume, saturated liquid: 0.823 L/kg (0.0132 cf/lb) 8401
- specific volume, saturated vapor: 41.1 L/kg (0.6590 cf/lb) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Velocity of sound, saturated liquid</td>
<td>557 m/s (1826 ft/s)</td>
<td>8401</td>
</tr>
<tr>
<td>Velocity of sound, saturated vapor</td>
<td>150 m/s (491 ft/s)</td>
<td>8401</td>
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<tr>
<td>Viscosity, saturated liquid</td>
<td>195 μPa·s (0.195 cp)</td>
<td>8401</td>
</tr>
<tr>
<td>Viscosity, saturated vapor</td>
<td>11.7 μPa·s (0.0117 cp)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated liquid</td>
<td>0.0793 W/m·K (0.0458 Btu/hr·ft°F)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01157 W/m·K (0.00669 Btu/hr·ft°F)</td>
<td>8401</td>
</tr>
<tr>
<td>60 °C (140 °F)</td>
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<tr>
<td>Pressure, liquid (bubble point)</td>
<td>1679 kPa (243.5 psi)</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure, vapor (dew point)</td>
<td>1517 kPa (220.0 psi)</td>
<td>8401</td>
</tr>
<tr>
<td>Heat of vaporization</td>
<td>143.2 kJ/kg for liquid and vapor both at nominal composition (61.6 Btu/lb)</td>
<td>8401</td>
</tr>
<tr>
<td></td>
<td>126.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.2 Btu/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Critical point</td>
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<tr>
<td>Temperature</td>
<td>109.9 °C (229.8 °F)</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure</td>
<td>4402 kPa (638.5 psi)</td>
<td>8401</td>
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<tr>
<td>Density</td>
<td>497 kg/m³ (31.0 lb/ft³)</td>
<td>8401</td>
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<tr>
<td>Specific volume</td>
<td>2.01 L/kg (0.0323 ft³/lb)</td>
<td>8401</td>
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</tbody>
</table>

**ENVIRONMENTAL**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODP (ozone depletion potential)</td>
<td>0.025 mass-weighted average (model-derived relative to R 11)</td>
<td>9501</td>
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<tr>
<td></td>
<td>0.030 mass-weighted average (semi-empirical relative to R 11)</td>
<td>9501</td>
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<tr>
<td>GWP (global warming potential)</td>
<td>980 mass-weighted average relative to CO2 for 100 yr integration</td>
<td>9501</td>
</tr>
<tr>
<td>HGWP (halocarbon GWP)</td>
<td>0.16 mass-weighted average relative to R 11 for infinite integration period</td>
<td>DW</td>
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</tbody>
</table>

**SAFETY**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Page</th>
</tr>
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<tbody>
<tr>
<td>Safety group (ASHRAE Standard 34)</td>
<td>A1/A1</td>
<td>8601</td>
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<tr>
<td>Long-term occupational limit</td>
<td>DuPont: components are 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk</td>
<td>MSDS</td>
</tr>
<tr>
<td>Exposure limit consistent to OSHA PEL</td>
<td>DuPont: will not burn</td>
<td>MSDS</td>
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<tr>
<td>Emergency exposure limit</td>
<td>17,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)</td>
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</tr>
<tr>
<td>Refrigerant Concentration Limit (RCL)</td>
<td>none (nonflammable as tested)</td>
<td>3441</td>
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<tr>
<td></td>
<td>TOC, DuPont: slightly ethereal</td>
<td>MSDS</td>
</tr>
<tr>
<td>Flammability</td>
<td>DuPont: clear, colorless</td>
<td>MSDS</td>
</tr>
<tr>
<td>LFL-UFL (flammability limits in air)</td>
<td>DuPont: will not burn</td>
<td>MSDS</td>
</tr>
<tr>
<td>Flash point</td>
<td>DuPont: slightly ethereal</td>
<td>MSDS</td>
</tr>
<tr>
<td>Detection</td>
<td>DuPont: clear, colorless</td>
<td>MSDS</td>
</tr>
<tr>
<td>Appearance</td>
<td>DuPont: slightly ethereal</td>
<td>MSDS</td>
</tr>
<tr>
<td>Odor</td>
<td>DuPont: clear, colorless</td>
<td>MSDS</td>
</tr>
</tbody>
</table>

**PRODUCTION**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>First commercial use as a refrigerant</td>
<td>2029 by refrigerants 22, 124</td>
<td>8C01</td>
</tr>
<tr>
<td>Last year production allowed</td>
<td>Not known to be commercialized in developed countries under</td>
<td></td>
</tr>
</tbody>
</table>
the Montreal Protocol
R-402A

--- REFRIGERANT DATA SUMMARY ---

R-402A  R-125/290/22 (60.0/2.0/38.0)  see
zeotrope   ternary blend  RDB#

COMMON USE(S)
low- and medium-temperature commercial and transport refrigeration
equipment, primarily for service or retrofit of existing equipment as
an alternative for refrigerant 502; typically offers improved
capacity, slightly lower efficiency, and similar discharge
temperature compared to that refrigerator

IDENTIFIERS

common name(s):  R-402A; R402A; R 402A  3B01
                HFC/HC/HCFC-402A  3B01
                not HCFC-402A  3B01
trade name(s):  AlliedSignal Genetron(R) HP80  MSDS
                 DuPont Suva(R) HP80  3C02
                 ICI Arcon(R) 402A  CSDS
ARI container color / Pantone number:  light brown (sand) / 461  6601

PHYSICAL

nominal blend formulation

composition:  R-125/290/22  3B01
component weight fractions:  60.0 / 2.0 / 38.0 %  3B01
component weight tolerances:  ±1.0 / ±1.0 / ±2.0  3B01
component mole fractions:  50.766 / 4.606 / 44.628 %  8820

properties

molar mass:  101.55014 g/mol (0.223880 lb/mol)  8820

normal boiling point

bubble point temperature:  -49.2 °C (-56.5 °F)  8401
dew point temperature:  -47.0 °C (-52.7 °F)  8401
maximum temperature glide:  2.11 °C (3.8 °F)  8401
density, saturated liquid:  1431 kg/m3 (89.31 lb/cf)  8401
density, saturated vapor:  5.70 kg/m3 (0.356 lb/cf)  8401
specific volume, saturated liquid:  0.699 L/kg (0.0112 cf/lb)  8401
specific volume, saturated vapor:  175.5 L/kg (2.8104 cf/lb)  8401
heat of vaporization:  194.3 kJ/kg (83.5 Btu/lb)  8401
velocity of sound, saturated liquid:  773 m/s (2536 ft/s)  8401
velocity of sound, saturated vapor:  142 m/s (464 ft/s)  8401
viscosity, saturated liquid:  370 µPa·s (0.370 cp)  8401
viscosity, saturated vapor:  9.50 µPa·s (0.00950 cp)  8401
thermal conductivity, liquid:  0.1014 W/m·K (0.0586 Btu/hr·ft·°F)  8401
thermal conductivity, vapor:  0.0078 W/m·K (0.0045 Btu/hr·ft·°F)  8401

normal pressure, 20 °C (68 °F)

density, vapor:  4.288 kg/m3 (0.2677 lb/cf)  8401

normal pressure, 21.1 °C (70 °F)

density, vapor:  4.271 kg/m3 (0.2666 lb/cf)  8401

20 °C (68 °F)

pressure, liquid (bubble point):  1185.4 kPa (171.93 psia)  8401
pressure, vapor (dew point):  1149.0 kPa (166.65 psia)  8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
### Refrigerant Database

**Density, Saturated Liquid:** 1168 kg/m³ (72.94 lb/cf) 8401  
**Density, Saturated Vapor:** 60.64 kg/m³ (3.786 lb/cf) 8401  
**Specific Volume, Saturated Liquid:** 0.856 L/kg (0.0137 cf/lb) 8401  
**Specific Volume, Saturated Vapor:** 16.5 L/kg (0.2642 cf/lb) 8401  
**Velocity of Sound, Saturated Liquid:** 425 m/s (1395 ft/s) 8401  
**Velocity of Sound, Saturated Vapor:** 137 m/s (449 ft/s) 8401  
**Viscosity, Saturated Liquid:** 150 µPa·s (0.150 cp) 8401  
**Viscosity, Saturated Vapor:** 12.9 µPa·s (0.0129 cp) 8401  
**Thermal Conductivity, Saturated Liquid:** 0.0694 W/m·K (0.0401 Btu/hr·ft·°F)  
**Thermal Conductivity, Saturated Vapor:** 0.01300 W/m·K (0.00751 Btu/hr·ft·°F)  

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
<th>Unit</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 °C (140 °F)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure, Liquid (Bubble Point)</td>
<td>3049 kPa (442.2 psia)</td>
<td></td>
<td>8401</td>
</tr>
<tr>
<td>Pressure, Vapor (Dew Point)</td>
<td>3008 kPa (436.3 psia)</td>
<td></td>
<td>8401</td>
</tr>
<tr>
<td>Heat of Vaporization</td>
<td>84.9 kJ/kg for liquid and vapor both at nominal composition (36.5 Btu/lb)</td>
<td></td>
<td>8401</td>
</tr>
<tr>
<td></td>
<td>84.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (36.4 Btu/lb)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Critical Point**  
**Temperature:**  
75.5 °C (167.9 °F) 3437  
76.0 °C (168.9 °F) 8401  
**Pressure:**  
4135 kPa (599.7 psia) 3437  
4234 kPa (614.1 psia) 8401  
**Density:**  
542 kg/m³ (33.8 lb/cf) 3437  
544 kg/m³ (34.0 lb/cf) 8401  
**Specific Volume:**  
1.84 L/kg (0.0294 cf/lb) 8401  
1.85 L/kg (0.0296 cf/lb) 3437  

**Environmental**  
**ODP (Ozone Depletion Potential):** 0.013 mass-weighted average (model-derived relative to R 11) 9501  
**GWP (Global Warming Potential):** 3000 mass-weighted average relative to CO₂ for 100 yr integration 9501  
**HGWP (Halocarbon GWP):** 0.51 mass-weighted average relative to R 11 for infinite integration period DW  

**Safety**  
**Classification**  
**Safety Group (ASHRAE Standard 34):** A1/A1 8601  
**NFPA 704 Degrees of Hazard (H-F-R-S):** AlliedSignal: 2-0-0 MSDS  
**NPCA HMIS Hazard Ratings (H-F-R):** DuPont: 1-0-1 MSDS  
**Long-Term Occupational Limit:**  
**Exposure Limit Consistent to OSHA PEL:** DuPont: components are 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk MSDS  

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
emergency exposure limit
Refrigerant Concentration Limit (RCL):

39,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

acute (short-term) toxicity
LC50 (lethal concentration, 50%):
rat, 4 hr, AlliedSig: ≥300,000 MSDS ppm (fatal concentration by inhalation for half of test animals)
dog, AlliedSignal: 50,000 ppm MSDS v/v (lowest observed effect level in test animals)

cardiac sensitization threshold/LOEL:

flammability
LFL-UFL (flammability limits in air):

none (nonflammable as tested) 3C02

heat of combustion (by ASHRAE 34-92):

-1.4 MJ/kg (-589 Btu/lb) UL

Al liedSig: gas, not applicable MSDS

autoignition temperature:

723 °C (1333 °F) 5931

Al liedSignal: >250°C (>482°F) MSDS

autodecomposition temperature:

practically nonflammable 5931

(former UL Classification:
(withdrawn for revision of the classification system, category SBQ2)

appearance:

DuPont: clear, colorless MSDS

odor:

DuPont: slight ethereal MSDS

PRODUCTION

first commercial use as a refrigerant: 1992

last year production allowed: 2029 based on refrigerant 22 8C01

in developed countries under the Montreal Protocol
R-402B

REFRIGERANT DATA SUMMARY

R-402B  R-125/290/22 (38.0/2.0/60.0)  see RDB#
zeotrope ternary blend

COMMON USE(S)
low- and medium-temperature commercial and transport refrigeration including ice machines, primarily for aftermarket use to service or retrofit existing equipment as an alternative for refrigerant 502; typically offers improved capacity and efficiency, but approximately 14 °C (25 °F) higher discharge temperature, compared to that refrigerant

IDENTIFIERS

common name(s): R-402B; R402B; R 402B 3B01
HFC/HC/HCFC-402B
not HCFC-402B
trade name(s): AlliedSignal Genetron(R) HP81 MSDS
DuPont Suva(R) HP81 3C02
ARI container color / Pantone number: green-brown (olive) / 385 6601

PHYSICAL

nominal blend formulation
composition: R-125/290/22 3B01
component weight fractions: 38.0 / 2.0 / 60.0 % 3B01
component weight tolerances: ±2.0 / ±1.0 / ±2.0 3B01
component mole fractions: 29.986 / 4.296 / 65.718 % 8820

properties
molar mass: 94.70922 g/mol (0.208798 lb/mol) 8820

normal boiling point
bubble point temperature: -47.2 °C (-52.9 °F) 8401
dew point temperature: -44.9 °C (-48.0 °F) 8401
maximum temperature glide: 2.32 °C (4.2 °F) 8401
density, saturated liquid: 1410 kg/m³ (88.01 lb/cf) 8401
density, saturated vapor: 5.26 kg/m³ (0.328 lb/cf) 8401
specific volume, saturated liquid: 0.709 L/kg (0.0114 cf/lb) 8401
specific volume, saturated vapor: 19.0 L/kg (0.0348 cf/lb) 8401
heat of vaporization: 210.1 kJ/kg (90.3 Btu/lb) 8401
velocity of sound, saturated liquid: 807 m/s (2648 ft/s) 8401
velocity of sound, saturated vapor: 149 m/s (488 ft/s) 8401
viscosity, saturated liquid: 358 μPa·s (0.358 cp) 8401
viscosity, saturated vapor: 9.70 μPa·s (0.00970 cp) 8401
thermal conductivity, liquid: 0.1061 W/m·K (0.0613 Btu/hr·ft·°F) 8401
thermal conductivity, vapor: 0.0075 W/m·K (0.0043 Btu/hr·ft·°F) 8401

normal pressure, 20 °C (68 °F)
density, vapor: 3.999 kg/m³ (0.2496 lb/cf) 8401

normal pressure, 21.1 °C (70 °F)
density, vapor: 3.983 kg/m³ (0.2486 lb/cf) 8401

20 °C (68 °F)
pressure, liquid (bubble point): 1104.2 kPa (160.15 psia) 8401
pressure, vapor (dew point): 1061.3 kPa (153.93 psia) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
density, saturated liquid: 1171 kg/m³ (73.11 lb/ft³) 8401
density, saturated vapor: 50.95 kg/m³ (3.181 lb/ft³) 8401
specific volume, saturated liquid: 0.854 L/kg (0.0137 cf/lb) 8401
specific volume, saturated vapor: 19.6 L/kg (0.3144 cf/lb) 8401
velocity of sound, saturated liquid: 474 m/s (1556 ft/s) 8401
velocity of sound, saturated vapor: 146 m/s (480 ft/s) 8401
viscosity, saturated liquid: 157 μPa·s (0.157 cp) 8401
viscosity, saturated vapor: 12.7 μPa·s (0.0127 cp) 8401
thermal conductivity, saturated liquid: 0.0750 W/m·K (0.0434 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01216 W/m·K (0.00703 Btu/hr·ft·°F) 8401

- 60 °C (140 °F) ---------------------
  pressure, liquid (bubble point): 2852 kPa (413.7 psia) 8401
  pressure, vapor (dew point): 2797 kPa (405.7 psia) 8401
  heat of vaporization: 105.5 kJ/kg for liquid and 8401
  vapor both at nominal composition (45.4 Btu/lb)
  106.2 kJ/kg coexisting liquid and vapor at bubble-point 8401
  pressure (45.6 Btu/lb)

- critical point ---------------------
temperature: 82.6 °C (180.7 °F) 3435
  83.0 °C (181.5 °F) 8401
pressure: 4445 kPa (644.8 psia) 3435
  4525 kPa (656.3 psia) 8401
density: 531 kg/m³ (33.1 lb/cf) 3435
  536 kg/m³ (33.5 lb/cf) 8401
specific volume: 1.86 L/kg (0.0299 cf/lb) 8401
  1.88 L/kg (0.0302 cf/lb) 3435

ENVIRONMENTAL
ODP (ozone depletion potential): 0.020 mass-weighted average 9501
  (model-derived relative to R 11)
  0.030 mass-weighted average (semi-empirical relative to R 8401
  11)
GWP (global warming potential): 2580 mass-weighted average relative to CO2 for 100 yr 9501
  integration
HGWP (halocarbon GWP): 0.44 mass-weighted average relative to R 11 for infinite integration period

SAFETY
- classification ---------------------
safety group (ASHRAE Standard 34): A1/A1 8601
NFPA 704 degrees of hazard (H-F-R-S): AlliedSignal: 2-0-0 MSDS
  health-flammability-reactivity [special]: 0=no, 4=severe
  AlliedSignal: 2-0-0 MSDS
  DuPont: 1-0-1 MSDS
  health-flammability-reactivity 0=insignificant, 4=extreme

- long-term occupational limit -------
exposure limit consistent to OSHA PEL: DuPont: components are 1000 ppm v/v TWA for 8 hr/day and 8401
  40 hr/wk

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
- emergency exposure limit
  Refrigerant Concentration Limit (RCL): 32,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

- acute (short-term) toxicity
  LC50 (lethal concentration, 50%): rat, 4 hr, AlliedSig: >300,000 ppm (fatal concentration by inhalation for half of test animals)
  cardiac sensitization threshold/LOEL: dog, AlliedSignal: 50,000 ppm v/v (lowest observed effect level in test animals)

- flammability
  LFL-UFL (flammability limits in air): none (nonflammable as tested) 3442
  heat of combustion (by ASHRAE 34-92): -1.6 MJ/kg (-672 Btu/lb) UL
  flash point: AlliedSig: gas, not applicable MSDS 641 °C (1186 °F) 5931
  autoignition temperature: AlliedSignal: >250°C (>482°F) MSDS
  autodecomposition temperature: practically nonflammable 5931
  former UL Classification: (withdrawn for revision of the classification system, category SBQT2)

- detection
  appearance: DuPont: clear, colorless MSDS
  odor: DuPont: slight ethereal MSDS

PRODUCTION
  first commercial use as a refrigerant: 1992
  last year production allowed: 2029 based on refrigerant 22 8C01
  in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-403A

R-403A  R-290/22/218 (5.0/75.0/20.0)  see
zeotrope  ternary blend  RDB#

COMMON USE(S)
commercial and transport refrigeration; alternative for refrigerant 502

IDENTIFIERS
common name(s): R-403A; R403A; R 403A  4B71
trade name(s): HC/HCF/FC-403A, not HCFC-403A  4B71
historical name(s): Rhône Iscone 69-S
                          Star Refrigeration Starton 69
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL
• nominal blend formulation -------
  composition: R-290/22/218  4B71
  component weight fractions: 5.0 / 75.0 / 20.0  4B71
  component weight tolerances: +0.2, -0.2 / ±2.0 / ±2.0  4B71
  component mole fractions: 10.430 / 79.785 / 9.785  8820

• properties ----------------------
  molar mass: 91.98503 g/mol (0.202792 lb/mol)

• normal boiling point --------
  bubble point temperature: -44.0 °C (-47.2 °F)  8814
  dew point temperature: -42.3 °C (-44.1 °F)  8814
  maximum temperature glide: 1.70 °C (3.1 °F)  8814
  density, saturated liquid: 1352 kg/m3 (84.41 lb/cf)  8814
  density, saturated vapor: 5.05 kg/m3 (0.315 lb/cf)  8814
  specific volume, saturated liquid: 0.740 L/kg (0.0118 cf/lb)  8814
  specific volume, saturated vapor: 198.2 L/kg (3.1742 cf/lb)  8814
  heat of vaporization: 214.4 kJ/kg (92.2 Btu/lb)  3331
                          216.3 kJ/kg (93.0 Btu/lb)  8814
  velocity of sound, saturated liquid: 812 m/s (2665 ft/s)  8814
  velocity of sound, saturated vapor: 152 m/s (499 ft/s)  8814
  viscosity, saturated liquid: 323 μPa·s (0.323 cp)  8814
  viscosity, saturated vapor: 9.77 μPa·s (0.00977 cp)  8814
  thermal conductivity, liquid: 0.1042 W/m·K (0.0602 Btu/ft·°F)  8814
  thermal conductivity, vapor: 0.0074 W/m·K (0.0043 Btu/ft·°F)  8814

• normal pressure, 20 °C (68 °F) ----- density, vapor:
  3.866 kg/m3 (0.2426 lb/cf)  8814

• normal pressure, 21.1 °C (70 °F) density, vapor:
  3.871 kg/m3 (0.2416 lb/cf)  8814

• 20 °C (68 °F) ----------------------- pressure, liquid (bubble point): 971.3 kPa (140.87 psia)  8814
  pressure, vapor (dew point): 949.3 kPa (137.69 psia)  8814
  density, saturated liquid: 1144 kg/m3 (71.39 lb/cf)  8814
  density, saturated vapor: 43.47 kg/m3 (2.714 lb/cf)  8814
specific volume, saturated liquid: 0.875 L/kg (0.0140 cf/lb) 8814
specific volume, saturated vapor: 23.0 L/kg (0.3685 cf/lb) 8814
velocity of sound, saturated liquid: 508 m/s (1668 ft/s) 8814
velocity of sound, saturated vapor: 151 m/s (495 ft/s) 8814
viscosity, saturated liquid: 154 μPa·s (0.154 cp) 8814
viscosity, saturated vapor: 12.6 μPa·s (0.0126 cp) 8814
thermal conductivity, saturated liquid: 0.0765 W/m·K (0.0442 Btu/hr·ft²°F) 8814
thermal conductivity, saturated vapor: 0.01176 W/m·K (0.00680 Btu/hr·ft²°F) 8814

* 60 °C (140 °F) ---------------------
  pressure, liquid (bubble point): 2526 kPa (366.4 psia) 8814
  pressure, vapor (dew point): 2501 kPa (362.8 psia) 8814
  heat of vaporization: 119.3 kJ/kg for liquid and vapor both at nominal composition (51.3 Btu/lb) 8814
  vapor 118.3 kJ/kg coexisting liquid and vapor at bubble-point pressure (50.9 Btu/lb) 8814

* critical point ---------------------
  temperature: 91.2 °C (196.2 °F) 8814
  pressure: 4686 kPa (679.6 psia) 8814
  density: 508 kg/m3 (31.7 lb/ft³) 8814
  specific volume: 1.97 L/kg (0.0315 cf/lb) 8814

ENVIRONMENTAL
ODP (ozone depletion potential): 0.026 mass-weighted average (model-derived relative to R 11) 9501
GWP (global warming potential): 0.038 mass-weighted average (semi-empirical relative to R 11) 9501
LCP (global warming potential): 3150 mass-weighted average relative to CO2 for 100 yr integration 9501
HGWP (halocarbon GWP): 8.4 mass-weighted average relative to R 11 for infinite integration period DW

SAFETY
* classification -----------------------
  safety group (ASHRAE Standard 34): A1/A1 8601
  long-term occupational limit -------
  exposure limit consistent to OSHA PEL: Rhône-Poulenc: 1,000 ppm v/v ltr
  TWA for 8 hr/day and 40 hr/wk
  emergency exposure limit ----------
  Refrigerant Concentration Limit (RCL): 29,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)
  flammability ----------------------
  LFL-UFL (flammability limits in air): none (nonflammable as tested) 3C02

PRODUCTION
last year production allowed: 2029 based on refrigerant 22 in developed countries under the Montreal Protocol 8C01
R-403B

--- REFRIGERANT DATA SUMMARY ---

R-403B  R-290/22/218 (5.0/56.0/39.0)  see RDB#
zeotrope  ternary blend

COMMON USE(S)
commercial and transport refrigeration; alternative for refrigerant 502

IDENTIFIERS

common name(s):  R-403B; R403B; R 403B
trade name(s):  HC/HFC/FC-403B, not HCFC-403B
historical name(s):  Rhône-Poulenc Isceon 69-L
ARI container color / Pantone number:  none, use light green grey/413 6601

PHYSICAL

nominal blend formulation -------
composition:  R-290/22/218
component weight fractions:  5.0 / 56.0 / 39.0 %
component weight tolerances:  ±0.2, ±2.0 / ±2.0
component mole fractions:  11.708 / 66.873 / 21.418 %

properties ----------------------
molar mass:  103.25749 g/mol (0.227644 lb/mol)

normal boiling point
bubble point temperature:  -43.8 °C (-46.8 °F)
dew point temperature:  -42.3 °C (-44.1 °F)
maximum temperature glide:  1.51 °C (2.7 °F)
density, saturated liquid:  1385 kg/m³ (86.47 lb/cf)
density, saturated vapor:  5.61 kg/m³ (0.350 lb/cf)
5.68 kg/m³ (0.354 lb/cf)
specific volume, saturated liquid:  0.722 L/kg (0.0116 cf/lb)
specific volume, saturated vapor:  176.2 L/kg (2.8223 cf/lb)
heat of vaporization:  191.0 kJ/kg (82.1 Btu/lb)
191.7 kJ/kg (82.4 Btu/lb)
velocity of sound, saturated liquid:  757 m/s (2484 ft/s)
velocity of sound, saturated vapor:  141 m/s (464 ft/s)
viscosity, saturated liquid:  317 µPa·s (0.317 cp)
viscosity, saturated vapor:  9.89 µPa·s (0.00989 cp)
thermal conductivity, liquid:  0.0939 W/m·K (0.0543 Btu/ft·hr·°F)
thermal conductivity, vapor:  0.0076 W/m·K (0.0044 Btu/ft·hr·°F)

normal pressure, 20 °C (68 °F) ----
density, vapor:  4.366 kg/m³ (0.2726 lb/cf)

normal pressure, 21.1 °C (70 °F) ----
density, vapor:  4.349 kg/m³ (0.2715 lb/cf)

20 °C (68 °F) -------------------
pressure, liquid (bubble point):  958.3 kPa (138.98 psia)
pressure, vapor (dew point):  938.2 kPa (136.07 psia)
density, saturated liquid:  1166 kg/m³ (72.78 lb/cf)
density, saturated vapor:  48.70 kg/m³ (3.040 lb/cf)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
specific volume, saturated liquid: 0.858 L/kg (0.0137 cf/lb) 8414
specific volume, saturated vapor: 20.6 L/kg (0.3292 cf/lb) 8414
velocity of sound, saturated liquid: 460 m/s (1510 ft/s) 8414
velocity of sound, saturated vapor: 139 m/s (456 ft/s) 8414
viscosity, saturated liquid: 148 μPa·s (0.148 cp) 8414
viscosity, saturated vapor: 12.7 μPa·s (0.0127 cp) 8414
thermal conductivity, saturated liquid: 0.0686 W/m·K (0.0397 Btu/hr·ft°F) 8414
thermal conductivity, saturated vapor: 0.01208 W/m·K (0.00698 Btu/hr·ft°F) 8414

25 °C (77 °F) ------------------------
pressure, saturated vapor: 1318.3 kPa (191.20 psia) 3A64
density, saturated liquid: 1150 kg/m³ (71.79 lb/ft³) 3A64
viscosity, saturated liquid: 224 μPa·s (0.224 cp) 3A64
viscosity, vapor at 1 atm: 13.0 μPa·s (0.0130 cp) 3A64
thermal conductivity, saturated liquid: 0.0848 W/m·K (0.0490 Btu/hr·ft°F) 3A64

60 °C (140 °F) ------------------------
pressure, liquid (bubble point): 2486 kPa (360.5 psia) 8814
pressure, vapor (dew point): 2462 kPa (357.1 psia) 8814
heat of vaporization: 100.6 kJ/kg for liquid and vapor both at nominal composition (43.3 Btu/lb) 8414
99.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (42.6 Btu/lb) 8414

Critical point -------------------------
temperature: 88.7 °C (191.6 °F) 8814
pressure: 4397 kPa (637.7 psia) 8814
density: 523 kg/m³ (32.6 lb/ft³) 8414
specific volume: 1.70 L/kg (0.0273 cf/lb) 3A64
1.91 L/kg (0.0306 cf/lb) 8414

Environmental
ODP (ozone depletion potential): 0.019 mass-weighted average (model-derived relative to R 11) 9501
0.028 mass-weighted average (semi-empirical relative to R 11) 9501
GWP (global warming potential): 4420 mass-weighted average relative to CO₂ for 100 yr integration 9501
HGWP (halocarbon GWP): 16 mass-weighted average relative to R 11 for infinite integration period DW

Safety
- classification ------------------------
safety group (ASHRAE Standard 34): Al/Al 8601
- long-term occupational limit --------
exposure limit consistent to OSHA PEL: Rhône-Poulenc: 1,000 ppm v/v 1tr
TWA for 8 hr/day and 40 hr/wk
- emergency exposure limit ----------
Refrigerant Concentration Limit (RCL): 34,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)
- flammability ------------------------
LFL-UFL (flammability limits in air): none (nonflammable as tested) 3A65
PRODUCTION

last year production allowed: 2029 based on refrigerant 22 8C01 in developed countries under the Montreal Protocol
R-404A

--- REFRIGERANT DATA SUMMARY ---

R-404A  R-125/143a/134a (44.0/52.0/4.0)
zeotrope  ternary blend

COMMON USE(S)
commercial and transport refrigeration; alternative for refrigerant 502 with comparable capacity and efficiency and lower compressor discharge temperature

IDENTIFIERS

common name(s):  R-404A; R-404A; R-404A
                 HFC/HFC/HFC-404A, not HFC-404A
trade name(s):   AlliedSignal Genetron(R) 404A  MSDS
                 Ausimont Meforx(R) M55  7726
                 Daikin R-404A  MSDS
                 DuPont Suva(R) HP62  3C04
                 Elf Atochem Forane(R) 404A  4769
                 HRP (UK) HARF(R) 404A
                 Solvay Solkane(R) 404A
historical name(s):  Elf Atochem Forane(R) FX-70  4769
                     Hoechst Reclin(R) 404A  4777
                     Solvay Reclin(R) 404A

ARI container color / Pantone number:
orange  021  6601

PHYSICAL

nominal blend formulation
composition:  R-125/143a/134a  4B71
component weight fractions:  44.0 / 52.0 / 4.0 %
component weight tolerances:  ±2.0 / ±1.0 / ±2.0
component mole fractions:  35.782 / 60.392 / 3.826 %

properties
molar mass:
97.60335 g/mol (0.215179 mol)
8820 lb/mol

normal boiling point
bubble point temperature:
-46.4 °C (-51.6 °F)  3C04
-46.6 °C (-51.8 °F)  8401
dew point temperature:
-45.8 °C (-50.4 °F)
maximum temperature glide:
0.78 °C (1.4 °F)
8401
density, saturated liquid:
1308 kg/m³ (81.67 lb/cf)  8401
5.48 kg/m³ (0.342 lb/cf)  8401
density, saturated vapor:
0.764 L/kg (0.0122 cf/lb)  8401
2.9224 L/kg (2.2922 cf/lb)  8401
specific volume, saturated liquid:
182.4 L/kg (2.9224 cf/lb)
198.7 kJ/kg (85.4 Btu/lb)  3C02
200.1 kJ/kg (86.0 Btu/lb)  8401
specific volume, saturated vapor:
heat of vaporization:
745 m/s (2444 ft/s)  8401
413 m/s (470 ft/s)
329 µPa·s (0.329 cp)  8401
9.10 µPa·s (0.00910 cp)  8401
thermal conductivity, liquid:
0.0988 W/m·K (0.0571 Btu/hr·ft·°F)
18401
thermal conductivity, vapor:
0.0900 W/m·K (0.0052 Btu/hr·ft·°F)

normal pressure, 20 °C (68 °F)
density, vapor: 4.130 kg/m³ (0.2579 lb/cf) 8401

- normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 4.114 kg/m³ (0.2568 lb/cf) 8401

• 20 °C (68 °F) ---------------------
  pressure, liquid (bubble point): 1102.2 kPa (159.86 psia) 8401
  density, saturated liquid: 1068 kg/m³ (66.70 lb/cf) 8401
  density, saturated vapor: 56.40 kg/m³ (3.521 lb/cf) 8401
  specific volume, saturated liquid: 0.936 L/kg (0.0150 cf/lb) 8401
  specific volume, saturated vapor: 17.7 L/kg (0.2840 cf/lb) 8401
  velocity of sound, saturated liquid: 411 m/s (1350 ft/s) 8401
  velocity of sound, saturated vapor: 136 m/s (446 ft/s) 8401
  viscosity, saturated liquid: 136 μPa·s (0.136 cp) 8401
  viscosity, saturated vapor: 12.2 μPa·s (0.0122 cp) 8401
  thermal conductivity, saturated liquid: 0.0694 W/m·K (0.0401 Btu/hr·ft·°F) 8401
  thermal conductivity, saturated vapor: 0.01534 W/m·K (0.000887 Btu/hr·ft·°F) 8401

• 60 °C (140 °F) ---------------------
  pressure, liquid (bubble point): 2886 kPa (418.5 psia) 8401
  pressure, vapor (dew point): 2871 kPa (416.4 psia) 8401
  heat of vaporization: 82.2 kJ/kg for liquid and vapor both at nominal composition (35.3 Btu/lb) 8401
  and vapor at bubble-point pressure (35.3 Btu/lb) 8401

• critical point ---------------------
  temperature: 72.1 °C (161.7 °F) 3C04
  pressure: 3732 kPa (541.2 psia) 3C04
  density: 489 kg/m³ (30.5 lb/cf) 8401
  specific volume: 2.05 L/kg (0.0328 cf/lb) 8401

ENVIRONMENTAL

  ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
  (model-derived relative to R 11)
  <0.00004 mass-weighted average 9501
  (semi-empirical relative to R 11)

  GWP (global warming potential): 4540 mass-weighted average 9501
  relative to CO2 for 100 yr integration

  HGWP (halocarbon GWP): 0.80 mass-weighted average DW
  relative to R 11 for infinite integration period

SAFETY

• classification ---------------------
  safety group (ASHRAE Standard 34): A1/A1 8601
  NFPA 704 degrees of hazard (H-F-R-S): AlliedSignal: 1-0-1 MSDS
  health-flammability-reactivity [-special]: 0=no, 4=severe
  NPCA HMIS hazard ratings (H-F-R): AlliedSignal: 1-0-1 MSDS
  DuPont: 1-0-1 MSDS
  health-flammability-reactivity 0=insignificant, 4=extreme
long-term occupational limit
exposure limit consistent to OSHA PEL:

- Solvay SAEL TWA: 1,000 ppm v/v MSDS
tWA for 8 hr/day and 40 hr/wk

emergency exposure limit
Refrigerant Concentration Limit (RCL):

- 69,000 ppm v/v (preliminary
  value under review, based on
draft ASHRAE 34aa)

flammability

- LFL-UFL (flammability limits in air):
  none (nonflammable as tested) 3C02
  -6.6 MJ/kg (-2827 Btu/lb) UL

- heat of combustion (by ASHRAE 34-92):
  AlliedSig: gas, not applicable MSDS
  Elf Atochem: nonflammable MSDS
  TOC, DuPont: will not burn MSDS

- flash point:
  728 °C (1342 °F) 5931

- autoignition temperature:
  AlliedSignal: >250°C (>482°F) MSDS
  practically nonflammable 6938
  (withdrawn for revision of the
  classification system,
category SBQT2)

- autodecomposition temperature:

- former UL Classification:

detection

- appearance:
  DuPont: clear, colorless MSDS

- odor:
  DuPont: slight ethereal MSDS

PRODUCTION

- first commercial use as a refrigerant: 1993

- last year production allowed: unrestricted 8C01
R-405A

REFRIGERANT DATA SUMMARY

R-405A R-22/152a/142b/C318 (45.0/7.0/5.5/42.5)
zeotrope tetraary blend

COMMON USE(S)

service fluid to replace refrigerant 12 in mobile air conditioners
and refrigeration equipment; service fluid to replace refrigerant 500

IDENTIFIERS

common name(s): R-405A; R405A; R-405A
HCFC/HFC/HCFC/FC-405A
not HCFC-405A
trade name(s): ATG R-405A
China Sun G2015
Greencool (Gu) G2015

name used in U.S. EPA SNAP Rule:
HCFC/HFC/Fluorocalkane Blend A
ARI container color / Pantone number:
none, use light green grey/413 6601

PHYSICAL

nominal blend formulation

composition: R-22/152a/142b/C318
component weight fractions: 45.0 / 7.0 / 5.5 / 42.5 %
component weight tolerances:
≥2.0 / ±1.0 / ±1.0 / ±2.0 and 4B71
sum of 152a and 142b +0.0, -2.0 4B71
component mole fractions: 58.239/ 11.860/ 6.125/ 23.777 8820
%

properties

molar mass: 111.90682 g/mol (0.246712 lb/mol)

normal freezing/melting/triple point:

-62.0 °C (-79.6 °F)

normal boiling point

bubble point temperature: -32.9 °C (-27.2 °F)
dew point temperature: -24.5 °C (-12.0 °F)
maximum temperature glide: 8.41 °C (15.1 °F)
density, saturated liquid: 1448 kg/m3 (90.38 lb/ft³)
density, saturated vapor: 5.70 kg/m3 (0.356 lb/ft³)
specific volume, saturated liquid: 0.691 L/kg (0.0111 cf/lb)
specific volume, saturated vapor: 175.6 L/kg (2.8121 cf/lb)
heat of vaporization:

196.0 kJ/kg (84.3 Btu/lb)

velocity of sound, saturated liquid:

743 m/s (2438 ft/s)
velocity of sound, saturated vapor:

667 m/s (2187 ft/s)
viscosity, saturated vapor:

10.27 μPa·s (0.01027 cp)
viscosity, saturated liquid:

354 μPa·s (0.354 cp)
thermal conductivity, liquid:

0.0913 W/m·K (0.0527 Btu/ft·hr·°F)
thermal conductivity, vapor:

0.0082 W/m·K (0.0047 Btu/ft·hr·°F)

normal pressure, 20 °C (68 °F)
density, vapor:

4.750 kg/m3 (0.2965 lb/ft³)

normal pressure, 21.1 °C (70 °F)
density, vapor:

4.731 kg/m3 (0.2953 lb/ft³)

20 °C (68 °F)

pressure, liquid (bubble point):

660.1 kPa (95.74 psia)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
pressure, vapor (dew point): 534.8 kPa (77.56 psia) 8401
density, saturated liquid: 1273 kg/m³ (79.50 lb/cf) 8401
density, saturated vapor: 27.91 kg/m³ (1.742 lb/cf) 8401
specific volume, saturated liquid: 0.785 L/kg (0.0126 cf/lb) 8401
specific volume, saturated vapor: 35.8 L/kg (0.5740 cf/lb) 8401
velocity of sound, saturated liquid: 515 m/s (1689 ft/s) 8401
velocity of sound, saturated vapor: 141 m/s (462 ft/s) 8401
viscosity, saturated liquid: 188 μPa·s (0.188 cp) 8401
viscosity, saturated vapor: 12.2 μPa·s (0.0122 cp) 8401
thermal conductivity, saturated liquid: 0.0723 W/m·K (0.0418 Btu/hr·ft²°F) 8401
thermal conductivity, saturated vapor: 0.01119 W/m·K (0.00647 Btu/hr·ft²°F) 8401

60 °C (140 °F) -------------------
pressure, liquid (bubble point): 1784 kPa (258.7 psia) 8401
pressure, vapor (dew point): 1572 kPa (228.0 psia) 8401
heat of vaporization: 124.7 kJ/kg for liquid and vapor both at nominal composition (53.6 Btu/lb) 8401
96.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (41.4 Btu/lb) 8401

---
critical point ---------------
temperature: 106.0 °C (222.8 °F) 8401
pressure: 4292 kPa (622.5 psia) 8401
density: 535 kg/m³ (33.4 lb/cf) 8401
specific volume: 1.87 L/kg (0.0299 cf/lb) 8401

ENVIRONMENTAL
ODP (ozone depletion potential): 0.018 mass-weighted average (model-derived relative to R11) 5301
0.026 mass-weighted average (semi-empirical relative to R11) 9501
GWP (global warming potential): 5750 mass-weighted average relative to CO2 for 100 yr integration 9501
HGWP (halocarbon GWP): 0.17 mass-weighted average relative to R11 for infinite integration period DW

SAFETY
---
classification ---------------------
safety group (ASHRAE Standard 34): none (application pending)
components are A1,A2,A2,Alr

---
long-term occupational limit ------
exposure limit consistent to OSHA PEL: Greencool AEL: 1,000 ppm v/v MSDS
TWA for 8 hr/day and 40 hr/wk

---
emergency exposure limit ---------
Refrigerant Concentration Limit (RCL): 32,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

---
flammability ----------------------
LFL-UFL (flammability limits in air): none (nonflammable as tested)
flash point: Greencool: none MSDS

---
detection ------------------------
appearance: Greencool: clear, colorless MSDS
odor: Greencool: slight ethereal MSDS
<table>
<thead>
<tr>
<th>PRODUCTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>first commercial use as a refrigerant: 1995</td>
</tr>
<tr>
<td>last year production allowed: 2029 by refrigerants 22, 142b 8C01 in developed countries under the Montreal Protocol</td>
</tr>
</tbody>
</table>
**R-406A**

--- REFRIGERANT DATA SUMMARY ---

<table>
<thead>
<tr>
<th>R-406A</th>
<th>R-22/600a/142b (55.0/4.0/41.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>zotrope</td>
<td>ternary blend</td>
</tr>
</tbody>
</table>

**COMMON USE(S)**
Alternative for refrigerants 12 and 500, originally targeted for mobile air conditioning, the market focus has shifted to refrigeration; primarily for aftermarket use to service or retrofit existing equipment.

**IDENTIFIERS**

<table>
<thead>
<tr>
<th>common name(s)</th>
<th>R-406A; R406A; R-406A</th>
<th>4B71</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HCFC/HC/HCFC-406A</td>
<td>4B71</td>
</tr>
<tr>
<td></td>
<td>not HCFC-406A</td>
<td>4B71</td>
</tr>
<tr>
<td>trade name(s)</td>
<td>McMullen Oil McCool R-406A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monroe Air Tech Autofrost-X3</td>
<td>8354</td>
</tr>
<tr>
<td></td>
<td>People's Welding Supply GHG-X3</td>
<td>8354</td>
</tr>
<tr>
<td>historical name(s)</td>
<td>GHG Refrigerant-12 Substitute</td>
<td>4886</td>
</tr>
<tr>
<td></td>
<td>ICOR R-406A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Solvay Solkane(R) 406A</td>
<td>5128</td>
</tr>
</tbody>
</table>

**ARI container color / Pantone number:**
none, use light green grey/413 6601 with red / 185 band

**PHYSICAL**

- nominal blend formulation
  
<table>
<thead>
<tr>
<th>composition</th>
<th>R-22/600a/142b</th>
</tr>
</thead>
<tbody>
<tr>
<td>component weight fractions</td>
<td>55.0 / 4.0 / 41.0 %</td>
</tr>
<tr>
<td>component weight tolerances</td>
<td>±2.0 / ±1.0 / ±1.0</td>
</tr>
<tr>
<td>component mole fractions</td>
<td>57.156 / 6.184 / 36.660 %</td>
</tr>
</tbody>
</table>

- properties
  
<table>
<thead>
<tr>
<th>molar mass</th>
<th>89.85739 g/mol (0.198102 lb/mol)</th>
</tr>
</thead>
</table>

- normal boiling point
  
  | bubble point temperature | -32.3 °C (-26.2 °F) |
  |                         | -32.7 °C (-26.9 °F) |
  |                         | -23.4 °C (-10.0 °F) |
  |                         | -23.5 °C (-10.4 °F) |
  | dew point temperature  | 9.16 °C (16.5 °F) |
  |                         | 1255 kg/m³ (78.35 lb/cf) |
  |                         | 4.56 kg/m³ (0.285 lb/cf) |
  |                         | 0.797 L/kg (0.0128 cf/lb) |
  |                         | 219.6 L/kg (3.5178 cf/lb) |
  |                         | 241.5 kg/kg (103.8 Btu/lb) |
  |                         | 836 m/s (2744 ft/s) |
  |                         | 159 m/s (522 ft/s) |
  |                         | 355 μPa·s (0.355 cp) |
  |                         | 9.32 μPa·s (0.00932 cp) |
  |                         | 0.0082 W/m·K (0.0047 Btu/hr·ft°F) |
  |                         | 0.1064 W/m·K (0.0615 Btu/hr·ft°F) |
  | velocity of sound, saturated liquid | 8401 |
  | velocity of sound, saturated vapor | 8401 |
  | viscosity, saturated liquid | 8401 |
  | viscosity, saturated vapor | 8401 |
  | thermal conductivity, liquid | 8401 |
  | thermal conductivity, vapor | 8401 |

- normal pressure, 20 °C (68 °F)
  
  | density, vapor | 3.813 kg/m³ (0.2380 lb/cf) |

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
- normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 3.797 kg/m³ (0.2371 lb/cf) 8401
- 20 °C (68 °F) ------------
  pressure, liquid (bubble point): 633.0 kPa (91.81 psia) 5127
  646.5 kPa (93.76 psia) 8401
  491.0 kPa (71.21 psia) 5127
  503.8 kPa (73.06 psia) 8401
  density, saturated liquid: 1114 kg/m³ (69.53 lb/cf) 8401
  density, saturated vapor: 20.87 kg/m³ (1.303 lb/cf) 8401
  specific volume, saturated liquid: 0.898 L/kg (0.0144 cf/lb) 8401
  specific volume, saturated vapor: 47.9 L/kg (0.7676 cf/lb) 8401
  velocity of sound, saturated liquid: 601 m/s (1970 ft/s) 8401
  velocity of sound, saturated vapor: 161 m/s (529 ft/s) 8401
  viscosity, saturated liquid: 194 μPa·s (0.194 cp) 8401
  viscosity, saturated vapor: 11.0 μPa·s (0.0110 cp) 8401
  thermal conductivity, saturated liquid: 0.0838 W/m·K (0.0484 Btu/hr·ft²°F) 8401
  thermal conductivity, saturated vapor: 0.01104 W/m·K (0.00638 Btu/hr·ft²°F) 8401
- 60 °C (140 °F) ------------
  pressure, liquid (bubble point): 1703 kPa (247.0 psia) 5127
  1733 kPa (251.4 psia) 8401
  1435 kPa (208.1 psia) 5127
  1475 kPa (213.9 psia) 8401
  heat of vaporization: 162.3 kJ/kg for liquid and vapor both at nominal composition (69.8 Btu/lb) 8401
  147.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (63.3 Btu/lb) 8401
- critical point -------------
  temperature: 114.5 °C (238.1 °F) 5127
  116.5 °C (241.7 °F) 8401
  pressure: 4581 kPa (664.4 psia) 5127
  4883 kPa (708.2 psia) 8401
  density: 456 kg/m³ (28.4 lb/cf) 5127
  459 kg/m³ (28.6 lb/cf) 8401
  specific volume: 2.16 L/kg (0.0349 cf/lb) 8401
  2.19 L/kg (0.0352 cf/lb) 5127

ENVIRONMENTAL

ODP (ozone depletion potential): 0.036 mass-weighted average (model-derived relative to R 11) 9501
  0.055 mass-weighted average (semi-empirical relative to R 11) 9501
GWP (global warming potential): 1990 mass-weighted average relative to CO2 for 100 yr integration 9501
HGWP (halocarbon GWP): 0.34 mass-weighted average relative to R 11 for infinite integration period

SAFETY

- classification -----------------
  safety group (ASHRAE Standard 34): A1/A2 8601
- emergency exposure limit ---------
  Refrigerant Concentration Limit (RCL): 25,000 ppm v/v (preliminary

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
flammanility --------------
LFL-UFL (flammability limits in air): value under review, based on
draft ASHRAE 34aa)
none (nonflammable as tested) 4886
worst fractionation flammable 4886
(12.8-20.7% in DIN51649 test) mfr

PRODUCTION
first commercial use as a refrigerant: March 1993 mfr
last year production allowed: 2029 by refrigerants 22, 142b 8C01
in developed countries under the Montreal Protocol
R-407A

--- REFREIGRANT DATA SUMMARY ---

R-407A
zeotrope
ternary blend

**COMMON USE(S)**
alternative for refrigerant 502 in new equipment and for retrofit of some existing systems

Note: The composition tolerances indicated for this refrigerant were originally ±2/±1/±2 (see RDB6101), but were subsequently changed in ASHRAE Standard 34-1992 addendum 34y to ±2/±2/±2 (see RDB7250).

**IDENTIFIERS**
- **common name(s):** R-407A; R407A; R 407A
- **trade name(s):** ICI Klea(R) 407A
- **ARI container color / Pantone number:** lime green / 368

**PHYSICAL**
- **nominal blend formulation -------**
  - **composition:** R-32/125/134a
  - **component weight fractions:** 20.0 / 40.0 / 40.0 %
  - **component mole fractions:** 34.642 / 30.031 / 35.327 %
- **properties --------------------------**
  - **molar mass:** 90.11001 g/mol (0.198659 lb/mol)
  - **normal boiling point ---------------**
    - **bubble point temperature:** -45.2 °C (-49.4 °F)
    - **dew point temperature:** -38.7 °C (-37.7 °F)
    - **maximum temperature glide:** 6.52 °C (11.7 °F)
    - **density, saturated liquid:** 1405 kg/m³ (87.70 lb/ft³)
    - **density, saturated vapor:** 4.88 kg/m³ (0.305 lb/ft³)
    - **specific volume, saturated liquid:** 0.712 L/kg (0.0114 ft³/lb)
    - **specific volume, saturated vapor:** 204.8 L/kg (3.2807 ft³/lb)
    - **heat of vaporization:** 234.4 kJ/kg (100.8 Btu/lb)
    - **velocity of sound, saturated liquid:** 791 m/s (2596 ft/s)
    - **velocity of sound, saturated vapor:** 153 m/s (503 ft/s)
    - **viscosity, saturated liquid:** 376 µPa·s (0.376 cP)
    - **viscosity, saturated vapor:** 393.23 µPa·s (0.39323 cP)
    - **thermal conductivity, liquid:** 0.1200 W/m·K (0.0693 Btu/hr·ft°F)
    - **thermal conductivity, vapor:** 0.0086 W/m·K (0.0049 Btu/hr·ft°F)
- **normal pressure, 20 °C (68 °F) -----**
  - **density, vapor:** 3.811 kg/m³ (0.2379 lb/ft³)
- **normal pressure, 21.1 °C (70 °F) ---**
  - **density, vapor:** 3.795 kg/m³ (0.2369 lb/ft³)
- **20 °C (68 °F) --------------------**
  - **pressure, liquid (bubble point):** 1091.1 kPa (158.25 psia)
  - **pressure, vapor (dew point):** 944.1 kPa (136.93 psia)
  - **density, saturated liquid:** 1168 kg/m³ (72.93 lb/ft³)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
density, saturated vapor: 42.68 kg/m3 (2.665 lb/cf) 8401
specific volume, saturated liquid: 0.856 L/kg (0.0137 cf/lb) 8401
specific volume, saturated vapor: 23.4 L/kg (0.3753 cf/lb) 8401
velocity of sound, saturated liquid: 471 m/s (1545 ft/s) 8401
velocity of sound, saturated vapor: 151 m/s (494 ft/s) 8401
viscosity, saturated liquid: 159 μPa·s (0.0159 cp) 8401
viscosity, saturated vapor: 12.6 μPa·s (0.0126 cp) 8401
thermal conductivity, saturated liquid: 0.0858 W/m·K (0.0496 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01328 W/m·K (0.00767 Btu/hr·ft·°F) 8401

- 60 °C (140 °F) ----------------
  pressure, liquid (bubble point): 2894 kPa (419.8 psia) 8401
  pressure, vapor (dew point): 2680 kPa (388.7 psia) 8401
  heat of vaporization: 117.1 kJ/kg for liquid and vapor both at nominal composition (50.3 Btu/lb) 8401
  103.4 kJ/kg coexisting liquid and vapor at bubble-point pressure (44.4 Btu/lb) 8401

- critical point -----------------
temperature: 81.9 °C (179.4 °F) 8401
  pressure: 4487 kPa (650.8 psia) 8401
density: 531 kg/m3 (33.2 lb/cf) 8401
specific volume: 1.88 L/kg (0.0302 cf/lb) 8401

ENVIRONMENTAL
ODP (ozone depletion potential): <0.00002 mass-weighted average (model-derived relative to R11) 9501
GWP (global warming potential): 2340 mass-weighted average relative to CO2 for 100 yr integration 9501
HGWP (halocarbon GWP): 0.40 mass-weighted average relative to R 11 for infinite integration period 9501

SAFETY
- classification -------------------
safety group (ASHRAE Standard 34): A1/A1 8601
- long-term occupational limit --------
exposure limit consistent to OSHA PEL: ICI OEL: 1,000 ppm v/v TWA for 6B35 8 hr/day and 40 hr/wk
- emergency exposure limit ----------
Refrigerant Concentration Limit (RCL): 69,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

- flammability ---------------------
LFL-UFL (flammability limits in air): none (nonflammable as tested) 3A61
heat of combustion (by ASHRAE 34-92): -3.4 MJ/kg (-1474 Btu/lb) mfr
  -3.6 MJ/kg (-1538 Btu/lb) UL
flash point: ICI: does not flash 5931
autoignition temperature: 685 °C (1265 °F) MSDS
former UL Classification: practically nonflammable (withdrawn for revision of the classification system, 5931

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>appearance</td>
<td>ICI: colorless liquified gas</td>
</tr>
<tr>
<td>odor</td>
<td>ICI: faint ether-like odor</td>
</tr>
</tbody>
</table>

**PRODUCTION**

- first commercial use as a refrigerant: 1993
- last year production allowed: unrestricted

8C01
R-407B

REFRIGERANT DATA SUMMARY

R-407B R-32/125/134a (10.0/70.0/20.0) see RDB#
zeotrope ternary blend ----

COMMON USE(S)
alternative for refrigerant 502 for retrofit of existing systems operating at high lift conditions (e.g., evaporating at -40 °C, -40 °F, and condensing at 40 °C, 105 °F, or higher) and in hermetic compressors where discharge temperature is limited; under consideration as an alternative for refrigerant 22 both in new equipment and as a service fluid

Note: The composition tolerances indicated for this refrigerant were originally ±2/±1/±2 (see RDB6101), but were subsequently changed in ASHRAE Standard 34-1992 addendum 34y to ±2/±2/±2 (see RDB7250).

IDENTIFIERS

common name(s): R-407B; R407B; R 407B 4B71
HFC/HFC/HFC-407B, not HFC-407B 4B71
trade name(s): ICI Klea(R) 407B MSDS
ICI Klea(R) 61 4133
ARI container color / Pantone number: cream / 156 6601

PHYSICAL

· nominal blend formulation --------
  composition: R-32/125/134a 4B71
  component weight fractions: 10.0 / 70.0 / 20.0 % 4B71
  component weight tolerances: ±2.0 / ±2.0 / ±2.0 4B71
  component mole fractions: 19.787 / 60.036 / 20.178 % 8820
  properties ----------------------
    molar mass: 102.93680 g/mol (0.226937 lb/mol) 8820

· normal boiling point ----------
  bubble point temperature: -46.8 °C (-52.2 °F) 8401
  dew point temperature: -42.4 °C (-44.3 °F) 8401
  maximum temperature glide: 4.39 °C (7.9 °F) 8401
  density, saturated liquid: 1460 kg/m3 (91.13 lb/cf) 8401
  density, saturated vapor: 5.62 kg/m3 (0.351 lb/cf) 8401
  specific volume, saturated liquid: 0.685 L/kg (0.0110 cf/lb) 8401
  specific volume, saturated vapor: 176.3 L/kg (2.8244 cf/lb) 8401
  heat of vaporization: 200.0 kJ/kg (86.0 Btu/lb) 8401
  velocity of sound, saturated liquid: 750 m/s (2460 ft/s) 8401
  velocity of sound, saturated vapor: 141 m/s (463 ft/s) 8401
  viscosity, saturated liquid: 393 μPa·s (0.393 cp) 8401
  viscosity, saturated vapor: 9.85 μPa·s (0.00985 cp) 8401
  thermal conductivity, liquid: 0.1069 W/m·K (0.0618 Btu/hr·ft·°F) 8401
  thermal conductivity, vapor: 0.0087 W/m·K (0.0050 Btu/hr·ft·°F) 8401

· normal pressure, 20 °C (68 °F) ----
  density, vapor: 4.351 kg/m3 (0.2716 lb/cf) 8401

· normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 4.334 kg/m3 (0.2706 lb/cf) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure, liquid (bubble point)</td>
<td>1153.0 kPa (167.23 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure, vapor (dew point)</td>
<td>1055.4 kPa (153.07 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Density, saturated liquid</td>
<td>1197 kg/m³ (74.70 lb/ft³)</td>
<td>8401</td>
</tr>
<tr>
<td>Density, saturated vapor</td>
<td>55.99 kg/m³ (3.496 lb/ft³)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated liquid</td>
<td>0.836 L/kg (0.0134 cf/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated vapor</td>
<td>17.9 L/kg (0.2861 cf/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Velocity of sound, saturated liquid</td>
<td>417 m/s (1368 ft/s)</td>
<td>8401</td>
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<tr>
<td>Velocity of sound, saturated vapor</td>
<td>136 m/s (446 ft/s)</td>
<td>8401</td>
</tr>
<tr>
<td>Viscosity, saturated liquid</td>
<td>156 µPa s (0.156 cp)</td>
<td>8401</td>
</tr>
<tr>
<td>Viscosity, saturated vapor</td>
<td>12.9 µPa s (0.0129 cp)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated liquid</td>
<td>0.0739 W/m·K (0.0427 Btu/hr·ft²°F)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01385 W/m·K (0.00800 Btu/hr·ft²°F)</td>
<td>8401</td>
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<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure, liquid (bubble point)</td>
<td>3039 kPa (440.8 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure, vapor (dew point)</td>
<td>2915 kPa (422.8 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Heat of vaporization</td>
<td>87.0 kJ/kg for liquid and vapor both at nominal composition (37.4 Btu/lb)</td>
<td>8401</td>
</tr>
<tr>
<td></td>
<td>80.6 kJ/kg coexisting liquid and vapor at bubble-point pressure (34.6 Btu/lb)</td>
<td>8401</td>
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</table>

<table>
<thead>
<tr>
<th>Critical point</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>74.4 °C (165.9 °F)</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure</td>
<td>4083 kPa (592.2 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Density</td>
<td>562 kg/m³ (35.1 lb/ft³)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume</td>
<td>1.78 L/kg (0.0285 cf/lb)</td>
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**Environmental**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODP (ozone depletion potential)</td>
<td>&lt;0.00002 mass-weighted average 9501 (model-derived relative to R 11)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;0.00012 mass-weighted average 9501 (semi-empirical relative to R 11)</td>
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</tr>
<tr>
<td>GWP (global warming potential)</td>
<td>3070 mass-weighted average relative to CO₂ for 100 yr integration 9501</td>
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<tr>
<td>HGWP (halocarbon GWP)</td>
<td>0.52 mass-weighted average relative to R 11 for infinite integration</td>
<td>DW</td>
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**Safety**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Source</th>
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<tbody>
<tr>
<td>Classification</td>
<td>A1/A1</td>
<td>8601</td>
</tr>
<tr>
<td>Long-term occupational limit</td>
<td>ICI OEL: 1,000 ppm v/v TWA for 6B35 8 hr/day and 40 hr/wk</td>
<td></td>
</tr>
<tr>
<td>Emergency exposure limit</td>
<td>Refrigerant Concentration Limit (RCL): 69,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)</td>
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</tr>
<tr>
<td>Flammability</td>
<td>LFL-UFL (flammability limits in air): none (nonflammable as tested) 3A62</td>
<td></td>
</tr>
<tr>
<td></td>
<td>heat of combustion (by ASHRAE 34-92): -1.5 MJ/kg (~653 Btu/lb) mfr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-1.8 MJ/kg (~775 Btu/lb) UL</td>
<td></td>
</tr>
<tr>
<td>Flash point</td>
<td>ICI: does not flash</td>
<td>MSDS</td>
</tr>
<tr>
<td>autoignition temperature:</td>
<td>723 °C (1333 °F)</td>
<td>5931</td>
</tr>
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<td>-----------------------------------</td>
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<tr>
<td>former UL Classification:</td>
<td>practically nonflammable</td>
<td>5931</td>
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<td></td>
<td>(withdrawn for revision of the</td>
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</tr>
<tr>
<td></td>
<td>classification system,</td>
<td></td>
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<td></td>
<td>category SBQT2)</td>
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</table>

- detection -------------------------

<table>
<thead>
<tr>
<th>appearance:</th>
<th>ICI: colorless liquified gas</th>
<th>MSDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>odor:</td>
<td>ICI: faint ether-like odor</td>
<td>MSDS</td>
</tr>
</tbody>
</table>

**PRODUCTION**

first commercial use as a refrigerant: 1993

last year production allowed: unrestricted 8C01
**R-407C**

--------------------------- REFRIGERANT DATA SUMMARY ---------------------------
R-407C  R-32/125/134a (23.0/25.0/52.0)  see RDB#
zeotrope ternary blend  ----

**COMMON USE(S)**
alternative for refrigerant 22 in air conditioners and heat pumps for both new equipment and retrofit use for aftermarket service; generally not suitable in equipment with a flooded evaporator due to high glide: This refrigerant and its use in air conditioners and heat pumps may be covered by U.S. patents 5,370,811 and 5,438,849, respectively, issued to Y. Yoshida, K. Arita, and M. Funakura and assigned to Matsushita Electric Industrial Company, Limited (Osaka, Japan). Other U.S. and foreign patents may apply, including - but not limited to - European 430169, Japanese 1928524 and 1928525, and Korean 69627.

Note: The composition tolerances indicated for this refrigerant were originally ±2/±1/±2 (see RDB6101), but were subsequently changed in ASHRAE Standard 34-1992 addendum 34w to ±2/±2/±2 (see RDB6801).

**IDENTIFIERS**

<table>
<thead>
<tr>
<th>common name(s):</th>
<th>R-407C; R407C; R 407C</th>
<th>6101</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>HFC/HFC/HFC-407C, not HFC-407C</td>
<td>6101</td>
</tr>
<tr>
<td>trade name(s):</td>
<td>AlliedSignal Genetron(R) 407C</td>
<td>MSDS</td>
</tr>
<tr>
<td></td>
<td>Ausimont Meforex(R) M95</td>
<td>7726</td>
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<tr>
<td></td>
<td>Daikin R-407C</td>
<td>MSDS</td>
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<tr>
<td></td>
<td>DuPont Suva(R) 9000</td>
<td>MSDS</td>
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<tr>
<td></td>
<td>Elf Atochem Forane(R) 407C</td>
<td>6938</td>
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<td>HRP (UK) HARP(R) 407C</td>
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<td></td>
<td>ICI Klea(R) 407C</td>
<td>6B35</td>
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<tr>
<td></td>
<td>ICI Klea(R) 66</td>
<td>4135</td>
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<td></td>
<td>Solvay Solkane(R) 407C</td>
<td></td>
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<tr>
<td>historical name(s):</td>
<td>DuPont Suva(R) AC9000</td>
<td>4764</td>
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<tr>
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<td>Hoechst Reclin(R) 407C</td>
<td>7855</td>
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<td>Hoechst Reclin(R) HX3</td>
<td>7855</td>
</tr>
<tr>
<td>ARI container color / Pantone number:</td>
<td>medium brown (brown) / 471</td>
<td>6601</td>
</tr>
</tbody>
</table>

**PHYSICAL**

- nominal blend formulation -------
  composition: R-32/125/134a 6101
  component weight fractions: 23.0 / 25.0 / 52.0 % 6101
  component weight tolerances: ±2.0 / ±2.0 / ±2.0 6101
  component mole fractions: 38.111 / 17.956 / 43.933 % 8820
- properties ---------------------
  molar mass: 86.20283 g/mol (0.190045 lb/mol) 8820
- normal boiling point ----------
  bubble point temperature: -43.6 °C (-46.4 °F) 4765
  -43.6 °C (-46.5 °F) 5A31
  -43.8 °C (-46.9 °F) 8401
  dew point temperature: -36.7 °C (-34.1 °F) 8401
  maximum temperature glide: 7.09 °C (12.8 °F) 8401
  density, saturated liquid: 1382 kg/m3 (86.28 lb/cf) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
**Refrigerant Database**

**Density, saturated vapor:** 4.63 kg/m³ (0.289 lb/cf) 8401
**Specific volume, saturated liquid:** 0.724 L/kg (0.0116 cf/lb) 8401
**Specific volume, saturated vapor:** 216.0 L/kg (3.4592 cf/lb) 8401
**Heat of vaporization:** 248.0 kJ/kg (106.6 Btu/lb) 8401
**Velocity of sound, saturated liquid:** 806 m/s (2646 ft/s) 8401
**Velocity of sound, saturated vapor:** 158 m/s (518 ft/s) 8401
**Viscosity, saturated liquid:** 371 µPa·s (0.371 cp) 8401
**Viscosity, saturated vapor:** 9.81 µPa·s (0.00981 cp) 8401
**Thermal conductivity, liquid:** 0.1242 W/m·K (0.0718 Btu/hr·ft²·°F) 8401
**Thermal conductivity, vapor:** 0.0086 W/m·K (0.0050 Btu/hr·ft²·°F) 8401

<table>
<thead>
<tr>
<th>Normal pressure, 20 °C (68 °F)</th>
<th>3.647 kg/m³ (0.2276 lb/cf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal pressure, 21.1 °C (70 °F)</td>
<td>3.632 kg/m³ (0.2267 lb/cf)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pressure, liquid (bubble point)</th>
<th>1035.7 kPa (150.22 psia)</th>
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</thead>
<tbody>
<tr>
<td>Density, saturated liquid</td>
<td>879.8 kPa (127.61 psia)</td>
</tr>
<tr>
<td>Density, saturated vapor</td>
<td>1159 kg/m³ (72.35 lb/cf)</td>
</tr>
<tr>
<td>Specific volume, saturated liquid</td>
<td>37.59 kg/m³ (2.347 lb/cf)</td>
</tr>
<tr>
<td>Specific volume, saturated vapor</td>
<td>0.863 L/kg (0.0138 cf/lb)</td>
</tr>
<tr>
<td>Velocity of sound, saturated liquid</td>
<td>26.6 L/kg (0.4262 cf/lb)</td>
</tr>
<tr>
<td>Velocity of sound, saturated vapor</td>
<td>495 m/s (1624 ft/s)</td>
</tr>
<tr>
<td>Viscosity, saturated liquid</td>
<td>156 m/s (512 ft/s)</td>
</tr>
<tr>
<td>Viscosity, saturated vapor</td>
<td>163 µPa·s (0.163 cp)</td>
</tr>
<tr>
<td>Thermal conductivity, saturated liquid</td>
<td>0.0904 W/m·K (0.0522 Btu/hr·ft²·°F)</td>
</tr>
<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01309 W/m·K (0.00756 Btu/hr·ft²·°F)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pressure, liquid (bubble point)</th>
<th>2763 kPa (400.7 psia)</th>
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</thead>
<tbody>
<tr>
<td>Pressure, vapor (dew point)</td>
<td>2524 kPa (366.1 psia)</td>
</tr>
<tr>
<td>Heat of vaporization</td>
<td>130.9 kJ/kg for liquid and vapor both at nominal composition (56.3 Btu/lb)</td>
</tr>
<tr>
<td></td>
<td>113.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (48.7 Btu/lb)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperature</th>
<th>86.1 °C (186.9 °F)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>86.1 °C (187.0 °P)</td>
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<td></td>
<td>86.7 °C (188.1 °F)</td>
</tr>
<tr>
<td></td>
<td>87.3 °C (189.1 °F)</td>
</tr>
<tr>
<td>Pressure</td>
<td>4634 kPa (672.1 psia)</td>
</tr>
<tr>
<td>Density</td>
<td>513 kg/m³ (32.0 lb/cf)</td>
</tr>
<tr>
<td>Specific volume</td>
<td>1.95 L/kg (0.0312 cf/lb)</td>
</tr>
</tbody>
</table>

**Environmental**

**ODP (ozone depletion potential):** <0.00002 (mass-weighted average 9501 model-derived relative to R 11)
**GWP (global warming potential):** 1980 mass-weighted average 9501 relative to CO2 for 100 yr integration

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
SAFETY

- classification ---------------
  safety group (ASHRAE Standard 34): A1/A1 8601
  NFFA 704 degrees of hazard (H-F-R-S): AlliedSignal: 2-0-0 8601
  [-special]: 0=no, 4=severe
  NPCA HMIS hazard ratings (H-F-R): AlliedSignal: 2-0-0 MSDS
  DuPont: 1-0-1 MSDS
  health-flammability-reactivity
  0=insignificant, 4=extreme

- long-term occupational limit ------
exposure limit consistent to OSHA PEL:
  AlliedSignal PEL: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk
  ICI OEL: 1,000 ppm v/v TWA for 6B35
  8 hr/day and 40 hr/wk

- emergency exposure limit -------
  Refrigerant Concentration Limit (RCL):
  69,000 ppm v/v (preliminary value under review, based on
draft ASHRAE 34aa)

- flammability ---------------------
  LFL-UFL (flammability limits in air): none (nonflammable as tested) 5A31
  heat of combustion (by ASHRAE 34-92): -4.3 MJ/kg (-1840 Btu/lb) mfr
  -4.6 MJ/kg (-1993 Btu/lb) UL
  -4.9 MJ/kg (-2094 Btu/lb) UL
  flash point: DuPont Suva(R): 733°C (1351°F) 5931
  ICI Klea(R) 66: 704°C (1299°F) 5931
  autoignition temperature: Elf Atochem: >427°C (>800°F) MSDS
  praktically nonflammable
  autodecomposition temperature:
  former UL Classification:

- detection ----------------------
  appearance: colorless 5339
  odor: ICI: faint ether-like odor MSDS

PRODUCTION

- first commercial use as a refrigerant: 1994
  last year production allowed: unrestricted 8C01
R-407D

--------------- REFRIGERANT DATA SUMMARY ---------------
R-407D R-32/125/134a (15.0/15.0/70.0) see RDB#
zeotrope ternary blend ----

COMMON USE(S)
alternative for refrigerant 500 in ultra-low temperature cascade and
dlow-temperature (below -25 °C, -13 °F) systems, especially in
biomedical applications

IDENTIFIERS

- common name(s): R-407D; R407D; R 407D 7250
  HFC/HFC/HFC-407D, not HFC-407D 2909
- trade name(s): ICI Klea(R) 407D MSDS
- historical name(s): ICI Klea(R) 32/125/134a (15/15/70) blend

ARI container color / Pantone number: dark brown (chocolate) / 450 ARI

PHYSICAL

- nominal blend formulation ---------
  composition: R-32/125/134a 7250
  component weight fractions: 15.0 / 15.0 / 70.0 % 7250
  component weight tolerances: ±2.0 / ±2.0 / ±2.0 7250
  component mole fractions: 26.227 / 11.368 / 62.405 % 8820

- properties -----------------------
  molar mass: 90.96066 g/mol (0.200534 lb/mol) 8820
  normal boiling point --------------
  bubble point temperature: -39.4 °C (-39.0 °F) 8401
dew point temperature: -32.7 °C (-26.8 °F) 8401
  maximum temperature glide: 6.75 °C (12.2 °F) 8401
density, saturated liquid: 1384 kg/m³ (86.41 lb/cf) 8401
density, saturated vapor: 4.81 kg/m³ (0.300 lb/cf) 8401
  specific volume, saturated liquid: 0.722 L/kg (0.0116 cf/lb) 8401
  specific volume, saturated vapor: 208.1 L/kg (3.3331 cf/lb) 8401
  heat of vaporization: 240.3 kJ/kg (103.3 Btu/lb) 8401
  velocity of sound, saturated liquid: 792 m/s (2597 ft/s) 8401
  velocity of sound, saturated vapor: 154 m/s (505 ft/s) 8401
  viscosity, saturated liquid: 384 μPa·s (0.384 cp) 8401
  viscosity, saturated vapor: 9.72 μPa·s (0.00972 cp) 8401
  thermal conductivity, liquid: 0.1178 W·m·K (0.0681 Btu/hr·ft·°F) 8401
  thermal conductivity, vapor: 0.0088 W·m·K (0.0051 Btu/hr·ft·°F) 8401

- normal pressure, 20 °C (68 °F) -----
density, vapor: 3.853 kg/m³ (0.2406 lb/cf) 8401

- normal pressure, 21.1 °C (70 °F) ---
density, vapor: 3.838 kg/m³ (0.2396 lb/cf) 8401

- 20 °C (68 °F) -----------------------
  pressure, liquid (bubble point): 879.8 kPa (127.61 psia) 8401
  pressure, vapor (dew point): 750.0 kPa (108.77 psia) 8401
density, saturated liquid: 1182 kg/m³ (73.76 lb/cf) 8401
density, saturated vapor: 33.20 kg/m³ (2.073 lb/cf) 8401
  specific volume, saturated liquid: 0.846 L/kg (0.0136 cf/lb) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific volume, saturated vapor</td>
<td>30.1 L/kg (0.4824 cf/lb)</td>
</tr>
<tr>
<td>Velocity of sound, saturated vapor</td>
<td>508 m/s (1666 ft/s)</td>
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<tr>
<td>Velocity of sound, saturated vapor</td>
<td>153 m/s (502 ft/s)</td>
</tr>
<tr>
<td>Viscosity, saturated liquid</td>
<td>178 μPa·s (0.178 cp)</td>
</tr>
<tr>
<td>Viscosity, saturated vapor</td>
<td>12.0 μPa·s (0.0120 cp)</td>
</tr>
<tr>
<td>Thermal conductivity, saturated liquid</td>
<td>0.0880 W/m·K (0.0508 Btu/hr·ft²)</td>
</tr>
<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01304 W/m·K (0.00753 Btu/hr·ft²)</td>
</tr>
<tr>
<td><strong>60 °C (140 °F) ------------------------------</strong></td>
<td></td>
</tr>
<tr>
<td>Pressure, liquid (bubble point)</td>
<td>2387 kPa (346.2 psia)</td>
</tr>
<tr>
<td>Pressure, vapor (dew point)</td>
<td>2179 kPa (316.1 psia)</td>
</tr>
<tr>
<td>Heat of vaporization</td>
<td>135.8 kJ/kg for liquid and vapor</td>
</tr>
<tr>
<td>Vapor both at nominal composition (58.4 Btu/lb)</td>
<td>118.3 kJ/kg coexisting liquid and vapor at bubble-point pressure (50.9 Btu/lb)</td>
</tr>
<tr>
<td><strong>Critical point --------------------------</strong></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>91.6 °C (196.8 °F)</td>
</tr>
<tr>
<td>Pressure</td>
<td>4483 kPa (650.2 psia)</td>
</tr>
<tr>
<td>Density</td>
<td>508 kg/m³ (31.7 lb/cf)</td>
</tr>
<tr>
<td>Specific Volume</td>
<td>1.97 L/kg (0.0315 cf/lb)</td>
</tr>
</tbody>
</table>

**Environmental**

ODP (ozone depletion potential): <0.00002 mass-weighted average 9501 (model-derived relative to R 11)
<0.00036 mass-weighted average 9501 (semi-empirical relative to R 11)

GWP (global warming potential): 1820 mass-weighted average 9501 relative to CO2 for 100 yr integration

HGWP (halocarbon GWP): 0.31 mass-weighted average DW relative to R 11 for infinite integration period

**Safety**

Classification

Safety group (ASHRAE Standard 34): A1/A1
NFPA 704 degrees of hazard (H-F-R-S): ICI: 1-0-1 health-flammability-reactivity
 IC: none health-flammability-reactivity

Long-term occupational limit

Exposure limit consistent to OSHA PEL: ICI OEL: 1,000 ppm v/v TWA for 6835
8 hr/day and 40 hr/wk

Emergency exposure limit

Refrigerant Concentration Limit (RCL): 65,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

Flammability

LFL-UFL (flammability limits in air): none (nonflammable as tested)
Heat of combustion (by ASHRAE 34-92): -4.3 MJ/kg (~1864 Btu/lb)
Flash point: ICI: none (does not flash) MSDS practically nonflammable UL
 Former UL Classification: (withdrawn for revision of the classification system, category SBQT2)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Detection</th>
<th>Appearance: ICI: colorless liquified gas</th>
<th>MSDS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odor: ICI: faint ether-like odor</td>
<td>MSDS</td>
</tr>
</tbody>
</table>

**Production**

<table>
<thead>
<tr>
<th>First commercial use as a refrigerant:</th>
<th>1994</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last year production allowed:</td>
<td>Unrestricted</td>
</tr>
</tbody>
</table>

8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-407E

--- FRIGERANT DATA SUMMARY ---

R-407E  R-32/125/134a (25.0/15.0/60.0)
zeotrope  ternary blend

COMMON USE(S)
under consideration - particularly in Japan - as an alternative for refrigerator 22, both in new equipment and as a service fluid, in window and packaged air conditioners

IDENTIFIERS
common name(s): R-407E; R407E; R 407E 34f
R-32/125/134a (25/15/60)
R32/125/134a (25/15/60)
R 32/125/134a (25/15/60)
HFC/HFC/HFC-407E; not HFC-407E 34f
HFC-32/HFC-125/HFC-134a 2909
(25/15/60)
not HFC-32/125/134a (25/15/60) 2909
trade name(s): ICI Klea(R) Blend 25/15/60 MSDS
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL
- nominal blend formulation -------
  composition: R-32/125/134a 34f
  component weight fractions: 25.0 / 15.0 / 60.0 % 34f
  component weight tolerances: ±2.0 / ±2.0 / ±2.0 34f
  component mole fractions: 40.261 / 10.471 / 49.268 % 8820
- properties -----------------------
  molar mass: 83.78100 g/mol (0.184705 lb/mol) 8820
  normal boiling point -----------
  bubble point temperature: -42.8 °C (-45.1 °F) 8401
  dew point temperature: -35.6 °C (-32.0 °F) 8401
  maximum temperature glide: 7.25 °C (13.0 °F) 8401
  density, saturated liquid: 1367 kg/m³ (85.34 lb/ft³) 8401
  density, saturated vapor: 4.48 kg/m³ (0.280 lb/ft³) 8401
  specific volume, saturated liquid: 0.732 L/kg (0.0117 cf/lb) 8401
  specific volume, saturated vapor: 223.3 L/kg (3.5768 cf/lb) 8401
  heat of vaporization: 256.9 kJ/kg (110.5 Btu/lb) 8401
  velocity of sound, saturated liquid: 816 m/s (2679 ft/s) 8401
  velocity of sound, saturated vapor: 172 m/s (564 ft/s) 8401
  viscosity, saturated liquid: 368 μPa·s (0.368 cp) 8401
  viscosity, saturated vapor: 9.76 μPa·s (0.00976 cp) 8401
  thermal conductivity, liquid: 0.1269 W/m·K (0.0733 Btu/hr·ft·°F) 8401
  thermal conductivity, vapor: 0.0086 W/m·K (0.0050 Btu/hr·ft·°F) 8401
- normal pressure, 20 °C (68 °F) ------
  density, vapor: 3.545 kg/m³ (0.2213 lb/ft³) 8401
  normal pressure, 21.1 °C (70 °F) ----
  density, vapor: 3.531 kg/m³ (0.2204 lb/ft³) 8401
- 20 °C (68 °F) ---------------------
  pressure, liquid (bubble point): 999.8 kPa (145.01 psia) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure, vapor (dew point)</td>
<td>843.3 kPa (122.32 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Density, saturated liquid</td>
<td>1152 kg/m³ (71.94 lb/cf)</td>
<td>8401</td>
</tr>
<tr>
<td>Density, saturated vapor</td>
<td>34.78 kg/m³ (2.171 lb/cf)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated liquid</td>
<td>0.868 L/kg (0.0139 cf/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated vapor</td>
<td>28.8 L/kg (0.4606 cf/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Velocity of sound, saturated liquid</td>
<td>511 m/s (1675 ft/s)</td>
<td>8401</td>
</tr>
<tr>
<td>Velocity of sound, saturated vapor</td>
<td>160 m/s (524 ft/s)</td>
<td>8401</td>
</tr>
<tr>
<td>Viscosity, saturated liquid</td>
<td>165 μPa·s (0.165 cp)</td>
<td>8401</td>
</tr>
<tr>
<td>Viscosity, saturated vapor</td>
<td>12.3 μPa·s (0.0123 cp)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated liquid</td>
<td>0.0934 W/m·K (0.00540 Btu/hr·ft²·°F)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01298 W/m·K (0.00750 Btu/hr·ft²·°F)</td>
<td>8401</td>
</tr>
<tr>
<td><strong>60 °C (140 °F)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure, liquid (bubble point)</td>
<td>2679 kPa (388.5 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure, vapor (dew point)</td>
<td>2433 kPa (352.9 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Heat of vaporization</td>
<td>139.8 kJ/kg for liquid and vapor both at nominal composition (60.1 Btu/lb)</td>
<td>8401</td>
</tr>
<tr>
<td></td>
<td>119.1 kJ/kg coexisting liquid and vapor at bubble-point pressure (51.2 Btu/lb)</td>
<td>8401</td>
</tr>
<tr>
<td><strong>Critical point</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature</td>
<td>88.8 °C (191.8 °F)</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure</td>
<td>4734 kPa (686.6 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Density</td>
<td>500 kg/m³ (31.2 lb/cf)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume</td>
<td>2.00 L/kg (0.0320 cf/lb)</td>
<td>8401</td>
</tr>
</tbody>
</table>

**Environmental**

**ODP (ozone depletion potential):**
- <0.00002 mass-weighted average (model-derived relative to R 11)
- <0.00031 mass-weighted average (semi-empirical relative to R 11)

**GWP (global warming potential):**
- 1750 mass-weighted average relative to CO2 for 100 yr integration

**HGWP (halocarbon GWP):**
- 0.30 mass-weighted average relative to R 11 for infinite integration period

**Safety**

- **Classification**
  - Safety group (ASHRAE Standard 34): A1/A1
  - NFPA 704 degrees of hazard (H-F-R-S): 34f
    - Health-flammability-reactivity [-special]: 0=no, 4=severe

- **Long-term occupational limit**
  - Exposure limit consistent to OSHA PEL: ICI OEL: 1,000 ppm v/v TWA for MSDS 8 hr/day and 40 hr/wk

- **Emergency exposure limit**
  - Refrigerant Concentration Limit (RCL): 69,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

- **Flammability**
  - LFL-UFL (flammability limits in air): ICI: nonflammable as tested
  - Heat of combustion (by ASHRAE 34-92): -4.8 MJ/kg (~2084 Btu/lb)
  - Flash point: ICI: does not flash
- detection

  appearance: ICI: colorless liquified gas
  odor: ICI: faint ethereal

PRODUCTION

  first commercial use as a refrigerant: projected: 1998
  last year production allowed: unrestricted

  8C01
### R-408A

<table>
<thead>
<tr>
<th>Refrigrant Data Summary</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R-408A</td>
<td>R-125/143a/22 (7.0/46.0/47.0)</td>
</tr>
<tr>
<td>Zeotrope</td>
<td>ternary blend</td>
</tr>
</tbody>
</table>

#### COMMON USE(S)

Alternative for refrigerant 502, primarily for aftermarket use to service or retrofit existing low and medium temperature refrigeration equipment; under limited consideration as a blowing agent and aerosol propellant.

#### IDENTIFIERS

- **common name(s):** R-408A; R408A; 408A
- **trade name(s):** Elf Atochem Forane(R) 408A
- **historical name(s):** Elf Atochem Forane(R) FX-10
- **name used in U.S. EPA SNAP Rule:** HCFC Blend Epsilon
- **ARI container color / Pantone number:** medium purple / 248

#### PHYSICAL

- **nominal blend formulation ------**
  - **composition:** R-125/143a/22
  - **component weight fractions:** 7.0 / 46.0 / 47.0 %
  - **component weight tolerances:** ±2.0 / ±1.0 / ±2.0
  - **component mole fractions:** 5.075 / 47.628 / 47.297 %
- **properties --------------------**
  - **molar mass:** 87.01468 g/mol (0.191835 lb/mol)

- **normal boiling point ------------**
  - **bubble point temperature:** -45.5 °C (-49.8 °F)
  - **dew point temperature:** -45.0 °C (-49.0 °F)
  - **maximum temperature glide:** 0.46 °C (0.8 °F)
  - **density, saturated liquid:** 1293 kg/m^3 (80.70 lb/cf)
  - **density, saturated vapor:** 4.85 kg/m^3 (0.303 lb/cf)
  - **specific volume, saturated liquid:** 0.774 L/kg (0.0124 cf/lb)
  - **specific volume, saturated vapor:** 206.2 L/kg (3.3024 cf/lb)
  - **heat of vaporization:** 224.9 kJ/kg (96.7 Btu/lb)
  - **velocity of sound, saturated liquid:** 809 m/s (2653 ft/s)
  - **velocity of sound, saturated vapor:** 155 m/s (508 ft/s)
  - **viscosity, saturated liquid:** 318 μPa·s (0.318 cp)
  - **viscosity, saturated vapor:** 9.05 μPa·s (0.00905 cp)
  - **thermal conductivity, liquid:** 0.1058 W/m·K (0.0611 Btu/hr·ft·°F)
  - **thermal conductivity, vapor:** 0.0078 W/m·K (0.0045 Btu/hr·ft·°F)

- **normal pressure, 20 °C (68 °F) ------**
  - **density, vapor:** 3.678 kg/m^3 (0.2296 lb/cf)

- **normal pressure, 21.1 °C (70 °F) ---**
  - **density, vapor:** 3.664 kg/m^3 (0.2287 lb/cf)

- **20 °C (68 °F) -------------------**
  - **pressure, liquid (bubble point):** 1050.7 kPa (152.39 psia)

**SEE DATA LIMITATIONS AND NOTES ON PAGE 2**
pressure, vapor (dew point): 1042.7 kPa (151.23 psia) 8401
density, saturated liquid: 1076 kg/m³ (67.17 lb/ft³) 8401
density, saturated vapor: 46.63 kg/m³ (2.911 lb/ft³) 8401
specific volume, saturated liquid: 0.929 L/kg (0.0149 cf/lb) 8401
specific volume, saturated vapor: 21.4 L/kg (0.3435 cf/lb) 8401
velocity of sound, saturated liquid: 484 m/s (1587 ft/s) 8401
velocity of sound, saturated vapor: 151 m/s (497 ft/s) 8401
viscosity, saturated liquid: 144 μPa·s (0.144 cp) 8401
viscosity, saturated vapor: 12.0 μPa·s (0.0120 cp) 8401
thermal conductivity, saturated liquid: 0.0764 W/m·K (0.0442 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01313 W/m·K (0.00759 Btu/hr·ft·°F) 8401

60 °C (140 °F) ---------------------
pressure, liquid (bubble point): 2744 kPa (398.0 psia) 8401
pressure, vapor (dew point): 2733 kPa (396.4 psia) 8401
heat of vaporization: 112.7 kJ/kg for liquid and vapor both at nominal composition (48.4 Btu/lb)
112.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (48.4 Btu/lb)

Critical Point -------------------
temperature: 83.3 °C (182.0 °F) 8401
pressure: 4424 kPa (641.6 psia) 8401
density: 481 kg/m³ (30.0 lb/ft³) 8401
specific volume: 2.08 L/kg (0.0333 cf/lb) 8401

Environmental

ODP (ozone depletion potential): 0.016 mass-weighted average (model-derived relative to R 11)
0.024 mass-weighted average (semi-empirical relative to R 11) 9501

GWP (global warming potential): 3640 mass-weighted average relative to CO2 for 100 yr integration 9501
HGWP (halocarbon GWP): 0.64 mass-weighted average relative to R 11 for infinite integration period DW

Safety

classification ----------------------
safety group (ASHRAE Standard 34): A1/A1 8601
Refrigerant Concentration Limit (RCL): 47,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

flammability ----------------------
LFL-UFL (flammability limits in air): none (nonflammable as tested) 4770
heat of combustion (by ASHRAE 34-92): 5.7 MJ/kg (2435 Btu/lb) UL
flash point: Atchem: gas, not applicable MSDS
autoignition temperature: 698 °C (1288 °F) 5931
former UL Classification: practically nonflammable 6938
(withdrawn for revision of the classification system, category SBQT2)

detection ------------------------
appearance: Elf Atochem: clear, colorless  MSDS
odor: Elf Atochem: faint ethereal  MSDS

PRODUCTION
first commercial use as a refrigerant: circa 1994
last year production allowed: 2029 based on refrigerant 22  8C01
in developed countries under the Montreal Protocol
R-409A

--- REFRIGERANT DATA SUMMARY ---

R-409A  R-22/124/142b (60.0/25.0/15.0)  see
zeotrope  ternary blend  RDB#

COMMON USE(S)
For refrigerant 12, primarily for aftermarket use to
service or retrofit low- and medium-temperature refrigeration
systems; promoted where removal of residual mineral oil is difficult,
preventing use of refrigerant 134a, such as those with small hermetic
compressors (e.g., vending machines).

IDENTIFIERS

common name(s):  R-409A; R409A; R 409A  6101
HCFC/HCFC/HCFC-409A  6101
not HCFC-409A  6101

trade name(s):  AlliedSignal Genetron(R) 409A  MSDS
Elf Atochem Forane(R) 409A  MSDS
HRP (UK) HARP(R) 409A  MSDS
ICI Arcton(R) 409A  CSDS
Solvay R409A  6101

historical name(s):  Elf Atochem Forane(R) FX-56  4771
name used in U.S. EPA SNAP Rule:  HCFC Blend Gamma
ARI container color / Pantone number:  medium brown (tan) / 465  6601

PHYSICAL

nominal blend formulation ---------
composition:  R-22/124/142b  6101
component weight fractions:  60.0 / 25.0 / 15.0 %  6101
component weight tolerances:  ±2.0 / ±2.0 / ±1.0  6101
component mole fractions:  67.609 / 17.848 / 14.543 %  8820

properties ------------------------
molar mass:  97.43345 g/mol (0.214804 lb/mol)  8820

normal boiling point ----------
bubble point temperature:  -35.4 °C (-31.8 °F)  8401
dew point temperature:  -26.1 °C (-15.0 °F)  4136
-27.5 °C (-17.6 °F)  8401
maximum temperature glide:  7.89 °C (14.2 °F)  8401
density, saturated liquid:  1395 kg/m3 (87.07 lb/cf)  8401
5 kg/m3 (0.31 lb/cf)  8401
specific volume, saturated vapor:  199.4 L/kg (3.1944 cf/lb)  8401
heat of vaporization:  220.2 kJ/kg (94.7 Btu/lb)  8401
velocity of sound, saturated liquid:  806 m/s (2644 ft/s)  8401
velocity of sound, saturated vapor:  152 m/s (498 ft/s)  8401
viscosity, saturated liquid:  365 µPa·s (0.365 cp)  8401
viscosity, saturated vapor:  9.85 µPa·s (0.00985 cp)  8401
thermal conductivity, liquid:  0.1028 W/m·K (0.0594 Btu/hr·ft·°F)  8401
thermal conductivity, vapor:  0.0078 W/m·K (0.0045 Btu/hr·ft·°F)  8401

normal pressure, 20 °C (68 °F) -----
density, vapor:  4.128 kg/m3 (0.2577 lb/cf)  8401

normal pressure, 21.1 °C (70 °F) ---
**density, vapor:** 4.112 kg/m³ (0.2567 lb/ft³) 8401

| 20 °C (68 °F) | pressure, liquid (bubble point): 725.2 kPa (105.17 psia) | 8401 |
|              | pressure, vapor (dew point): 592.8 kPa (85.98 psia) | 8401 |
|              | density, saturated liquid: 1223 kg/m³ (76.34 lb/ft³) | 8401 |
|              | density, saturated vapor: 27.00 kg/m³ (1.685 lb/ft³) | 8401 |
|              | specific volume, saturated liquid: 0.818 L/kg (0.0131 cf/lb) | 8401 |
|              | specific volume, saturated vapor: 37.0 L/kg (0.5934 cf/lb) | 8401 |
|              | velocity of sound, saturated liquid: 559 m/s (1833 ft/s) | 8401 |
|              | velocity of sound, saturated vapor: 154 m/s (504 ft/s) | 8401 |
|              | viscosity, saturated liquid: 193 μPa·s (0.193 cp) | 8401 |
|              | viscosity, saturated vapor: 11.8 μPa·s (0.0118 cp) | 8401 |
| thermal conductivity, saturated liquid: | 0.0799 W/m·K (0.0462 Btu/hr·ft²°F) | 8401 |
| thermal conductivity, saturated vapor: | 0.01080 W/m·K (0.00624 Btu/hr·ft²°F) | 8401 |

| 60 °C (140 °F) | pressure, liquid (bubble point): 1941 kPa (281.5 psia) | 8401 |
|               | pressure, vapor (dew point): 1714 kPa (248.6 psia) | 8401 |
|               | heat of vaporization: 141.6 kJ/kg for liquid and vapor both at nominal composition (60.9 Btu/lb) | 8401 |
|               | 125.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.0 Btu/lb) | 8401 |

**critical point**

| temperature: | 106.9 °C (224.4 °F) | 8401 |
| pressure:    | 4499 kPa (652.5 psia) | 4771 |
|              | 4693 kPa (680.7 psia) | 8401 |
| density:     | 508 kg/m³ (31.7 lb/ft³) | 8401 |
| specific volume: | 1.97 L/kg (0.0316 cf/lb) | 8401 |

**ENVIRONMENTAL**

ODP (ozone depletion potential):
- 0.039 mass-weighted average (model-derived relative to R 11)
- 0.046 mass-weighted average (semi-empirical relative to R 11)

GWP (global warming potential):
- 1640 mass-weighted average relative to CO₂ for 100 yr integration

HGWP (halocarbon GWP):
- 0.27 mass-weighted average relative to R 11 for infinite integration period

**SAFETY**

classification

| safety group (ASHRAE Standard 34): | Al/Al | 8601 |
| NFFA 704 degrees of hazard (H-F-R-S): | AlliedSignal: 2-0-0 | MSDS |
| NPCA HMIS hazard ratings (H-F-R): | health-flammability-reactivity [-special]: 0=no, 4=severe | AlliedSignal: 2-0-0 | MSDS |
| long-term occupational limit ------ | health-flammability-reactivity | 0=insignificant, 4=extreme |
| exposure limit consistent to OSHA PEL: | Solvay SAEL: 1,000 ppm v/v TWA | MSDS |
| emergency exposure limit ---- | for 8 hr/day and 40 hr/wk |  |
Refrigerant Database

Refrigerant Concentration Limit (RCL): 20,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

flammability ---------------------
LFL-UFL (flammability limits in air): none (nonflammable as tested)  4136
heat of combustion (by ASHRAE 34-92): 3.0 MJ/kg (1296 Btu/lb)  UL
flash point: AlliedSignal: none  MSDS
Elf Atochem: not applicable  MSDS
autoignition temperature: 704 °C (1299 °F)  5931
autodecomposition temperature: AlliedSignal: >250°C (>482°F)  MSDS
former UL Classification: practically nonflammable  6938
(withdrawn for revision of the classification system, category SBQ2)

detection -----------------------
appearance: AlliedSignal: clear, colorless MSDS
odor: AlliedSignal: faint ethereal MSDS

PRODUCTION
first commercial use as a refrigerant: 1993  8C01
last year production allowed: 2029 by components in developed countries under the Montreal Protocol
R-409B

R-409B  R-22/124/142b (65.0/25.0/10.0)  see
zeotrope  binary blend  RDB#

COMMON USE(S)
alternative for refrigerants 12 and 500, primarily for aftermarket
use to service or retrofit transport refrigeration

IDENTIFIERS

common name(s):  R-409B; R409B; R-409B 6801
HCFC/HCFC/HCFC-409B  6801
not HCFC-409B  2909
trade name(s):  Elf Atochem Forane(R) 409B
Elf Atochem Forane(R) FX-57 MSDS
ARI container color / Pantone number:  none, use light green grey/413 6601

PHYSICAL

nominal blend formulation  ---------

composition:  R-22/124/142b  6801
component weight fractions:  65.0 / 25.0 / 10.0 %  6801
component weight tolerances: ±2.0 / ±2.0 / ±1.0  6801
component mole fractions:  72.671 / 17.709 / 9.620 %  8820

properties  --------------------------
molar mass:  96.67323 g/mol (0.213128 lb/mol)  8820

normal boiling point  ------------
bubble point temperature:  -36.5 °C (-33.7 °F)  8401
dew point temperature:  -29.7 °C (-21.5 °F)  8401
maximum temperature glide:  6.82 °C (12.3 °F)  8401
density, saturated liquid:  1406 kg/m3 (87.79 lb/cf)  8401
density, saturated vapor:  5.02 kg/m3 (0.313 lb/cf)  8401
specific volume, saturated liquid:  0.711 L/kg (0.0114 cf/lb)  8401
specific volume, saturated vapor:  199.2 L/kg (3.1916 cf/lb)  8401
heat of vaporization:  219.6 kJ/kg (94.4 Btu/lb)  8401
velocity of sound, saturated liquid:  807 m/s (2649 ft/s)  8401
velocity of sound, saturated vapor:  156 m/s (513 ft/s)  8401
viscosity, saturated liquid:  362 µPa·s (0.362 cp)  8401
viscosity, saturated vapor:  9.88 µPa·s (0.00988 cp)  8401
thermal conductivity, liquid:  0.1035 W/m·K (0.0598 Btu/hr·ft°F)  8401
thermal conductivity, vapor:  0.0077 W/m·K (0.0044 Btu/hr·ft°F)  8401

normal pressure, 20 °C (68 °F)  ----
density, vapor:  4.093 kg/m3 (0.2555 lb/cf)  8401

normal pressure, 21.1 °C (70 °F)  ----
density, vapor:  4.077 kg/m3 (0.2545 lb/cf)  8401

20 °C (68 °F)  --------------
pressure, liquid (bubble point):  758.5 kPa (110.01 psia)  8401
pressure, vapor (dew point):  640.6 kPa (92.91 psia)  8401
density, saturated liquid:  1227 kg/m3 (76.62 lb/cf)  8401
density, saturated vapor:  29.16 kg/m3 (1.820 lb/cf)  8401
specific volume, saturated liquid:  0.815 L/kg (0.0131 cf/lb)  8401
specific volume, saturated vapor:  34.3 L/kg (0.5494 cf/lb)  8401
velocity of sound, saturated liquid: 554 m/s (1817 ft/s) 8401
velocity of sound, saturated vapor: 154 m/s (504 ft/s) 8401
viscosity, saturated liquid: 189 µPa·s (0.189 cp) 8401
viscosity, saturated vapor: 12.0 µPa·s (0.0120 cp) 8401
thermal conductivity, saturated liquid: 0.0800 W/m·K (0.0462 Btu/hr·ft°F) 8401
thermal conductivity, saturated vapor: 0.01081 W/m·K (0.00624 Btu/hr·ft°F) 8401

- 60 °C (140 °F) -----------------
  pressure, liquid (bubble point): 2028 kPa (294.1 psia) 8401
  pressure, vapor (dew point): 1830 kPa (265.5 psia) 8401
  heat of vaporization: 139.1 kJ/kg for liquid and vapor both at nominal composition (59.8 Btu/lb) 8401
  124.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (53.6 Btu/lb) 8401

- critical point -----------------
  temperature: 104.4 °C (219.9 °F) 8401
  pressure: 4711 kPa (683.3 psia) 8401
  density: 511 kg/m³ (31.9 lb/ft³) 8401
  specific volume: 1.96 L/kg (0.0313 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): 0.033 mass-weighted average (model-derived relative to R 11) 9501
GWP (global warming potential): 0.046 mass-weighted average (semi-empirical relative to R 11) 9501
HGWP (halocarbon GWP): 1620 mass-weighted average relative to CO₂ for 100 yr integration 9501

SAFETY

- classification -------------------
  safety group (ASHRAE Standard 34): A1/Al 8601
  safety group (IARC): Group 5A 8601

- emergency exposure limit ----------
  Refrigerant Concentration Limit (RCL): 20,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

- flammability ---------------------
  LFL-UFL (flammability limits in air): none (nonflammable as tested) 4136
  flash point: Elf Atochem: not applicable MSDS
  autoignition temperature: 698 °C (1288 °F) UL
  former UL Classification: practically nonflammable UL
  (withdrawn for revision of the classification system, category SBQT2)

- detection ------------------------
  appearance: Elf Atochem: clear, colorless MSDS
  odor: Elf Atochem: faint ethereal MSDS

PRODUCTION

first commercial use as a refrigerant: 1994
last year production allowed: 2029 by components in 8CO1
developed countries under the Montreal Protocol
R-410A

--- REFRIERGANT DATA SUMMARY ---

R-410A  R-32/125 (50.0/50.0)  see
zeotrope  binary blend  RDB#

COMMON USE(S)
replacement for refrigerant 22 for new residential and
light-commercial air conditioners and heat pumps, chillers, and
commercial refrigeration; aftermarket use to retrofit existing
chillers with components approved for high pressure; replacement for
refrigerant 13B1 in industrial refrigeration; under consideration as a
fire suppressant in aviation systems; may be covered by U.S. patent
4,978,467

IDENTIFIERS
common name(s):  R-410A; R410A; R 410A  6101
HFC/HFC-410A; not HFC-410A  6101
trade name(s):  AlliedSignal Genetron(R) AZ-20  3A59
Carrier Puron(TM)  mfr
Daikin R-410A  MSDS
DuPont Suva(R) 9100 (>May1996)  MSDS
Elf Atochem Forane(R) 410A  MSDS
Solvay Solkane(R) 410  6101
Solvay Solkane(R) 410A

ARI container color / Pantone number:  rose / 507  6601

PHYSICAL
nominal blend formulation  ---------------
composition:  R-32/125  6101
50.0 / 50.0 %  6101
component weight fractions:
component weight tolerances:  +0.5,-1.5 / +1.5,-0.5  6101
component mole fractions:  69.762 / 30.238 %  8820
properties  ----------------------
molar mass:  72.58481 g/mol (0.160022 lb/mol)  8820

normal boiling point  ---------------
temperature:  -52.7 °C (-62.9 °F)  5338
bubble point temperature:  -51.6 °C (-60.9 °F)  8401
dew point temperature:  -51.5 °C (-60.8 °F)  8401
maximum temperature glide:  0.05 °C (0.1 °F)  8401
density, saturated liquid:  1351 kg/m3 (84.33 lb/cf)  8401
density, saturated vapor:  4.17 kg/m3 (0.261 lb/cf)  8401
4.19 kg/m3 (0.262 lb/cf)  5338
specific volume, saturated liquid:  0.740 L/kg (0.0119 cf/lb)  8401
specific volume, saturated vapor:  239.6 L/kg (3.8377 cf/lb)  8401
heat of vaporization:
256.7 kJ/kg (110.3 Btu/lb)  5338
271.5 kJ/kg (116.7 Btu/lb)  8401

velocity of sound, saturated liquid:  845 m/s (2773 ft/s)  8401
velocity of sound, saturated vapor:  169 m/s (556 ft/s)  8401
viscosity, saturated liquid:  314 µPa·s (0.314 cp)  8401
viscosity, saturated vapor:  9.79 µPa·s (0.00979 cp)  8401
thermal conductivity, liquid:  0.1454 W/m·K (0.0840 Btu/hr·ft°F)  8401
thermal conductivity, vapor:  0.0081 W/m·K (0.0047 Btu/hr·ft°F)  8401
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<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
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<td>Btu/hr·ft²°F</td>
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<td>density, vapor:</td>
<td>3.061 kg/m³ (0.1911 lb/cf)</td>
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<td>density, saturated liquid:</td>
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<td>density, saturated vapor:</td>
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<td>60 °C (140 °F)</td>
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<td>pressure, vapor (dew point):</td>
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<td>heat of vaporization:</td>
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<td>critical point</td>
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<tr>
<td>specific volume:</td>
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**ENVIRONMENTAL**

- **ODP (ozone depletion potential):** <0.00002 mass-weighted average 9501 (model-derived relative to R 11)
- **GWP (global warming potential):** 2340 mass-weighted average 9501 relative to CO2 for 100 yr integration
- **HGWP (halocarbon GWP):** 0.39 mass-weighted average DW relative to R 11 for infinite integration period

**SAFETY**

- **classification** ---------------------
  - safety group (ASHRAE Standard 34): A1/A1 8601
  - NFPA 704 degrees of hazard (H-F-R-S): AlliedSignal: 2-0-1 MSDS health-flammability-reactivity
NPCA HMIS hazard ratings (H-F-R):
[-special]: 0=no, 4=severe
AlliedSignal: 1-0-1
DuPont: 1-0-1

health-flammability-reactivity
0=insignificant, 4=extreme

• long-term occupational limit -------
exposure limit consistent to OSHA PEL:
7110

• emergency exposure limit ----------
Refrigerant Concentration Limit (RCL):
55,000 ppm v/v (preliminary value under review, based on
draft ASHRAE 34aa)

• flammability -----------------------
LFL-UFL (flammability limits in air):
none (nonflammable as tested) 3A59
-4.4 MJ/kg (-1875 Btu/lb) UL
heat of combustion (by ASHRAE 34-92):
AlliedSignal: not applicable MSDS
DuPont: will not burn MSDS
flash point:
732 °C (1350 °F) 5931
AlliedSignal: >750°C (>1382°F) MSDS
autoignition temperature:
Elf Atochem: >427 °C (>800 °F) MSDS
autodecomposition temperature:
practically nonflammable 6938
(former UL Classification:
(withdrawn for revision of the
classification system, category SBQ72)

• detection ------------------------
appearance: DuPont: clear, colorless MSDS
odor: AlliedSignal: faint ethereal MSDS

PRODUCTION
last year production allowed: unrestricted 8C01
R-410B

------------------------- REFRIGERANT DATA SUMMARY -------------------------
R-410B  R-32/125 (45.0/55.0)  see RDB#
zeotrope  binary blend  ----

COMMON USE(S)
alternative for refrigerant 22 in new air conditioners and heat pumps
designed for higher discharge pressures

IDENTIFIERS
common name(s):  R-410B; R410B; R 410B  6101
HFC/HFC-410B, not HFC-410B
historical name(s):  before May 1996:
DuPont Suva(R)  9100
ARI container color / Pantone number:  maroon / 194  6601

PHYSICAL
• nominal blend formulation -------
  composition:  R-32/125  6101
  component weight fractions:  45.0 / 55.0 %  6101
  component weight tolerances:  ±1.0 / ±1.0  6101
  component mole fractions:  65.369 / 34.631 %  8820
• properties -----------------------
  molar mass:  75.57166 g/mol (0.166607 lb/mol)  8820
  normal freezing/melting/triple point:  -95.3 °C (-139.6 °F)
  • normal boiling point ---------
    bubble point temperature:  -51.5 °C (-60.7 °F)  8401
dew point temperature:  -51.4 °C (-60.6 °F)  8401
maximum temperature glide:  0.08 °C (0.1 °F)  8401
density, saturated liquid:  1367 kg/m³ (85.31 lb/cf)  8401
density, saturated vapor:  4.34 kg/m³ (0.271 lb/cf)  8401
specific volume, saturated liquid:  0.732 L/kg (0.0117 cf/lb)  8401
specific volume, saturated vapor:  230.2 L/kg (3.6787 cf/lb)  8401
heat of vaporization:  260.7 kJ/kg (112.1 Btu/lb)  8401
velocity of sound, saturated liquid:  833 m/s (2733 ft/s)  8401
velocity of sound, saturated vapor:  166 m/s (543 ft/s)  8401
viscosity, saturated liquid:  321 μPa·s (0.321 cp)  8401
viscosity, saturated vapor:  9.81 μPa·s (0.00981 cp)  8401
thermal conductivity, liquid:  0.1405 W/m·K (0.0812 Btu/hr·ft°F)  8401
thermal conductivity, vapor:  0.0081 W/m·K (0.0047 Btu/hr·ft°F)  8401
  • normal pressure, 20 °C (68 °F) ----
density, vapor:  3.187 kg/m³ (0.1990 lb/cf)  8401
  • normal pressure, 21.1 °C (70 °F) ---
density, vapor:  3.174 kg/m³ (0.1962 lb/cf)  8401
• 20 °C (68 °F)---------------------
  pressure, liquid (bubble point):  1434.1 kPa (208.00 psia)  8401
  pressure, vapor (dew point):  1428.2 kPa (207.14 psia)  8401
density, saturated liquid:  1097 kg/m³ (68.48 lb/cf)  8401
density, saturated vapor:  58.49 kg/m³ (3.651 lb/cf)  8401
specific volume, saturated liquid:  0.912 L/kg (0.0146 cf/lb)  8401
specific volume, saturated vapor:  17.1 L/kg (0.2739 cf/lb)  8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
velocity of sound, saturated liquid: 460 m/s (1509 ft/s) 8401
velocity of sound, saturated vapor: 160 m/s (524 ft/s) 8401
viscosity, saturated liquid: 130 μPa·s (0.130 cp) 8401
viscosity, saturated vapor: 13.6 μPa·s (0.0136 cp) 8401
thermal conductivity, saturated liquid: 0.0972 W/m·K (0.0562 Btu/hr·ft°F) 8401
thermal conductivity, saturated vapor: 0.01441 W/m·K (0.00833 Btu/hr·ft°F) 8401

- 60 °C (140 °F) ------------------------
  pressure, liquid (bubble point): 3807 kPa (552.1 psia) 8401
  pressure, vapor (dew point): 3798 kPa (550.8 psia) 8401
  heat of vaporization: 101.0 kJ/kg for liquid and 94.2 kJ/kg for vapor both at nominal composition (43.4 Btu/lb) 8401
  vapor at bubble-point pressure (42.2 Btu/lb) 8401

- critical point ------------------------
  temperature: 69.5 °C (157.0 °F) 8401
  71.0 °C (159.9 °F) 5A51
  pressure: 4665 kPa (676.6 psia) 8401
  4780 kPa (693.2 psia) 5A51
  density: 495 kg/m3 (30.9 lb/cf) 8401
  561 kg/m3 (35.0 lb/cf) 5A51
  specific volume: 1.78 L/kg (0.0285 cf/lb) 8401
  2.02 L/kg (0.0323 cf/lb) 5A51

ENVIRONMENTAL
ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
(model-derived relative to R 11)
GWP (global warming potential): 2490 mass-weighted average 9501
relative to CO2 for 100 yr integration
HGWP (halocarbon GWP): 0.42 mass-weighted average 9501
relative to R 11 for infinite integration period

SAFETY
- classification ------------------------
  safety group (ASHRAE Standard 34): A1/A1 8601
  NPCA HMIS hazard ratings (H-F-R): DuPont: 1-0-1 MSDS
  health-flammability-reactivity
  0=insignificant, 1=extreme
- emergency exposure limit ----------
  Refrigerant Concentration Limit (RCL): 58,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)
- flammability ------------------------
  LFL-UFL (flammability limits in air): none (nonflammable as tested) MSDS
  flash point: DuPont: will not burn MSDS
  725 °C (1337 °F) 5931
  autoignition temperature: practically nonflammable 5931
  former UL Classification: (withdrawn for revision of the classification system, category SBQT2)
- detection --------------------------
  appearance: DuPont: clear, colorless MSDS
  odor: DuPont: slight ethereal MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
| PRODUCTION | last year production allowed: unrestricted | 8C01 |
R-411A

------------------------ REFRIGERANT DATA SUMMARY ------------------------

R-411A  R-1270/22/152a (1.5/87.5/11.0)  see
zeotrope  ternary blend  RDB#

COMMON USE(S)
service fluid for aftermarket use to replace refrigerant 22

IDENTIFIERS

common name(s):  R-411A; R411A; R 411A  6101
            HC/HcFC/HFC-411A  6101
            not HCFC-411A  6101
trade name(s):  ATG R-411A  6101
            China Sun Group G2018a  6101
            Cool-Ex R411A  6101
            Greencool (Gu) G2018a  6101
ARI container color / Pantone number:  dark purple (violet) / 266  8820
            with red / 185 band  8820

PHYSICAL

• nominal blend formulation --------
  composition:  R-1270/22/152a  6101
  component weight fractions:  1.5 / 87.5 / 11.0 %  6101
  component weight tolerances:  +0.0, -1.0 / +2.0, -0.0 /  6101
  component mole fractions:  2.936 / 83.347 / 13.37 %  8820
• properties ------------------------
  molar mass:  82.36415 g/mol (0.181582 lb/mol)  8820
  normal freezing/melting/triple point:  -120.0 °C (-184.0 °F)  MSDS
  normal boiling point ----------------
  bubble point temperature:  -39.7 °C (-39.4 °F)  8401
  dew point temperature:  -37.2 °C (-35.0 °F)  8401
  maximum temperature glide:  2.44 °C (4.4 °F)  8401
  density, saturated liquid:  1328 kg/m³ (82.87 lb/cf)  8401
  density, saturated vapor:  4.41 kg/m³ (0.276 lb/cf)  8401
  specific volume, saturated liquid:  0.753 L/kg (0.0121 cf/lb)  8401
  specific volume, saturated vapor:  226.6 L/kg (3.6290 cf/lb)  8401
  heat of vaporization:  249.6 kJ/kg (107.3 Btu/lb)  8401
  velocity of sound, saturated liquid:  865 m/s (2838 ft/s)  8401
  velocity of sound, saturated vapor:  165 m/s (540 ft/s)  8401
  viscosity, saturated liquid:  340 μPa·s (0.340 cp)  8401
  viscosity, saturated vapor:  9.65 μPa·s (0.00965 cp)  8401
  thermal conductivity, liquid:  0.1162 W/m·K (0.0671
  Btu/hr·ft·°F)  8401
  thermal conductivity, vapor:  0.0074 W/m·K (0.0043
  Btu/hr·ft·°F)  8401
• normal pressure, 20 °C (68 °F) ------
  density, vapor:  3.481 kg/m³ (0.2173 lb/cf)  8401
• normal pressure, 21.1 °C (70 °F) ---
  density, vapor:  3.467 kg/m³ (0.2165 lb/cf)  8401
• 20 °C (68 °F) ------------------------
  pressure, liquid (bubble point):  860.3 kPa (124.77 psia)  8401
  pressure, vapor (dew point):  820.0 kPa (118.93 psia)  8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
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<thead>
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<th>Property</th>
<th>Value</th>
<th>Page</th>
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<td>specific volume, saturated liquid:</td>
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<td>pressure</td>
<td>4954 kPa (718.5 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>density</td>
<td>488 kg/m³ (30.4 lb/cf)</td>
<td>8401</td>
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<tr>
<td>specific volume</td>
<td>2.05 L/kg (0.0329 cf/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>ENVIRONMENTAL</td>
<td></td>
<td>8401</td>
</tr>
<tr>
<td>ODP (ozone depletion potential):</td>
<td>0.030 mass-weighted average (model-derived relative to R 11)</td>
<td>9501</td>
</tr>
<tr>
<td></td>
<td>0.044 mass-weighted average (semi-empirical relative to R 11)</td>
<td>9501</td>
</tr>
<tr>
<td>GWP (global warming potential):</td>
<td>1680 mass-weighted average relative to CO2 for 100 yr integration</td>
<td>9501</td>
</tr>
<tr>
<td>HGWP (halocarbon GWP):</td>
<td>0.28 mass-weighted average relative to R 11 for infinite integration period</td>
<td>DW</td>
</tr>
<tr>
<td>SAFETY</td>
<td></td>
<td>8601</td>
</tr>
<tr>
<td>classification</td>
<td>A1/A2</td>
<td>8601</td>
</tr>
<tr>
<td>long-term occupational limit ----------------</td>
<td>Greencool AEL: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk</td>
<td>8601</td>
</tr>
<tr>
<td>exposure limit consistent to OSHA PEL:</td>
<td></td>
<td>8601</td>
</tr>
<tr>
<td>emergency exposure limit --------------------</td>
<td>28,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)</td>
<td>8601</td>
</tr>
<tr>
<td>Refrigerant Concentration Limit (RCL):</td>
<td></td>
<td>8601</td>
</tr>
<tr>
<td>flammability</td>
<td>none (nonflammable as tested)</td>
<td>8601</td>
</tr>
<tr>
<td>LFL-UFL (flammability limits in air):</td>
<td>worst fractionation flammable mfr</td>
<td>8601</td>
</tr>
<tr>
<td>flash point:</td>
<td>Greencool: none</td>
<td>8601</td>
</tr>
<tr>
<td>detection</td>
<td>appearance: Greencool: clear, colorless</td>
<td>8601</td>
</tr>
<tr>
<td></td>
<td>odor: Greencool: slight ethereal</td>
<td>8601</td>
</tr>
</tbody>
</table>
PRODUCTION

first commercial use as a refrigerant: 1996
last year production allowed: 2029 based on refrigerant 22
in developed countries under the Montreal Protocol
R-411B

--- REFRIGERANT DATA SUMMARY ---

R-411B  R-1270/22/152a (3.0/94.0/3.0)  see
zeotrope  ternary blend  RDB#

COMMON USE(S)
- service fluid for aftermarket use to replace refrigerant 502 in commercial refrigeration and food warehouses

IDENTIFIERS
- common name(s):  R-411B; R411B; R 411B  6101
  HC/HCFC/HFC-411B  6101
  not HCFC-411B  6101
- trade name(s):  ATG R-411B  6101
  China Sun Group G2018b
  Cool-Ex R411B
  Greencool (Gu) G2018b
- ARI container color / Pantone number:  blue-green (teal) / 326
  with red / 185 band

PHYSICAL
- nominal blend formulation
  composition:  R-1270/22/152a  6101
  component weight fractions:  3.0 / 94.0 / 3.0 %  6101
  component weight tolerances:  +0.0,-1.0/+2.0,-0.0/+0.0,-1.0  6101
  component mole fractions:  5.922 / 90.305 / 3.773 %  8820
- properties
  molar mass:  83.06897 g/mol (0.183136 lb/mol)  8820
  normal freezing/melting/triple point:  -119.0 °C (-182.2 °F)  MSDS
  normal boiling point
    bubble point temperature:  -41.6 °C (-42.9 °F)  8401
    dew point temperature:  -41.3 °C (-42.3 °F)  8401
    maximum temperature glide:  0.31 °C (0.6 °F)  8401
    density, saturated liquid:  1342 kg/m³ (83.75 lb/cf)  8401
    density, saturated vapor:  4.51 kg/m³ (0.281 lb/cf)  8401
    specific volume, saturated liquid:  0.745 L/kg (0.0119 cf/lb)  8401
    specific volume, saturated vapor:  221.8 L/kg (3.5531 cf/lb)  8401
    heat of vaporization:  243.4 kJ/kg (104.6 Btu/lb)  8401
    velocity of sound, saturated liquid:  865 m/s (2837 ft/s)  8401
    velocity of sound, saturated vapor:  163 m/s (536 ft/s)  8401
    viscosity, saturated liquid:  339 μPa·s (0.339 cp)  8401
    viscosity, saturated vapor:  9.63 μPa·s (0.00963 cp)  8401
    thermal conductivity, liquid:  0.1164 W/m·K (0.0672 Btu/hr·ft·°F)  8401
    thermal conductivity, vapor:  0.0073 W/m·K (0.0042 Btu/hr·ft·°F)  8401
- normal pressure, 20 °C (68 °F)
  density, vapor:  3.508 kg/m³ (0.2190 lb/cf)  8401
- normal pressure, 21.1 °C (70 °F)
  density, vapor:  3.494 kg/m³ (0.2181 lb/cf)  8401
- 20 °C (68 °F)
  pressure, liquid (bubble point):  918.3 kPa (133.19 psia)  8401
  pressure, vapor (dew point):  899.0 kPa (130.39 psia)  8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Page</th>
</tr>
</thead>
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<tr>
<td>density, saturated liquid</td>
<td>1150 kg/m³ (71.77 lb/cf)</td>
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<td>density, saturated vapor</td>
<td>36.48 kg/m³ (2.277 lb/cf)</td>
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<tr>
<td>specific volume, saturated liquid</td>
<td>0.870 L/kg (0.0139 cf/lb)</td>
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<td>specific volume, saturated vapor</td>
<td>27.4 L/kg (0.4391 cf/lb)</td>
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<tr>
<td>velocity of sound, saturated liquid</td>
<td>571 m/s (1872 ft/s)</td>
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<tr>
<td>velocity of sound, saturated vapor</td>
<td>164 m/s (539 ft/s)</td>
<td>8401</td>
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<td>viscosity, saturated liquid</td>
<td>169 μPa·s (0.169 cp)</td>
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<tr>
<td>viscosity, saturated vapor</td>
<td>12.2 μPa·s (0.0122 cp)</td>
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<td>thermal conductivity, saturated liquid</td>
<td>0.0876 W/m·K (0.0056 Btu/hr·ft²°F)</td>
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<tr>
<td>thermal conductivity, saturated vapor</td>
<td>0.01136 W/m·K (0.00656 Btu/hr·ft²°F)</td>
<td>8401</td>
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<td>60 °C (140 °F)</td>
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<tr>
<td>pressure, liquid (bubble point)</td>
<td>2430 kPa (352.5 psia)</td>
<td>8401</td>
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<tr>
<td>pressure, vapor (dew point)</td>
<td>2406 kPa (348.9 psia)</td>
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<tr>
<td>heat of vaporization</td>
<td>145.0 kJ/kg for liquid and vapor both at nominal composition (62.3 Btu/lb)</td>
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<td>critical point</td>
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<td>ODP (ozone depletion potential)</td>
<td>0.032 mass-weighted average (model-derived relative to R 11)</td>
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<td>GWP (global warming potential)</td>
<td>1790 mass-weighted average relative to CO₂ for 100 yr integration</td>
<td>9501</td>
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<td>HGWFP (halocarbon GWP)</td>
<td>0.30 mass-weighted average relative to R 11 for infinite integration</td>
<td>DW</td>
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<td>SAFETY</td>
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<td>classification</td>
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<td>safety group (ASHRAE Standard 34)</td>
<td>Greencool AEL: 1,000 ppm v/v</td>
<td>MSDS</td>
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<td>long-term occupational limit</td>
<td>TWA for 8 hr/day and 40 hr/wk</td>
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<td>exposure limit consistent to OSHA PEL</td>
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<td>emergency exposure limit</td>
<td>27,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)</td>
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<td>Refrigerant Concentration Limit (RCL)</td>
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<tr>
<td>flammability</td>
<td>none (nonflammable as tested) mfr</td>
<td>MSDS</td>
</tr>
<tr>
<td>LFL-UFL (flammability limits in air)</td>
<td>worst fractionation flammable mfr</td>
<td></td>
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<tr>
<td>flash point</td>
<td>Greencool: none</td>
<td>MSDS</td>
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<tr>
<td>detection</td>
<td>appearance: Greencool: clear, colorless</td>
<td>MSDS</td>
</tr>
<tr>
<td></td>
<td>odor: Greencool: slight ethereal</td>
<td>MSDS</td>
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</table>

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>PRODUCTION</th>
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<tbody>
<tr>
<td><strong>first commercial use as a refrigerant:</strong> 1996</td>
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<tr>
<td><strong>last year production allowed:</strong> 2029 based on refrigerant 22 in developed countries under the Montreal Protocol</td>
</tr>
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<td>mfr 8C01</td>
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</table>
R-411C

--- REFRIGERANT DATA SUMMARY ---

R-411C R-1270/22/152a (3.0/95.5/1.5) see RDB#
zeotrope ternary blend ----

COMMON USE(S)

alternative for refrigerants 12, 22, 500, and 502 in air-conditioning and refrigeration applications with evaporator temperatures of -20 to 10 °C (-4 to 50 °F) and condensing temperatures of 25 to 60 °C (77 to 140 °F)

Note: The designation, tolerances, and safety classification indicated for this refrigerant were proposed, with contingencies, by ASHRAE SSPC 34 on 1997.06.29; the contingencies were removed on 1998.01.18. The designation, tolerances, and classification are subject to a review and approval procedure; assignment will not occur until published in an addendum or revision to ANSI/ASHRAE Standard 34-1997.

IDENTIFIERS

common name(s): R-411C; R411C; R 4 11C
R-1270/22/152a (3.0/95.5/1.5)
R1270/22/152a (3.0/95.5/1.5)
R 1270/22/152a (3.0/95.5/1.5)
HC/HCFC/HFC-411C
not HCFC-411C
 HC-1270/HFPC-22/HFC-152a 2909
 (3.0/95.5/1.5)
not HCFC-1270/22/152a 2909
trade name(s): China Sun Group G2018C
Greencool G2018C MSDS
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

nominal blend formulation --------

• composition: R-1270/22/152a
• component weight fractions: 3.0 / 95.5 / 1.5 %
• component weight tolerances: +0.0,-0.5/+1.0,-0.0/+0.0,-0.5
• component mole fractions: 5.949 / 92.156 / 1.895 % 8820
properties -----------------------
molar mass: 83.44068 g/mol (0.183955 lb/mol) 8820

normal freezing/melting/triple point:

• bubble point temperature: -41.8 °C (-43.3 °F) 8401
• dew point temperature: -40.9 °C (-41.5 °F) 8401
• maximum temperature glide: 0.95 °C (1.7 °F) 8401
• density, saturated liquid: 1349 kg/m3 (84.21 lb/ft3) 8401
• density, saturated vapor: 4.54 kg/m3 (0.283 lb/ft3) 8401
• specific volume, saturated liquid: 0.741 L/kg (0.0119 cf/lb) 8401
• specific volume, saturated vapor: 220.3 L/kg (3.5284 cf/lb) 8401
• heat of vaporization: 241.6 kJ/kg (103.9 Btu/lb) 8401
• velocity of sound, saturated liquid: 863 m/s (2833 ft/s) 8401
• velocity of sound, saturated vapor: 163 m/s (534 ft/s) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
viscosity, saturated liquid: 339 μPa·s (0.339 cp) 8401
viscosity, saturated vapor: 9.63 μPa·s (0.00963 cp) 8401
thermal conductivity, liquid: 0.1162 W/m·K (0.0671 Btu/hr·ft·°F) 8401
thermal conductivity, vapor: 0.0072 W/m·K (0.0042 Btu/hr·ft·°F) 8401

- normal pressure, 20 °C (68 °F) -----
density, vapor: 3.524 kg/m³ (0.2200 lb/cf) 8401

- normal pressure, 21.1 °C (70 °F) ---
density, vapor: 3.509 kg/m³ (0.2191 lb/cf) 8401

- 20 °C (68 °F) ----------------------
  pressure, liquid (bubble point): 926.8 kPa (134.42 psia) 8401
  pressure, saturated vapor: 913.7 kPa (132.52 psia) 8401
  density, saturated liquid: 1155 kg/m³ (72.09 lb/cf) 8401
  density, saturated vapor: 37.32 kg/m³ (2.330 lb/cf) 8401
  specific volume, saturated liquid: 0.866 L/kg (0.0139 cf/lb) 8401
  specific volume, saturated vapor: 26.8 L/kg (0.4292 cf/lb) 8401
  velocity of sound, saturated liquid: 569 m/s (1865 ft/s) 8401
  velocity of sound, saturated vapor: 164 m/s (537 ft/s) 8401
  viscosity, saturated liquid: 169 μPa·s (0.169 cp) 8401
  viscosity, saturated vapor: 12.3 μPa·s (0.0123 cp) 8401
  thermal conductivity, saturated liquid: 0.0872 W/m·K (0.0504 Btu/hr·ft·°F) 8401
  thermal conductivity, saturated vapor: 0.01132 W/m·K (0.00654 Btu/hr·ft·°F) 8401

- 60 °C (140 °F) ---------------------
  pressure, liquid (bubble point): 2451 kPa (355.5 psia) 8401
  pressure, vapor (dew point): 2436 kPa (353.3 psia) 8401
  heat of vaporization: 143.3 kJ/kg for liquid and vapor both at nominal composition (61.6 Btu/lb) 8401
  141.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (61.0 Btu/lb) 8401

- critical point ---------------------
temperature: 95.5 °C (203.9 °F) 8401
  pressure: 4951 kPa (718.1 psia) 8401
  density: 501 kg/m³ (31.3 lb/cf) 8401
  specific volume: 2.00 L/kg (0.0320 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): 0.032 mass-weighted average (model-derived relative to R 11) 9501
0.048 mass-weighted average (semi-empirical relative to R 11) 9501

GWP (global warming potential): 1820 mass-weighted average relative to CO₂ for 100 yr integration 9501

HGWP (halocarbon GWP): 0.30 mass-weighted average relative to R 11 for infinite integration period DW

SAFETY

- classification ---------------------
safety group (ASHRAE Standard 34): none (application pending) 8601
  Al/A1 proposed 18Jan98 A1g components are A3, A1, and A2 8601

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
NFPA 704 degrees of hazard (H-F-R-S):

NPCA HMIS hazard ratings (H-F-R):

- long-term occupational limit --------
  exposure limit consistent to OSHA PEL:

- emergency exposure limit  ------------
  Refrigerant Concentration Limit (RCL):

- flammability ------------------------
  LFL-UFL (flammability limits in air):

- detection ---------------------------
  appearance:
  odor:

PRODUCTION

first commercial use as a refrigerant: January 1996
last year production allowed: 2029 based on refrigerant 22 in developed countries under the Montreal Protocol

Greencool: 2-0-0 health-flammability-reactivity
[-special]: 0=no, 4=severe
Greencool: 2-0-0 health-flammability-reactivity
0=insignificant, 4=extreme
Greencool: components are 375, MSDS
ppm v/v TWA for 8 hr/day and
40 hr/wk
1,000, and 1,000 ppm v/v TWA MSDS
for 8 hr/day and 40 hr/wk
27,000 ppm v/v (preliminary
value under review, based on
draft ASHRAE 34aa)
none (nonflammable as tested) MSDS
Greencool: none MSDS
Greencool: clear, colorless MSDS
Greencool: slight volatile, MSDS
sweetish odor

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-412A

--- REFRIGERANT DATA SUMMARY ---

R-412A  R-22/218/142b (70.0/5.0/25.0)  see RDB#
zeotrope  ternary blend  ----

COMMON USE(S)
replacement for refrigerant 500 in low- and medium-temperature refrigeration with hermetic (especially rotary vane) compressors, such as biomedical and pharmaceutical applications; high stage of cascaded systems for ultra-low temperatures, for example with refrigerant 508A in the low stage

IDENTIFIERS
common name(s):  R-412A; R412A; R 412A  6101
HCF/FC/HCF-412A  6101
not HCFC-412A  2909
trade name(s):  ICI Arcton(R) 412A  MSDS
ICI Arcton(R) TP5R  MSDS
ARI container color / Pantone number:  none, use light green grey/413 6601
with red / 185 band

PHYSICAL

composition:  R-22/218/142b  6101
component weight fractions:  70.0  /  5.0 / 25.0 %  6101
component weight tolerances:  ±2.0  / ±2.0 / ±1.0  6101
component mole fractions:  74.619 / 2.451 / 22.930 %  8820

molar mass:  92.17363 g/mol (0.203208 lb/mol)  8820

normal freezing/melting/triple point:  -153.0 °C (-243.4 °F)  MSDS

bubble point temperature:  -36.4 °C (-33.6 °F)  8814
dew point temperature:  -28.8 °C (-19.9 °F)  8814
maximum temperature glide:  7.62 °C (13.7 °F)  8814
density, saturated liquid:  1362 kg/m³ (85.05 lb/ft³)  8814
density, saturated vapor:  4.77 kg/m³ (0.298 lb/ft³)  8814
specific volume, saturated liquid:  0.734 L/kg (0.0118 cf/lb)  8814
specific volume, saturated vapor:  209.8 L/kg (3.3607 cf/lb)  8814
heat of vaporization:  230.7 kJ/kg (99.2 Btu/lb)  8814
velocity of sound, saturated liquid:  827 m/s (2713 ft/s)  8814
velocity of sound, saturated vapor:  157 m/s (514 ft/s)  8814
viscosity, saturated liquid:  359 μPa·s (0.359 cp)  8814
viscosity, saturated vapor:  9.75 μPa·s (0.00975 cp)  8814
thermal conductivity, liquid:  0.1069 W/m·K (0.0617 Btu/hr·ft·°F)  8814
thermal conductivity, vapor:  0.0077 W/m·K (0.0045 Btu/hr·ft·°F)  8814

normal pressure, 20 °C (68 °F) -----
density, vapor:  3.903 kg/m³ (0.2437 lb/ft³)  8814

normal pressure, 21.1 °C (70 °F) --
density, vapor:  3.887 kg/m³ (0.2427 lb/ft³)  8814

20 °C (68 °F) -----------------------
pressure, liquid (bubble point):  753.2 kPa (109.25 psia)  8814

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
pressure, vapor (dew point): 617.1 kPa (89.51 psia) 8814
density, saturated liquid: 1192 kg/m3 (74.42 lb/cf) 8814
density, saturated vapor: 26.62 kg/m3 (1.662 lb/cf) 8814
specific volume, saturated liquid: 0.839 L/kg (0.0134 cf/lb) 8814
specific volume, saturated vapor: 37.6 L/kg (0.6017 cf/lb) 8814
velocity of sound, saturated liquid: 572 m/s (1878 ft/s) 8814
velocity of sound, saturated vapor: 158 m/s (520 ft/s) 8814
viscosity, saturated liquid: 188 µPa·s (0.188 cp) 8814
viscosity, saturated vapor: 11.8 µPa·s (0.0118 cp) 8814
thermal conductivity, saturated liquid: 0.0827 W/m·K (0.0478 Btu/hr·ft°F) 8814
thermal conductivity, saturated vapor: 0.01083 W/m·K (0.00626 Btu/hr·ft°F) 8814

60 °C (140 °F) -----------------------
pressure, liquid (bubble point): 2008 kPa (291.3 psia) 8814
pressure, vapor (dew point): 1773 kPa (257.1 psia) 8814
heat of vaporization: 148.6 kJ/kg for liquid and 143.4 kJ/kg coexisting liquid and vapor at bubble-point pressure (61.7 Btu/lb)

---
critical point ---------------------
temperature: 107.5 °C (225.5 °F) 8814
pressure: 4883 kPa (708.2 psia) 8814
density: 499 kg/m3 (31.2 lb/cf) 8814
specific volume: 2.00 L/kg (0.0321 cf/lb) 8814

ENVIRONMENTAL

ODP (ozone depletion potential): 0.035 mass-weighted average (model-derived relative to R11) 9501
GWP (global warming potential): 2340 mass-weighted average relative to CO2 for 100 yr integration DW
HGWP (halocarbon GWP): 2.4 mass-weighted average relative to R 11 for infinite integration period

SAFETY

classification ---------------------
safety group (ASHRAE Standard 34): A1/A2 8601
long-term occupational limit ------
exposure limit consistent to OSHA PEL: ICI exposure limit: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk
emergency exposure limit --------
Refrigerant Concentration Limit (RCL): 26,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)
flammbability -------------------
LFL-UFL (flammability limits in air): mfr worst fractionable flammable mfr
flash point: ICI: does not flash MSDS
appearance: ICI: colorless liquified gas MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
odor: ICI: faint ether-like odor

PRODUCTION
first commercial use as a refrigerant: circa 1997
last year production allowed: 2029 by refrigerants 22, 142b 8C01 in developed countries under the Montreal Protocol
R-413A

--- REFRIGERANT DATA SUMMARY ---

R-413A
R-218/134a/600a (9.0/88.0/3.0) see RDB#

zeotrope ternary blend

COMMON USE(S)
alternative for refrigerant 12 for commercial and transport refrigeration and as a service fluid for domestic refrigerators and freezers, mobile air conditioners, and vending machines

IDENTIFIERS

common name(s): R-413A; R143A; R 413A 34af
R-218/134a/600a (9/88/3) 2909
FC/HFC/HC-413A; not HFC-413A 34af
FC-218/HFC-134a/HC-600a (9/88/3) 2909
not FC-218/134a/600a (9/88/3) 2909
not HFC-218/134a/600a (9/88/3) 2909

trade name(s): Rhodia Iscone 49
historical name(s): Rhône-Poulenc Iscone 49
Rhône-Poulenc RX2

ARI container color / Pantone number: none, use light green grey/413 6601
with red / 185 band

PHYSICAL

nominal blend formulation -------

composition: R-218/134a/600a 34af
component weight fractions: 9.0 / 88.0 / 3.0 % 34af
component weight tolerances: ±1.0 / ±2.0 / ±0.0,-1.0 34af
component mole fractions: 4.976 / 89.658 / 5.366 % 8820

properties -----------------
molar mass: 103.95370 g/mol (0.229179 lb/mol)

normal boiling point ------------

bubble point temperature: -29.3 °C (-20.7 °F) 8814
dew point temperature: -27.6 °C (-17.7 °F) 8814
maximum temperature glide: 1.67 °C (3.0 °F) 8814
density, saturated liquid: 1344 kg/m³ (83.89 lb/cf) 8814
density, saturated vapor: 5.39 kg/m³ (0.337 lb/cf) 8814
specific volume, saturated liquid: 0.744 L/kg (0.0119 cf/lb) 8814
specific volume, saturated vapor: 185.4 L/kg (2.9700 cf/lb) 8814
heat of vaporization: 210.6 kJ/kg (90.5 Btu/lb) 8814
velocity of sound, saturated liquid: 734 m/s (2409 ft/s) 8814
velocity of sound, saturated vapor: 143 m/s (471 ft/s) 8814
viscosity, saturated liquid: 370 µPa·s (0.370 cp) 8814
viscosity, saturated vapor: 9.46 µPa·s (0.00946 cp) 8814
thermal conductivity, liquid: 0.0999 W/m·K (0.0577 Btu/hr·ft·°F) 8814
thermal conductivity, vapor: 0.0093 W/m·K (0.0054 Btu/hr·ft·°F) 8814

normal pressure, 20 °C (68 °F) -------
density, vapor: 4.417 kg/m³ (0.2758 lb/cf) 8814

normal pressure, 21.1 °C (70 °F) ---
density, vapor: 4.399 kg/m³ (0.2746 lb/cf) 8814

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
20 °C (68 °F) --

- Pressure, liquid (bubble point): 619.0 kPa (89.78 psia) 8814
- Pressure, vapor (dew point): 603.3 kPa (87.50 psia) 8814
- Density, saturated liquid: 1184 kg/m³ (73.91 lb/cf) 8814
- Density, saturated vapor: 30.13 kg/m³ (1.881 lb/cf) 8814
- Specific volume, saturated liquid: 0.845 L/kg (0.0135 cf/lb) 8814
- Specific volume, saturated vapor: 33.2 L/kg (0.5317 cf/lb) 8814
- Velocity of sound, saturated liquid: 507 m/s (1665 ft/s) 8814
- Velocity of sound, saturated vapor: 142 m/s (467 ft/s) 8814
- Viscosity, saturated liquid: 194 μPa·s (0.194 cp) 8814
- Viscosity, saturated vapor: 11.4 μPa·s (0.0114 cp) 8814
- Thermal conductivity, saturated liquid: 0.0786 W/m·K (0.0454 Btu/hr·ft°F) 8814
- Thermal conductivity, saturated vapor: 0.0135 W/m·K (0.00780 Btu/hr·ft°F) 8814

60 °C (140 °F) 

- Pressure, liquid (bubble point): 1770 kPa (256.7 psia) 8814
- Pressure, vapor (dew point): 1753 kPa (254.2 psia) 8814
- Heat of vaporization: 129.5 kJ/kg for liquid and vapor both at nominal composition (55.7 Btu/lb) 8814
- 129.8 kJ/kg coexisting liquid and vapor at bubble-point pressure (55.8 Btu/lb) 8814

Critical Point

- Temperature: 101.4 °C (214.5 °F) 8814
- Pressure: 4237 kPa (614.5 psia) 8814
- Density: 501 kg/m³ (31.3 lb/cf) 8814
- Specific volume: 2.00 L/kg (0.0320 cf/lb) 8814

Environmental

- ODP (ozone depletion potential): <0.00002 mass-weighted average 9501 (model-derived relative to R 11)
- GWP (global warming potential): 2180 mass-weighted average relative to CO2 for 100 yr integration 9501
- HGWG (halocarbon GWP): 3.9 mass-weighted average relative to R 11 for infinite integration period (DW)

Safety

- Classification --
  - Safety group (ASHRAE Standard 34): A1/A2 34b
- Refrigerant Concentration Limit (RCL): 49,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

- Flammability --
  - LFL-UFL (flammability limits in air): worst fractionation flammable mfr
  - Flash point: Rhodia: not applicable MSDS

- Detection --
  - Appearance: Rhodia: colorless MSDS
  - Odor: Rhodia: slightly ethereal MSDS

Production

See data limitations and notes on page 2.
| first commercial use as a refrigerant: | circa 1996 |
| last year production allowed:        | unrestricted |
| mfr                                 | 8C01         |
R-414A

------------------------ REFRIGERANT DATA SUMMARY ------------------------
R-414A  R-22/124/600a/142b (51.0/28.5/4.0/16.5)  see
zeotrope  tetrary blend  RDB#

COMMON USE(S)
alternative for refrigerant 12, primarily for aftermarket use to
service or retrofit existing automobile air conditioners, other
mobile air-conditioning (MAC) systems, and commercial refrigeration;
also marketed as a replacement for refrigerants 134a and 500 in
commercial refrigeration

Note: The designation, tolerances, and safety classification
indicated for this refrigerant were proposed by ASHRAE SSPC 34 on
1998.06.21. They are subject to a review and approval procedure that
is now underway; assignment will not occur until published in an
addendum or revision to ANSI/ASHRAE Standard 34-1997.

IDENTIFIERS

common name(s):  R-414A; R414A; R 414A  34+
                  HCFC/HCFC/HC/HCFC-414A  34+
                  not HCFC-414A  2909
                  HCFC-22/HCFC-124/HC-600a/HCFC-
                  142b (51.0/28.5/4.0/16.5)  2909
trade name(s):  GHG-X4; Autofrost-X4  8354
                  McMullen Oil Chill-It  8354
                  McMullen Oil McCool Chill-It
                  Monroe Air Tech Autofrost-X4  8354
historical name(s):
                  name used in U.S. EPA SNAP Rule:
                  HCFC Blend Xi
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

  nominal blend formulation ---------

    composition:  R-22/124/600a/142b  34+

    component weight fractions:  51.0 / 28.5 / 4.0 / 16.5 %  34+

    component weight tolerances:  ±2.0 / ±2.0 / ±0.5 / ±0.5,-1.0  34+

    component mole fractions:  57.172/ 20.242/ 6.671/ 15.915  8820

    molar mass:  96.93217 g/mol (0.213699 lb/mol)  8820

  properties ------------------------

    bubble point temperature:  -34.0 °C (-29.3 °F)  8401
    dew point temperature:  -25.8 °C (-14.4 °F)  8401
    maximum temperature glide:  8.27 °C (14.9 °F)  8401
    density, saturated liquid:  1323 kg/m³ (82.56 lb/cf)  8401
    density, saturated vapor:  4.96 kg/m³ (0.309 lb/cf)  8401
    specific volume, saturated liquid:  0.756 L/kg (0.0121 cf/lb)  8401
    specific volume, saturated vapor:  201.7 L/kg (3.2311 cf/lb)  8401
    heat of vaporization:  222.3 kJ/kg (95.6 Btu/lb)  8401
    velocity of sound, saturated liquid:  805 m/s (2641 ft/s)  8401
    velocity of sound, saturated vapor:  152 m/s (499 ft/s)  8401
    viscosity, saturated liquid:  355 μPa·s (0.355 cp)  8401
viscosity, saturated vapor: 9.67 μPa·s (0.00967 cp) 8401
thermal conductivity, liquid: 0.1013 W/m·K (0.0585 Btu/hr·ft°F) 8401
thermal conductivity, vapor: 0.0081 W/m·K (0.0047 Btu/hr·ft°F) 8401

- normal pressure, 20 °C (68 °F) ----- density, vapor: 4.111 kg/m³ (0.2566 lb/cf) 8401
density, vapor: 4.095 kg/m³ (0.2556 lb/cf) 8401

- 20 °C (68 °F) ------------------ pressure, liquid (bubble point): 681.4 kPa (98.83 psia) 8401
density, saturated liquid: 550.4 kPa (79.83 psia) 8401
density, saturated vapor: 1165 kg/m³ (72.72 lb/cf) 8401
density, vapor: 24.84 kg/m³ (1.551 lb/cf) 8401
specific volume, saturated liquid: 0.859 L/kg (0.0138 cf/lb) 8401
specific volume, saturated vapor: 40.3 L/kg (0.6448 cf/lb) 8401
velocity of sound, saturated liquid: 563 m/s (1848 ft/s) 8401
velocity of sound, saturated vapor: 153 m/s (503 ft/s) 8401
viscosity, saturated liquid: 189 μPa·s (0.189 cp) 8401
viscosity, saturated vapor: 11.5 μPa·s (0.0115 cp) 8401
thermal conductivity, saturated liquid: 0.0791 W/m·K (0.0457 Btu/hr·ft°F) 8401
thermal conductivity, saturated vapor: 0.01107 W/m·K (0.00639 Btu/hr·ft°F) 8401

- 60 °C (140 °F) ------------------ pressure, liquid (bubble point): 1824 kPa (264.5 psia) 8401
pressure, vapor (dew point): 1596 kPa (231.5 psia) 8401
heat of vaporization: 127.8 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.9 Btu/lb) 8401

- critical point ------------------ temperature: 110.7 °C (231.3 °F) 8401
pressure: 4696 kPa (681.1 psia) 8401
density: 484 kg/m³ (30.2 lb/cf) 8401
specific volume: 2.07 L/kg (0.0331 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): 0.032 mass-weighted average (model-derived relative to R 11) 8401
ODP: 0.044 mass-weighted average (semi-empirical relative to R 11) 9501

GWP (global warming potential): 1530 mass-weighted average relative to CO2 for 100 yr integration 8401
HGWP (halocarbon GWP): 0.26 mass-weighted average relative to R 11 for infinite integration period 9501

SAFETY

- classification ------------------ safety group (ASHRAE Standard 34): none (application pending) 341
   components are A1, A1, A3, A2 8601

- long-term occupational limit ------- exposure limit consistent to OSHA PEL: Peoples Welding: 1000 ppm v/v MSDS
   TWA for 8 hr/day and 40 hr/wk
Refrigerant Concentration Limit (RCL): 19,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

flammability ----------------------
heat of combustion (by ASHRAE 34-92): 3.6 MJ/kg (1533 Btu/lb) UL
flash point: Peoples Welding: none MSDS
autoignition temperature: Peoples Welding: ~500° (932°F) MSDS
autodecomposition temperature: Peoples Welding: ≥204° (400°F) MSDS
former UL Classification: practically nonflammable UL (withdrawn for revision of the classification system, category SBQT2)

PRODUCTION
first commercial use as a refrigerant: January 1996 mfr
last year production allowed: 2029 by refrigerants 22, 124, and 142b 8C01 in developed countries under the Montreal Protocol
R-414B

REFRIGERANT DATA SUMMARY

R-414B: R-22/124/600a/142b (50.0/39.0/1.5/9.5)
zeotrope: tetracy blend

COMMON USE(S)

service alternative for refrigerants 12 and 134a, primarily for aftermarket use to retrofit automobile and other mobile air conditioning systems (MACS) and stationary refrigeration equipment

Note: The designation, tolerances, and safety classification indicated for this refrigerant were proposed by ASHRAE SSPC 34 on 1998.06.21. Designation and classification are subject to a review and approval procedure now underway; assignment will not occur until published in an addendum or revision to ANSI/ASHRAE Standard 34-1997.

IDENTIFIERS

common name(s): R-414B; R414B; R 414B
HCFC/HCFC/HC/HCFC-414B
HCFC-22/HCFC-124/HC-600a/
HCFC-142b (50/39/1.5/9.5)
not HCFC-22/124/600a/142b
trade name(s): AMI Automotive HOT SHOT(TM)
ESP (Canada) HOT SHOT
ICOR HOT SHOT
ARI container color / Pantone number: medium blue (blue) / 2995 ARI

PHYSICAL

nominal blend formulation

composition: R-22/124/600a/142b
component weight fractions: 50.0 / 39.0 / 1.5 / 9.5 %
component weight tolerances: ±2.0 / ±2.0 / ±0.5 / ±0.5
component mole fractions: 58.744/ 29.031/ 2.622/ 9.603 %

properties

molar mass: 101.58958 g/mol (0.223967 lb/mol)

normal boiling point

bubble point temperature: -34.4 °C (-29.9 °F)
dew point temperature: -26.1 °C (-15.0 °F)
maximum temperature glide: 8.27 °C (14.9 °F)
density, saturated liquid: 1390 kg/m3 (86.80 lb/cf)
density, saturated vapor: 5.20 kg/m3 (0.325 lb/cf)
specific volume, saturated liquid: 0.719 L/kg (0.0115 cf/lb)
specific volume, saturated vapor: 192.2 L/kg (3.0791 cf/lb)
heat of vaporization: 212.7 kJ/kg (91.4 Btu/lb)
velocity of sound, saturated liquid: 789 m/s (2587 ft/s)
velocity of sound, saturated vapor: 148 m/s (486 ft/s)
viscosity, saturated liquid: 365 μPa·s (0.365 cp)
viscosity, saturated vapor: 9.87 μPa·s (0.00987 cp)
thermal conductivity, liquid: 0.0990 W/m·K (0.0572 Btu/hr·ft°F)
thermal conductivity, vapor: 0.0080 W/m·K (0.0046 Btu/hr·ft°F)

normal pressure, 20 °C (68 °F)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, vapor, normal pressure, 21.1 °C (70 °F)</td>
<td>4.308 kg/m³ (0.2689 lb/cf)</td>
<td>8401</td>
</tr>
<tr>
<td>Density, vapor, 20 °C (68 °F)</td>
<td>4.290 kg/m³ (0.2678 lb/cf)</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure, liquid (bubble point)</td>
<td>693.9 kPa (100.64 psia)</td>
<td>8401</td>
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<tr>
<td>Pressure, vapor (dew point)</td>
<td>563.2 kPa (81.69 psia)</td>
<td>8401</td>
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<tr>
<td>Density, saturated liquid</td>
<td>1222 kg/m³ (76.27 lb/cf)</td>
<td>8401</td>
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<tr>
<td>Density, saturated vapor</td>
<td>26.70 kg/m³ (1.667 lb/cf)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated liquid</td>
<td>0.819 L/kg (0.0131 cf/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated vapor</td>
<td>37.5 L/kg (0.5999 cf/lb)</td>
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<tr>
<td>Velocity of sound, saturated liquid</td>
<td>548 m/s (1797 ft/s)</td>
<td>8401</td>
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<tr>
<td>Velocity of sound, saturated vapor</td>
<td>150 m/s (491 ft/s)</td>
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<tr>
<td>Viscosity, saturated liquid</td>
<td>193 µPa·s (0.193 cp)</td>
<td>8401</td>
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<tr>
<td>Viscosity, saturated vapor</td>
<td>11.8 µPa·s (0.0118 cp)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated liquid</td>
<td>0.0773 W/m·K (0.0447 Btu/hr·ft°F)</td>
<td>8401</td>
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<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01092 W/m·K (0.00631 Btu/hr·ft°F)</td>
<td>8401</td>
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<tr>
<td>Pressure, liquid (bubble point)</td>
<td>1860 kPa (269.7 psia)</td>
<td>8401</td>
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<tr>
<td>Pressure, vapor (dew point)</td>
<td>1637 kPa (237.5 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Heat of vaporization</td>
<td>136.7 kJ/kg for liquid and vapor both at nominal composition (58.8 Btu/lb) 118.3 kJ/kg coexisting liquid and vapor at bubble-point pressure (50.9 Btu/lb)</td>
<td>8401</td>
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<tr>
<td>Critical point</td>
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</tr>
<tr>
<td>Temperature</td>
<td>108.0 °C (226.4 °F)</td>
<td>8401</td>
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<tr>
<td>Pressure</td>
<td>4588 kPa (665.4 psia)</td>
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<tr>
<td>Density</td>
<td>507 kg/m³ (31.6 lb/cf)</td>
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<tr>
<td>Specific volume</td>
<td>1.97 L/kg (0.0316 cf/lb)</td>
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**ENVIRONMENTAL**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
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<tbody>
<tr>
<td>ODP (ozone depletion potential)</td>
<td>0.031 mass-weighted average</td>
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<tr>
<td>(model-derived relative to R 11)</td>
<td>(semi-empirical relative to R 11)</td>
<td>9501</td>
</tr>
<tr>
<td>GWP (global warming potential)</td>
<td>1410 mass-weighted average</td>
<td>9501</td>
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<tr>
<td>relative to CO2 for 100 yr integration</td>
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<td></td>
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<tr>
<td>HGWP (halocarbon GWP)</td>
<td>0.23 mass-weighted average</td>
<td>DW</td>
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<tr>
<td>relative to R 11 for infinite integration</td>
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</table>

**SAFETY**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>Classification</td>
<td>none (application pending)</td>
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<tr>
<td>Safety group (ASHRAE Standard 34)</td>
<td>A1/A1 proposed 98Jun21</td>
<td>34m</td>
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<tr>
<td>components are A1, A1, A3, A2</td>
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<tr>
<td>Emergency exposure limit</td>
<td>18,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)</td>
<td>8601</td>
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<tr>
<td>Refrigerant Concentration Limit (RCL)</td>
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<tr>
<td>Flammability</td>
<td>ICOR: none, will not burn</td>
<td>MSDS</td>
</tr>
<tr>
<td>LFL-UFL (flammability limits in air)</td>
<td>ICOR: will not burn</td>
<td>MSDS</td>
</tr>
<tr>
<td>Flash point</td>
<td></td>
<td></td>
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</tbody>
</table>
autoignition temperature: ICOR: 632 °C (1170 °F)  
former UL Classification: practically nonflammable  
MSDS UL  
(withdrawn for revision of the classification system, category SBQT2)

PRODUCTION
first commercial use as a refrigerant: March 1996  
last year production allowed: 2029 by refrig 22,124, and 142b 8C01  
in developed countries under the Montreal Protocol
R-416A

--- REFRIGERANT DATA SUMMARY ---

R-416A  R-134a/124/600 (59.0/39.5/1.5)  see RDB#

ternary blend

COMMON USE(S)
replacement for refrigerant 12 for aftermarket use as a service fluid in mobile air conditioners, transport refrigeration equipment, and other applications

Note: The designation and safety classification indicated for this refrigerant as well as tolerances of (+½, -1/ +1, -½ / +0.0, -0.3) were proposed by ASHRAE SSPC 34 on 1997.11.21. Revised tolerances of (+½, -1 / +1, -½ / +0.1, -0.2) were proposed by ASHRAE SSPC 34 on 1998.06.21. They are subject to a review and approval procedure now underway; assignment will not occur until published in an addendum or revision to ANSI/ASHRAE Standard 34-1997. Publication was recommended on 1999.06.20. Early product literature for this blend (before September 1997) from InterCool Energy Corporation (ICE) showed the formulation to be R-134a/124/600 (59/39/2); the manufacturer has indicated that the formulation was not changed, but is now being shown more precisely as (59.0/39.5/1.5). This refrigerant may be covered by U.S. patents 5,360,566 and 5,425,890.

IDENTIFIERS

common name(s):  R-416A; R416A; R 416A  R-134a/124/600 (59/39.5/1.5)
R134a/124/600 (59/39.5/1.5)  R 134a/124/600 (59/39.5/1.5)
HFC/HCFC/HC-416A  34an
not HCFC-416A  34an
HFC-134a/HCFC-124/HC-600 (59/39.5/1.5)  8601
not HCFC-134a/124/600 (59/39.5/1.5)  8601
trade name(s):  IGC/ICE FRIGC(R) FR-12(TM)  5A41
Pennzoil FRIGC(R) FR-12(TM)  6C06
name used in U.S. EPA SNAP Rule:  HCFC Blend Beta
ARI container color / Pantone number:  yellow-green (lime) / 381  ARI

PHYSICAL

nominal blend formulation ---------

component weight fractions:  59.0 / 39.5 / 1.5 %  34an
component weight tolerances:  +0.5, -1.0/+1.0, -0.5/+0.0, -0.3  34an
+0.5, -1.0/+1.0, -0.5/+0.1, -0.2  34+
component mole fractions:  64.719 / 32.393 / 2.888 %  8820

properties ------------------------
molar mass:  111.92031 g/mol (0.246742 lb/mol)  8820

normal boiling point ---------------
bubble point temperature:  -23.4 °C (-10.0 °F)  8401
dew point temperature:  -21.8 °C (-7.3 °F)  8401
maximum temperature glide:  1.55 °C (2.8 °F)  8401
density, saturated liquid: 1387 kg/m³ (86.60 lb/cf) 8401
density, saturated vapor: 5.67 kg/m³ (0.354 lb/cf) 8401
specific volume, saturated liquid: 0.721 L/kg (0.0115 cf/lb) 8401
specific volume, saturated vapor: 176.4 L/kg (2.8253 cf/lb) 8401
heat of vaporization: 198.9 kJ/kg (85.5 Btu/lb) 8401
velocity of sound, saturated liquid: 719 m/s (2359 ft/s) 8401
velocity of sound, saturated vapor: 140 m/s (458 ft/s) 8401
viscosity, saturated liquid: 373 μPa·s (0.373 cp) 8401
viscosity, saturated vapor: 9.67 μPa·s (0.00967 cp) 8401
thermal conductivity, liquid: 0.0946 W/m·K (0.0547 Btu/hr·ft·°F) 8401
thermal conductivity, vapor: 0.0094 W/m·K (0.0054 Btu/hr·ft·°F) 8401

- normal pressure, 20 °C (68 °F) -----
density, vapor: 4.765 kg/m³ (0.2975 lb/cf) 8401

- normal pressure, 21.1 °C (70 °F) ----
density, vapor: 4.746 kg/m³ (0.2963 lb/cf) 8401

- 20 °C (68 °F) ----------------------
  pressure, liquid (bubble point): 504.8 kPa (73.22 psia) 8401
  pressure, vapor (dew point): 479.8 kPa (69.58 psia) 8401
  density, saturated liquid: 1248 kg/m³ (77.93 lb/cf) 8401
  density, saturated vapor: 25.14 kg/m³ (1.570 lb/cf) 8401
  specific volume, saturated liquid: 0.801 L/kg (0.0128 cf/lb) 8401
  specific volume, saturated vapor: 39.8 L/kg (0.6371 cf/lb) 8401
  velocity of sound, saturated liquid: 528 m/s (1731 ft/s) 8401
  velocity of sound, saturated vapor: 140 m/s (458 ft/s) 8401
  viscosity, saturated liquid: 215 μPa·s (0.215 cp) 8401
  viscosity, saturated vapor: 11.3 μPa·s (0.0113 cp) 8401
  thermal conductivity, saturated liquid: 0.0774 W/m·K (0.0447 Btu/hr·ft·°F) 8401
  thermal conductivity, saturated vapor: 0.01273 W/m·K (0.00736 Btu/hr·ft·°F) 8401

- 60 °C (140 °F) -----------------------
  pressure, liquid (bubble point): 1479 kPa (214.5 psia) 8401
  pressure, vapor (dew point): 1426 kPa (206.8 psia) 8401
  heat of vaporization: 132.8 kJ/kg for liquid and vapor both at nominal composition (57.1 Btu/lb) 8401
  127.0 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.6 Btu/lb) 8401

- critical point -----------------------
temperature: 108.2 °C (226.8 °F) 8401
pressure: 4016 kPa (582.5 psia) 8401
density: 517 kg/m³ (32.3 lb/cf) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): 0.010 mass-weighted average (model-derived relative to R 11) 9501

0.011 mass-weighted average (semi-empirical relative to R 11) 9501

GWP (global warming potential): 1190 mass-weighted average relative to CO₂ for 100 yr integration 9501

 HGWP (halocarbon GWP): 0.20 mass-weighted average relative to R 11 for infinite integration period DW
SAFETY

- classification -----------------
  safety group (ASHRAE Standard 34):
    none (application pending)
    Al/A1 recommended 99Jun20 34n
    components are Al, A1, and A3 8601
  IGC/ICE: 2-0-0
  health-flammability-reactivity
  [-special]: 0=no, 4=severe

- emergency exposure limit --------
  Refrigerant Concentration Limit (RCL):
    22,000 ppm v/v (preliminary
    value under review, based on
    draft ASHRAE 34aa)

- acute (short-term) toxicity ------
  cardiac sensitization (CS) EC50:
    dog, 10 min: ≤90,000 ppm v/v
    (effective concentration in
    half of test animals)
    dog, 10 min, 2/6: ≤90,000 ppm
    v/v (lowest observed effect
    level in test animals)
    dog, 10 min, 2/6: ≤70,000 ppm
    v/v (lowest observed effect
    level in test animals)
    dog, 10 min, 0/6: ≤50,000 ppm
    v/v (no observed effect level
    in test animals)

  cardiac sensitization threshold/LOEL:

  cardiac sensitization (CS) NOEL:

- flammability ---------------------
  heat of combustion (by ASHRAE 34-92):
    7.8 MJ/kg (3370 Btu/lb)
    flash point:
    autoignition temperature:

  detection ------------------------
  appearance: clear, colorless gas
  odor: faint hydrocarbon odor

PRODUCTION

- first commercial use as a refrigerant: May 1995
- last year production allowed: 2029 based on refrigerant 124 8C01
  in developed countries under the Montreal Protocol
### R-729 (air)

<table>
<thead>
<tr>
<th>Refrigerant</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-729</td>
<td>Air (78% v/v nitrogen, 21% oxygen, 1% argon)</td>
</tr>
<tr>
<td>inorganic</td>
<td>Zeotropic blend</td>
</tr>
</tbody>
</table>

Included in **volume 1**

with single-compound refrigerants

based on common designation.
R-1130

------------------ REFRIGERANT DATA SUMMARY ------------------
R-1130 blend of dichloroethene isomers

Included in volume 1 with single-compound refrigerants based on common designation.
R-500

--- REFRIGERANT DATA SUMMARY ---

R-500
R-12/152a (73.8/26.2)
azeotrope binary blend

CAS number: 56275-41-3
RDB# ----

COMMON USE(S)

- centrifugal chillers, heat pump water heaters, transport refrigeration; use as a refrigerant may be covered by U.S. patent 2,492,725 (C. Ashley, 27 December 1949)

Note: This azeotrope was first introduced to achieve the same capacity in equipment operated on 50 Hz current as refrigerant 12 with 60 Hz current [see RDB 2C04].

IDENTIFIERS

common name(s): R-500; R500; R 500 2909
CFC/HFC-500 2909
not CFC-500 or HCFC-500 2909

CAS number: 56275-41-3 Chemical Abstracts
Service Registry Number

trade name(s):
AlliedSignal Genetron(R) 500 MSDS
Asahi Glass Film AF-500
Daikin Daiflon(R) 500
DuPont Freon(R) 500 MSDS
Elf Atochem Forane(R) 500 MSDS
Hoechst Frigen(R) 500

historical name(s):
Carrier Corporation Carrene 7
ICI Arcon(R) 500

ARI container color / Pantone number: yellow / 109 6601

PHYSICAL

- nominal blend formulation
  composition: R-12/152a 2909
  component weight fractions: 73.8 / 26.2 % 2909
  component mole fractions: 60.610 / 39.390 % 8820
  azeotropic temperature: 0.0 °C (32.0 °F) 2909

- properties
  molar mass: 99.30230 g/mol (0.218924 lb/mol) 8820
  normal freezing/melting/triple point:
    -158.9 °C (-254.0 °F) 0036
  normal boiling point
    bubble point temperature: -33.6 °C (-28.5 °F) 8401
    dew point temperature: -33.6 °C (-28.5 °F) 8401
    maximum temperature glide: 0.00 °C (0.0 °F) 8401
    density, saturated liquid: 1319 kg/m3 (82.35 lb/cf) 8401
    density, saturated vapor: 5.27 kg/m3 (0.329 lb/cf) 8401
    specific volume, saturated liquid: 0.758 L/kg (0.0121 cf/lb) 8401
    specific volume, saturated vapor: 189.8 L/kg (3.0400 cf/lb) 8401
    heat of vaporization: 202.5 kJ/kg (87.0 Btu/lb) 8401
    velocity of sound, saturated liquid: 762 m/s (2502 ft/s) 8401
    velocity of sound, saturated vapor: 148 m/s (484 ft/s) 8401
    viscosity, saturated liquid: 319 μPa·s (0.319 cp) 8401
    viscosity, saturated vapor: 9.21 μPa·s (0.00921 cp) 8401
    thermal conductivity, liquid: 0.0951 W/m·K (0.0549) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
### Refrigerant Database

**Thermal Conductivity, Vapor**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal pressure, 20 °C (68 °F)</td>
<td>4.213 kg/m³ (0.2630 lb/cf)</td>
<td>Btu/hr·ft·°F</td>
<td>8401</td>
</tr>
<tr>
<td>Normal pressure, 21.1 °C (70 °F)</td>
<td>4.196 kg/m³ (0.2619 lb/cf)</td>
<td>Btu/hr·ft·°F</td>
<td>8401</td>
</tr>
<tr>
<td>20 °C (68 °F)</td>
<td>670.6 kPa (97.26 psia)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure, liquid (bubble point)</td>
<td>668.8 kPa (97.00 psia)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Density, saturated liquid</td>
<td>1158 kg/m³ (72.32 lb/cf)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated liquid</td>
<td>32.02 kg/m³ (1.999 lb/cf)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated vapor</td>
<td>0.863 L/kg (0.0138 cf/lb)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated liquid</td>
<td>31.2 L/kg (0.5003 cf/lb)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Velocity of sound, saturated liquid</td>
<td>528 m/s (1732 ft/s)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Velocity of sound, saturated vapor</td>
<td>148 m/s (485 ft/s)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Viscosity, saturated liquid</td>
<td>172 μPa·s (0.172 cp)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Viscosity, saturated vapor</td>
<td>11.4 μPa·s (0.0114 cp)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated liquid</td>
<td>0.0744 W/m·K (0.0430 Btu/hr·ft²°F)</td>
<td></td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01178 W/m·K (0.00681 Btu/hr·ft²°F)</td>
<td></td>
<td>8401</td>
</tr>
</tbody>
</table>

**60 °C (140 °F)**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure, liquid (bubble point)</td>
<td>1809 kPa (262.4 psia)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure, vapor (dew point)</td>
<td>1801 kPa (261.2 psia)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Heat of vaporization</td>
<td>129.7 kJ/kg for liquid and vapor both at nominal composition (55.8 Btu/lb)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td></td>
<td>127.1 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.6 Btu/lb)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
</tbody>
</table>

**Critical Point**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>102.1 °C (215.8 °F)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure</td>
<td>4173 kPa (605.2 psia)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Density</td>
<td>492 kg/m³ (30.7 lb/cf)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume</td>
<td>2.03 L/kg (0.0326 cf/lb)</td>
<td>Btu/hr·ft²°F</td>
<td>8401</td>
</tr>
</tbody>
</table>

**Environmental**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODP (ozone depletion potential)</td>
<td>0.605 mass-weighted average</td>
<td>9501</td>
</tr>
<tr>
<td>(model-derived relative to R 11)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GWP (global warming potential)</td>
<td>7870 mass-weighted average</td>
<td>9501</td>
</tr>
<tr>
<td>(semi-empirical relative to R 11)</td>
<td>relative to CO2 for 100 yr integration</td>
<td></td>
</tr>
<tr>
<td>HGWP (halocarbon GWP)</td>
<td>2.0 mass-weighted average</td>
<td>7214</td>
</tr>
<tr>
<td></td>
<td>relative to R 11 for infinite integration period</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.2 mass-weighted average</td>
<td></td>
</tr>
<tr>
<td></td>
<td>relative to R 11 for infinite integration period</td>
<td></td>
</tr>
</tbody>
</table>

**Safety**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classification</td>
<td>A1</td>
<td>6601</td>
</tr>
<tr>
<td>Safety group (ASHRAE Standard 34)</td>
<td>A1</td>
<td>6601</td>
</tr>
<tr>
<td>NFPA 704 degrees of hazard (H-F-R-S)</td>
<td>ARI recommendation: 2-0-0</td>
<td>3A15</td>
</tr>
<tr>
<td>Health-flammability-reactivity</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
NPCA HMIS hazard ratings (H-F-R):

UL Comparative Hazard to Life Group:

- short-term occupational limit ------
  ARI "IDLH" recommendation:
- long-term occupational limit ------
  exposure limit consistent to OSHA PEL:
- emergency exposure limit ----------
  Refrigerant Concentration Limit (RCL):

- flammability ----------------------
  LFL-UFL (flammability limits in air):
    flash point:
    autoignition temperature:
    autodecomposition temperature:
  former UL Classification:

- detection ------------------------
  appearance:
  odor:

PRODUCTION
- first commercial use as a refrigerant: circa 1950
- last year production allowed: 1995 based on refrigerant 12

[-special]: 0=no, 4=severe
  AlliedSignal: 2-0-0 MSDS
  DuPont: 1-0-1 MSDS
  health-flammability-reactivity
  0=insignificant, 4=extreme
  5(a) in absence of flame or
  hot objects

50,000 ppm v/v for 30 min 3A15
  ARI: 1,000 ppm v/v TWA for 8
  hr/day and 40 hr/wk

36,000 ppm v/v (preliminary
  value under review, based on
  draft ASHRAE 34aa)

none (nonflammable as tested) 0036
  AlliedSignal: no flash point MSDS
  DuPont: will not burn MSDS
  386 °C (727 °F) 5931
  DuPont: <445 °C (<833 °F) MSDS
  Elf Atochem: >427 °C (>800 °F) MSDS
  practically nonflammable 6938
  (withdrawn for revision of the
  classification system,
  category SBQT2)

DuPont: clear, colorless MSDS
  AlliedSignal: faint ethereal MSDS

8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
### R-501

#### REFRIGERANT DATA SUMMARY

<table>
<thead>
<tr>
<th>Composition</th>
<th>R-22/12 (75.0/25.0)</th>
<th>see RDB#</th>
</tr>
</thead>
<tbody>
<tr>
<td>azeotrope</td>
<td>binary blend</td>
<td></td>
</tr>
</tbody>
</table>

#### IDENTIFIERS

- **Common name(s):** R-501; R501; R 501
- **HCFC/CFC-501:** 2909
- **not CFC-501 or HCFC-501:** 2909
- **ARI container color / Pantone number:** none, use light green grey/413 6601

#### PHYSICAL

- **Nominal blend formulation**
  - **Composition:** R-22/12 2909
  - **Component weight fractions:** 75.0 / 25.0 % 2909
  - **Component mole fractions:** 80.751 / 19.249 % 8820
  - **Azeotropic temperature:** -41.0 °C (-41.8 °F) 2909

- **Properties**
  - **Molar mass:** 93.09844 g/mol (0.205247 lb/mol) 8820
  - **Normal boiling point**
    - **Bubble point temperature:** -40.5 °C (-40.9 °F) 8401
    - **Dew point temperature:** -40.3 °C (-40.6 °F) 8401
    - **Maximum temperature glide:** 0.13 °C (0.2 °F) 8401
    - **Density, Saturated Liquid:** 1428 kg/m³ (89.15 lb/cf) 8401
    - **Density, Saturated Vapor:** 5.06 kg/m³ (0.316 lb/cf) 8401
    - **Specific Volume, Saturated Liquid:** 0.700 L/kg (0.0112 cf/lb) 8401
    - **Specific Volume, Saturated Vapor:** 197.7 L/kg (3.1607 cf/lb) 8401
    - **Heat of Vaporization:** 214.9 kJ/kg (92.4 Btu/lb) 8401
    - **Velocity of Sound, Saturated Liquid:** 818 m/s (2685 ft/s) 8401
    - **Velocity of Sound, Saturated Vapor:** 153 m/s (503 ft/s) 8401
    - **Viscosity, Saturated Liquid:** 345 μPa·s (0.345 cp) 8401
    - **Viscosity, Saturated Vapor:** 9.67 μPa·s (0.00967 cp) 8401
    - **Thermal Conductivity, Liquid:** 0.1061 W/m·K (0.00513 Btu/hr·ft°F) 8401
    - **Thermal Conductivity, Vapor:** 0.0070 W/m·K (0.00040 Btu/hr·ft°F) 8401
  - **Normal Pressure, 20 °C (68 °F)**
    - **Density, Vapor:** 3.934 kg/m³ (0.2456 lb/cf) 8401
  - **Normal Pressure, 21.1 °C (70 °F)**
    - **Density, Vapor:** 3.918 kg/m³ (0.2446 lb/cf) 8401
  - **20 °C (68 °F)**
    - **Pressure, Liquid (Bubble Point):** 881.0 kPa (127.77 psia) 8401
    - **Pressure, Vapor (Dew Point):** 873.1 kPa (126.63 psia) 8401
    - **Density, Saturated Liquid:** 1228 kg/m³ (76.63 lb/cf) 8401
    - **Density, Saturated Vapor:** 39.71 kg/m³ (2.479 lb/cf) 8401
    - **Specific Volume, Saturated Liquid:** 0.815 L/kg (0.0130 cf/lb) 8401
    - **Specific Volume, Saturated Vapor:** 25.2 L/kg (0.4034 cf/lb) 8401
    - **Velocity of Sound, Saturated Liquid:** 542 m/s (1779 ft/s) 8401
    - **Velocity of Sound, Saturated Vapor:** 154 m/s (506 ft/s) 8401
    - **Viscosity, Saturated Liquid:** 175 μPa·s (0.175 cp) 8401
    - **Viscosity, Saturated Vapor:** 12.3 μPa·s (0.0123 cp) 8401
    - **Thermal Conductivity, Saturated Liquid:** 0.0800 W/m·K (0.0462 Btu/hr·ft°F) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
**Refrigerant Database**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01079 W/m·K (0.00623 Btu/hr·ft°F)</td>
</tr>
<tr>
<td>· 60 °C (140 °F)</td>
<td></td>
</tr>
<tr>
<td>pressure, liquid (bubble point)</td>
<td>2333 kPa (338.3 psia)</td>
</tr>
<tr>
<td>pressure, vapor (dew point)</td>
<td>2314 kPa (335.7 psia)</td>
</tr>
<tr>
<td>heat of vaporization</td>
<td>129.1 kJ/kg for liquid and vapor both at nominal composition (55.5 Btu/lb)</td>
</tr>
<tr>
<td>126.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.5 Btu/lb)</td>
<td></td>
</tr>
<tr>
<td>Critical point</td>
<td></td>
</tr>
<tr>
<td>temperature:</td>
<td>96.2 °C (205.2 °F)</td>
</tr>
<tr>
<td>pressure:</td>
<td>4764 kPa (691.0 psia)</td>
</tr>
<tr>
<td>density:</td>
<td>527 kg/m³ (32.9 lb/cf)</td>
</tr>
<tr>
<td>Environmental</td>
<td></td>
</tr>
<tr>
<td>ODP (ozone depletion potential)</td>
<td>0.231 mass-weighted average (model-derived relative to R 11)</td>
</tr>
<tr>
<td>GWP (global warming potential):</td>
<td>0.263 mass-weighted average (semi-empirical relative to R 11)</td>
</tr>
<tr>
<td>HGWP (halocarbon GWP):</td>
<td>4080 mass-weighted average relative to CO₂ for 100 yr integration</td>
</tr>
<tr>
<td>Safety</td>
<td></td>
</tr>
<tr>
<td>Classification</td>
<td>A1</td>
</tr>
<tr>
<td>Safety group (ASHRAE Standard 34):</td>
<td></td>
</tr>
<tr>
<td>Refrigerant Concentration Limit (RCL):</td>
<td>27,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)</td>
</tr>
<tr>
<td>Flammability</td>
<td>none (nonflammable as tested)</td>
</tr>
<tr>
<td>LFL-UFL (flammability limits in air):</td>
<td>637 °C (1179 °F)</td>
</tr>
<tr>
<td>Autoignition temperature</td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>1995 based on refrigerant 12 in developed countries under the Montreal Protocol</td>
</tr>
</tbody>
</table>

**SEE DATA LIMITATIONS AND NOTES ON PAGE 2**
R-502

REFRIGERANT DATA SUMMARY

R-502
R-22/115 (48.8/51.2)
azeotrope binary blend
CAS number 39432-81-0
see RDB# ----

COMMON USE(S)
low-temperature commercial, industrial, and transport refrigeration; high stage of multistage, cascaded systems for extremely low temperatures; limited use in appliances; limited use in air-source heat pumps, particularly those that are heating only hydronic

IDENTIFIERS
common name(s): R-502; R502; R 502 2909
HCFC/CFC-502 2909
not CFC-502 or HCFC-502 2909
CAS number: 39432-81-0 Chemical Abstracts Service Registry Number
trade name(s): AlliedSignal Genetron(R) 502 MSDS
Asahi Glass Fron AF-502 2909
Daikin Daiflon(R) 502 2909
DuPont Freon(R) 502 MSDS
Elf Atochem Forane(R) 502 MSDS
HRP (UK) HARP(R) 502 2909
Hoechst Frigen(R) 502 2909
ICI Arcton(R) 502 MSDS
2CIIRI Kehua (PRC) R-502 2909
ARI container color / Pantone number: light purple (lavender) / 251 6601

PHYSICAL
nominal blend formulation -------
composition: R-22/115 2909
component weight fractions: 48.8 / 51.2 % 2909
component mole fractions: 62.999 / 37.001 % 8820
azeotropic temperature: 19.0 °C (66.2 °F) 2909
properties ---------------------
molar mass: 111.62783 g/mol (0.246097 lb/mol) 8820
normal boiling point --------------
bubble point temperature: -45.3 °C (-49.5 °F) 8401
dew point temperature: -45.0 °C (-49.0 °F) 8401
maximum temperature glide: 0.04 °C (0.1 °F) 8401
density, saturated liquid: 1485 kg/m³ (92.72 lb/cf) 8401
density, saturated vapor: 6.21 kg/m³ (0.388 lb/cf) 8401
specific volume, saturated liquid: 0.673 L/kg (0.0108 cf/lb) 8401
specific volume, saturated vapor: 161.0 L/kg (2.5795 cf/lb) 8401
heat of vaporization: 173.3 kJ/kg (74.5 Btu/lb) 8401
velocity of sound, saturated liquid: 728 m/s (2387 ft/s) 8401
velocity of sound, saturated vapor: 136 m/s (445 ft/s) 8401
viscosity, saturated liquid: 340 μPa·s (0.340 cp) 8401
viscosity, saturated vapor: 9.73 μPa·s (0.00973 cp) 8401
thermal conductivity, liquid: 0.0906 W/m·K (0.0523 Btu/hr·ft·°F) 8401
thermal conductivity, vapor: 0.0070 W/m·K (0.0041 Btu/hr·ft·°F) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
normal pressure, 20 °C (68 °F) -------
density, vapor: 4.718 kg/m³ (0.2945 lb/cf) 8401

normal pressure, 21.1 °C (70 °F) ---
density, vapor: 4.699 kg/m³ (0.2934 lb/cf) 8401

20 °C (68 °F) ---------------
presure, liquid (bubble point): 1015.1 kPa (147.23 psia) 8401
pressure, vapor (dew point): 1014.6 kPa (147.16 psia) 8401
density, saturated liquid: 1237 kg/m³ (77.20 lb/cf) 8401
density, saturated vapor: 57.93 kg/m³ (3.616 lb/cf) 8401
specific volume, saturated liquid: 0.809 L/kg (0.0130 cf/lb) 8401
specific volume, saturated vapor: 17.3 L/kg (0.2765 cf/lb) 8401
velocity of sound, saturated liquid: 429 m/s (1406 ft/s) 8401
velocity of sound, saturated vapor: 132 m/s (433 ft/s) 8401
viscosity, saturated liquid: 152 µPa·s (0.152 cp) 8401
viscosity, saturated vapor: 12.7 µPa·s (0.0127 cp) 8401
thermal conductivity, saturated liquid: 0.0649 W/m·K (0.0375 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01150 W/m·K (0.00665 Btu/hr·ft·°F) 8401

60 °C (140 °F) ---------------
presure, liquid (bubble point): 2630 kPa (381.4 psia) 8401
pressure, vapor (dew point): 2630 kPa (381.4 psia) 8401
heat of vaporization: 86.0 kJ/kg for liquid and 8401
vapor both at nominal 8401
composition (37.0 Btu/lb) 8401
86.2 kJ/kg coexisting liquid 8401
and vapor at bubble-point 8401
pressure (37.0 Btu/lb) 8401

• critical point ---------------
temperature: 80.7 °C (177.3 °F) 8401
pressure: 4018 kPa (582.8 psia) 8401
density: 569 kg/m³ (35.5 lb/cf) 8401
specific volume: 1.76 L/kg (0.0282 cf/lb) 8401

ENVIRONMENTAL
ODP (ozone depletion potential): 0.221 mass-weighted average 9501
(model-derived relative to R 11) 9501
0.229 mass-weighted average 9501
(semi-empirical relative to R 11) 9501
GWP (global warming potential): 6200 mass-weighted average 9501
relative to CO₂ for 100 yr integration
HGWP (halocarbon GWP): 19 mass-weighted average 9501
relative to R 11 for infinite integration period
3.75 relative to R 11 for 9501
infinite integration period

SAFETY
• classification ---------------
safety group (ASHRAE Standard 34): A1 8601
NFPA 704 degrees of hazard (H-F-R-S): 3A15
ARI recommendation: 2-0-0 health-flammability-reactivity
[-special]: 0=no, 4=severe
NPCA HMIS hazard ratings (H-F-R): AlliedSignal: 2-0-0 MSDS
DuPont: 1-0-1 MSDS
health-flammability-reactivity
UL Comparative Hazard to Life Group: 0=insignificant, 4=extreme
short-term occupational limit -------
ARI "IDLH" recommendation: 5(a) in absence of flame or
hot objects
long-term occupational limit -------
NIOSH REL (recommended exposure limit):
none, components 1,000/1,000
ppm v/v TWA for 10 hr/day and
40 hr/wk
ACGIH TLV-TWA (time-weighted average):
none, components 1,000/1,000
ppm v/v TWA for 8 hr/day and
40 hr/wk
exposure limit consistent to OSHA PEL:
ARI: 1,000 ppm v/v TWA for 8
hr/day and 40 hr/wk
emergency exposure limit -------
Refrigerant Concentration Limit (RCL):
35,000 ppm v/v (preliminary
value under review, based on
draft ASHRAE 34aa)
acute (short-term) toxicity -------
LC50 (lethal concentration, 50%):
rat, 4 hr, AlliedSig: ≥300,000 MSDS
ppm (fatal concentration by
inhalation for half of test
animals)
ALC (approximate lethal concentration):
rat, 2 hr, 0/4: > 200,000 ppm 6272
(lowest exposure tested with
one more deaths by
inhalation)
cardiac sensitization (CS) EC50:
dog, 10 min: 100,000-200,000 6274
ppm v/v (effective
concentration in half of test
animals)
cardiac sensitization threshold/LOEL:
dog, 5 min, 5/12: 100,000 ppm 5644
v/v (lowest observed effect
level in test animals)
cardiac sensitization (CS) NOEL:
dog, 10 min, 0/6: 50,000 ppm 6274
v/v (no observed effect level
in test animals)
flammability ---------------
LFL-UFL (flammability limits in air):
none (nonflammable as tested) 2525
flash point:
AlliedSignal: no flash point MSDS
ICI: does not flash MSDS
autoignition temperature:
704 °C (1299 °F) 3960
autodecomposition temperature:
Elf Atocem: >427 °C (>800 °F) MSDS
former UL Classification:
practically nonflammable 5931
(withdrawn for revision of the
classification system,
category SBQT2)
detection --------------
appearance: DuPont: clear, colorless MSDS
odor: AlliedSignal: faint etheréal MSDS
PRODUCTION
first commercial use as a refrigerant: 1961 5C39
last year production allowed: 1995 based on refrigerant 115 8C01
in developed countries under
the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-503

--- REFRIGERANT DATA SUMMARY ---

<table>
<thead>
<tr>
<th>R-503</th>
<th>R-23/13 (40.1/59.9)</th>
<th>see RDB#</th>
</tr>
</thead>
<tbody>
<tr>
<td>azeotrope</td>
<td>binary blend</td>
<td></td>
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</tbody>
</table>

**COMMON USE(S)**

extremely low temperature industrial refrigeration, primarily for the low stage of cascade systems, as well as very low temperature commercial and industrial refrigeration

**IDENTIFIERS**

<table>
<thead>
<tr>
<th>common name(s):</th>
<th>R-503; R503; R 503</th>
<th>2909</th>
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<tr>
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<td>HFC/CFC-503</td>
<td>2909</td>
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<tr>
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<td>not CFC-503 or HCFC-503</td>
<td>2909</td>
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<tr>
<td>trade name(s):</td>
<td>AlliedSignal Genetron(R) 503</td>
<td>MSDS</td>
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<td>DuPont Freon(R) 503</td>
<td>MSDS</td>
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<tr>
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<td>Elf Atochem Forane(R) 503</td>
<td>MSDS</td>
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<td>Hoechst Frigen(R) 503</td>
<td>MSDS</td>
</tr>
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<td></td>
<td>ICI Arcton(R) 503</td>
<td>MSDS</td>
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</tbody>
</table>

ARI container color / Pantone number: blue-green (aqua) / 3268 6601

**PHYSICAL**

| nominal blend formulation | composition: R-23/13 | 2909 |
|                          | component weight fractions: 40.1 / 59.9 % | 2909 |
|                          | component mole fractions: 49.970 / 50.030 % | 8820 |
|                          | azeotropic temperature: -88.7 °C (-127.6 °F) | 3960 |

| properties | molar mass: 87.24658 g/mol (0.192346 lb/mol) | 8820 |
| normal boiling point | bubble point temperature: -87.5 °C (-125.5 °F) | 8401 |
|                   | dew point temperature: -87.5 °C (-125.5 °F) | 8401 |
|                   | maximum temperature glide: 0.02 °C (0.0 °F) | 8401 |
|                   | density, saturated liquid: 1487 kg/m3 (92.82 lb/cf) | 8401 |
|                   | density, saturated vapor: 5.98 kg/m3 (0.373 lb/cf) | 8401 |
|                   | specific volume, saturated liquid: 0.673 L/kg (0.0108 cf/lb) | 8401 |
|                   | specific volume, saturated vapor: 167.2 L/kg (2.6789 cf/lb) | 8401 |
|                   | heat of vaporization: 179.1 kJ/kg (77.0 Btu/lb) | 8401 |
|                   | velocity of sound, saturated liquid: 739 m/s (2426 ft/s) | 8401 |
|                   | velocity of sound, saturated vapor: 143 m/s (470 ft/s) | 8401 |
|                   | viscosity, saturated liquid: 357 μPa·s (0.357 cp) | 8401 |
|                   | viscosity, saturated vapor: 8.73 μPa·s (0.00873 cp) | 8401 |
|                   | thermal conductivity, liquid: 0.1021 W/m·K (0.0590 Btu/hr·ft·°F) | 8401 |
|                   | thermal conductivity, vapor: 0.0060 W/m·K (0.0035 Btu/hr·ft·°F) | 8401 |

| normal pressure, 20 °C (68 °F) | density, vapor: 3.657 kg/m3 (0.2283 lb/cf) | 8401 |
| normal pressure, 21.1 °C (70 °F) | density, vapor: 3.643 kg/m3 (0.2274 lb/cf) | 8401 |
| critical point | temperature: 18.4 °C (65.2 °F) | 8401 |
| | pressure: 4265 kPa (618.6 psia) | 8401 |

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
density: 552 kg/m³ (34.4 lb/ft³) 8401
specific volume: 1.81 L/kg (0.0290 cf/lb) 8401

ENVIRONMENTAL
- ODP (ozone depletion potential): 0.599 mass-weighted average (model-derived relative to R 11) 9501
- GWP (global warming potential): 14,300 mass-weighted average relative to CO₂ for 100 yr integration 9501
- HGWP (halocarbon GWP): 14 mass-weighted average relative to R 11 for infinite integration period DW

SAFETY
- classification ---------------
  - safety group (ASHRAE Standard 34): none (no application pending) 8601
  - NFPA 704 degrees of hazard (H-F-R-S): AlliedSignal: 1-0-1 MSDS
  - NPCA HMIS hazard ratings (H-F-R): health-flammability-reactivity
  - [-special]: 0=no, 4=severe MSDS
  - UL Comparative Hazard to Life Group: AlliedSignal: 1-0-1 MSDS
  - 6 in absence of flame or hot objects
- long-term occupational limit -------
  - exposure limit consistent to OSHA PEL: ICI provisional OEL: 1,000 ppm 5A24 v/v TWA for 8 hr/day and 40 hr/wk
- flammability ---------------------
  - LFL-UFL (flammability limits in air): AlliedSignal: no flash point MSDS
  - flash point: ICI: does not flash MSDS
  - autoignition temperature: >750 °C (>1382 °F) 5931
  - autodecomposition temperature: DuPont: >760 °C (>1400 °F) MSDS
  - former UL Classification: nonflammable (withdrawn for 5931 revision of the classification system, category SBQT2)
- detection -----------------------
  - appearance: DuPont: clear, colorless MSDS
  - odor: Allied: practically odorless MSDS
  - ICI: faint ether-like odor MSDS

PRODUCTION
- last year production allowed: 1995 based on refrigerant 13 8C01 in developed countries under the Montreal Protocol
### R-504

#### REFRIGERANT DATA SUMMARY

<table>
<thead>
<tr>
<th>R-504</th>
<th>R-32/115 (48.2/51.8)</th>
<th>see RDB#</th>
</tr>
</thead>
<tbody>
<tr>
<td>azeotrope</td>
<td>binary blend</td>
<td></td>
</tr>
</tbody>
</table>

#### IDENTIFIERS

- **common name(s):** R-504; R504; R 504 2909
- **HFC/CFC-504** 2909
- **not CFC-504 or HCFC-504** 2909
- **ARI container color / Pantone number:** none, use light green grey/413 6601

#### PHYSICAL

- **nominal blend formulation**
  - **composition:** R-32/115 2909
  - **component weight fractions:** 48.2 / 51.8 % 2909
  - **component mole fractions:** 73.424 / 26.576 % 8820
  - **azeotropic temperature:** 17.0 °C (62.6 °F) 2909
- **properties**
  - **molar mass:** 79.24841 g/mol (0.174713 lb/mol) 8820
- **normal boiling point**
  - **bubble point temperature:** -57.7 °C (-71.9 °F) 8401
  - **dew point temperature:** -56.2 °C (-69.2 °F) 8401
  - **maximum temperature glide:** 1.48 °C (2.7 °F) 8401
  - **density, saturated liquid:** 1372 kg/m³ (85.67 lb/cf) 8401
  - **density, saturated vapor:** 4.66 kg/m³ (0.291 lb/cf) 8401
  - **specific volume, saturated liquid:** 0.729 L/kg (0.0117 cf/lb) 8401
  - **specific volume, saturated vapor:** 214.4 L/kg (3.4347 cf/lb) 8401
  - **heat of vaporization:** 235.8 kJ/kg (101.4 Btu/lb) 8401
  - **velocity of sound, saturated liquid:** 779 m/s (2555 ft/s) 8401
  - **velocity of sound, saturated vapor:** 160 m/s (525 ft/s) 8401
  - **viscosity, saturated liquid:** 292 μPa·s (0.292 cp) 8401
  - **viscosity, saturated vapor:** 9.74 μPa·s (0.00974 cp) 8401
  - **thermal conductivity, liquid:** 0.1294 W/m·K (0.0747 Btu/hr·ft·°F) 8401
  - **thermal conductivity, vapor:** 0.0077 W/m·K (0.0044 Btu/hr·ft·°F) 8401
- **normal pressure, 20 °C (68 °F)**
  - **density, vapor:** 3.341 kg/m³ (0.2086 lb/cf) 8401
- **normal pressure, 21.1 °C (70 °F)**
  - **density, vapor:** 3.328 kg/m³ (0.2078 lb/cf) 8401
- **20 °C (68 °F)**
  - **pressure, liquid (bubble point):** 1649.3 kPa (239.21 psia) 8401
  - **pressure, vapor (dew point):** 1648.4 kPa (239.08 psia) 8401
  - **density, saturated liquid:** 1062 kg/m³ (66.27 lb/cf) 8401
  - **density, saturated vapor:** 74.94 kg/m³ (4.678 lb/cf) 8401
  - **specific volume, saturated liquid:** 0.942 L/kg (0.0151 cf/lb) 8401
  - **specific volume, saturated vapor:** 13.3 L/kg (0.2138 cf/lb) 8401
  - **velocity of sound, saturated liquid:** 390 m/s (1280 ft/s) 8401
  - **velocity of sound, saturated vapor:** 150 m/s (492 ft/s) 8401
  - **viscosity, saturated liquid:** 109 μPa·s (0.109 cp) 8401
  - **viscosity, saturated vapor:** 14 μPa·s (0.014 cp) 8401
  - **thermal conductivity, saturated liquid:** 0.0862 W/m·K (0.0498 Btu/hr·ft·°F) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
thermal conductivity, saturated vapor: 0.01531 W/m·K (0.00885 Btu/hr·ft°F)

- critical point ---------------------
  temperature: 62.1 °C (143.9 °F)
  pressure: 4439 kPa (643.8 psia)
  density: 505 kg/m³ (31.5 lb/ft³)
  specific volume: 1.98 L/kg (0.0317 cf/lb)

ENVIRONMENTAL

  ODP (ozone depletion potential): 0.207 mass-weighted average
  (model-derived relative to R 11)

  GWP (global warming potential): 5760 mass-weighted average
  relative to CO₂ for 100 yr integration

  HGWP (halocarbon GWP): 19 mass-weighted average
  relative to R 11 for infinite integration period

SAFETY

- classification ---------------------
  safety group (ASHRAE Standard 34): none (no application pending)

- emergency exposure limit ----------
  Refrigerant Concentration Limit (RCL): 41,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

- flammability ----------------------
  LFL-UFL (flammability limits in air): none (nonflammable as tested)

PRODUCTION

  last year production allowed: 1995 based on refrigerant 115 in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-505

REFRIGERANT DATA SUMMARY

R-505    R-12/31 (78.0/22.0)    see
azeotrope binary blend    RDB#

COMMON USE(S)
withdrawn from commercial use with identification of refrigerant 31
as carcinogenic; formerly used to replace refrigerant 12 in some
applications, including chillers with centrifugal compressors

IDENTIFIERS
common name(s): R-505; R505; R 505
CFC/HFC-505
not CFC-505 or HCFC-505
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL
\bullet nominal blend formulation -----
\hspace{1cm} composition: R-12/31
\hspace{1cm} component weight fractions: 78.0 / 22.0 %
\hspace{1cm} component mole fractions: 66.755 / 33.245 %
\hspace{1cm} azeotropic temperature: 115.0 °C (239.0 °F)
\hspace{1cm} molar mass: 103.48057 g/mol (0.228136 lb/mol)
\hspace{1cm} normal boiling point ----------
\hspace{1cm} temperature: -30.0 °C (-22.0 °F)
\hspace{1cm} heat of vaporization: 196.3 kJ/kg (84.4 Btu/lb)
\hspace{1cm} critical point ------------------
\hspace{1cm} temperature: 117.8 °C (244.0 °F)
\hspace{1cm} pressure: 4730 kPa (686.0 psia)
\hspace{1cm} density: 549 kg/m3 (34.3 lb/ft)
\hspace{1cm} specific volume: 1.82 L/kg (0.0292 cf/lb)

ENVIRONMENTAL
ODP (ozone depletion potential): 0.642 mass-weighted average
(model-derived relative to R 11)
0.704 mass-weighted average
(semi-empirical relative to R 11)

SAFETY
\bullet classification -------------
\hspace{1cm} safety group (ASHRAE Standard 34): none (no application pending)
UL Comparative Hazard to Life Group: 5 in absence of flame or hot
objects
\hspace{1cm} flammability ---------------
\hspace{1cm} LFL-UFL (flammability limits in air): none (nonflammable as tested)

PRODUCTION
last year production allowed: 1995 based on refrigerant 12
in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
--- REFRIGERANT DATA SUMMARY ---

R-506  R-31/114 (55.1/44.9)
azeotrope  binary blend  

COMMON USE(S)
withdrawn from commercial use with identification of refrigerant 31
as carcinogenic; formerly used in applications with high condensing
temperatures, such as for overhead crane cabs in steel mills

IDENTIFIERS
common name(s):  R-506; R506; R 506
HCFC/CFC-506
not CFC-506 or HCFC-506

ARI container color / Pantone number:  none, use light green grey/413 6601

PHYSICAL
Nominal blend formulation --------
composition:  R-31/114  2909
component weight fractions:  55.1 / 44.9 %  2909
component mole fractions:  75.368 / 24.612  8820
azeotropic temperature:  18.0 °C (64.4 °F)  2909

Properties ---------------------
molar mass:  93.69111 g/mol (0.206554 lb/mol)  8820

Normal boiling point ----------
temperature:  -12.3 °C (9.9 °F)  0036
heat of vaporization:  239.4 kJ/kg (102.9 Btu/lb)  0036

Critical point -----------------
temperature:  142.2 °C (288.0 °F)  1136
pressure:  5164 kPa (749.0 psia)  1136
density:  541 kg/m³ (33.7 lb/ft³)  1136
specific volume:  1.85 L/kg (0.0296 cf/lb)  1136

ENVIRONMENTAL
ODP (ozone depletion potential):  0.387 mass-weighted average  9501
(model-derived relative to R 11)

SAFETY
Classification -------------------
safety group (ASHRAE Standard 34):  none (no application pending)  8601
UL Comparative Hazard to Life Group:  5 in absence of flame or hot  0036
objects

Flammability ---------------------
LFL-UFL (flammability limits in air):  none (nonflammable as tested)  0036

PRODUCTION
Last year production allowed:  1995 based on refrigerant 114  8C01
in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-507A

--- REFRIGERANT DATA SUMMARY ---

R-507A  R-125/143a (50.0/50.0)  see
azeotrope  binary blend  RDB#

COMMON USE(S)
alternative for refrigerant 502 for low- and medium-temperature
commercial refrigeration (such as supermarket display cases),
transport refrigeration, and ice machines; this blend may be
protected under by U.S. patent 5,211,867

IDENTIFIERS
common name(s):  R-507A; R507A; R 507A  6801
also R-507; R507; R 507  4871
HFC/HFC-507A, not HFC-507A  6801
also HFC/HFC-507, not HFC-507  4871
trade name(s):  AlliedSignal Genetron(R) A2-50  3A60
Ausimont Meforex(R) M57  7726
Daikin R-507A  MSDS
Elf Atochem Forane(R) 507  MSDS
Solvay Solkane(R) 507
historical name(s):  Hoechst Reclin(R) 507A
ARI container color / Pantone number:  teal / 326  6601

PHYSICAL
nominal blend formulation --------
composition:  R-125/143a  4871
component weight fractions:  50.0 / 50.0 %  4871
component mole fractions:  41.184 / 58.816 %  8820

properties ------------------------
molar mass:  98.65875 g/mol (0.217946 lb/mol)  8820
normal freezing/melting/triple point:  -116.5 to -115.8 °C
                                      (-177.7 to -181.3 °F)  7116
normal boiling point ---------------
bubble point temperature:  -47.1 °C (-52.8 °F)  8401
dew point temperature:  -47.1 °C (-52.8 °F)  8401
maximum temperature glide:  0.00 °C (0.0 °F)  8401
density, saturated liquid:  1319 kg/m3 (82.33 lb/ft)  8401
density, saturated vapor:  5.59 kg/m3 (0.349 lb/ft)  8401
specific volume, saturated liquid:  0.758 L/kg (0.0121 cf/lb)  8401
specific volume, saturated vapor:  179.0 L/kg (2.8675 cf/lb)  8401
heat of vaporization:  196.1 kJ/kg (84.3 Btu/lb)  8401
velocity of sound, saturated liquid:  741 m/s (2432 ft/s)  8401
velocity of sound, saturated vapor:  142 m/s (465 ft/s)  8401
viscosity, saturated liquid:  327 µPa·s (0.327 cp)  8401
viscosity, saturated vapor:  9.10 µPa·s (0.00910 cp)  8401
thermal conductivity, liquid:  0.0978 W/m·K (0.0565
                                                  Btu/hr·ft·°F)  8401
thermal conductivity, vapor:  0.0089 W/m·K (0.0052
                                      Btu/hr·ft·°F)  8401

normal pressure, 20 °C (68 °F) -----
density, vapor:  4.183 kg/m3 (0.2611 lb/ft)  8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
density, vapor: 4.166 kg/m³ (0.2601 lb/cf) 8401

- 20 °C (68 °F) ---------------
  pressure, liquid (bubble point): 1127.5 kPa (163.53 psia) 8401
  pressure, vapor (dew point): 1126.4 kPa (163.37 psia) 8401
  density, saturated liquid: 1073 kg/m³ (66.97 lb/cf) 8401
  density, saturated vapor: 59.58 kg/m³ (3.720 lb/cf) 8401
  specific volume, saturated liquid: 0.932 L/kg (0.0149 cf/lb) 8401
  specific volume, saturated vapor: 16.8 L/kg (0.2688 cf/lb) 8401
  velocity of sound, saturated liquid: 403 m/s (1322 ft/s) 8401
  velocity of sound, saturated vapor: 134 m/s (440 ft/s) 8401
  viscosity, saturated liquid: 135 μPa·s (0.135 cp) 8401
  viscosity, saturated vapor: 12.3 μPa·s (0.0123 cp) 8401
  thermal conductivity, saturated liquid: 0.0684 W/m·K (0.0395 Btu/hr·ft·°F) 8401
  thermal conductivity, saturated vapor: 0.01542 W/m·K (0.00891 Btu/hr·ft·°F) 8401

- 60 °C (140 °F) ---------------
  pressure, liquid (bubble point): 2950 kPa (427.9 psia) 8401
  pressure, vapor (dew point): 2948 kPa (427.6 psia) 8401
  heat of vaporization: 77.0 kJ/kg for liquid and vapor both at nominal composition (33.1 Btu/lb) 8401
  77.6 kJ/kg coexisting liquid and vapor at bubble-point pressure (33.4 Btu/lb) 8401

- critical point ---------------
  temperature: 70.8 °C (159.4 °F) 8401
  70.9 °C (159.6 °F) 3A60
  pressure: 3715 kPa (538.8 psia) 8401
  3793 kPa (550.2 psia) 3A60
  density: 493 kg/m³ (30.7 lb/cf) 8401
  500 kg/m³ (31.2 lb/cf) 3A60
  specific volume: 2.00 L/kg (0.0321 cf/lb) 3A60
  2.03 L/kg (0.0325 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
(model-derived relative to R 11).

GWP (global warming potential): 4600 mass-weighted average 9501
relative to CO2 for 100 yr integration

HGWP (halocarbon GWP): 0.91 mass-weighted average DW
relative to R 11 for infinite integration period
0.96 relative to R 11 for infinite integration period 4683

SAFETY

- classification ---------------
  safety group (ASHRAE Standard 34): Al 8601
  NFPA 704 degrees of hazard (H-F-R-S): AlliedSignal: 2-0-0 8601
  health-flammability-reactivity HDR [-special]: 0=no, 4=severe
  NPCA HMIS hazard ratings (H-F-R): AlliedSignal: 2-0-0 8601
  health-flammability-reactivity 0=insignificant, 4=extreme

- emergency exposure limit --------
  Refrigerant Concentration Limit (RCL): 69,000 ppm v/v (preliminary)
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LFL-UFL (flammability limits in air)</td>
<td>7116</td>
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<tr>
<td>heat of combustion (by ASHRAE 34-92)</td>
<td>4683</td>
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<tr>
<td>flash point</td>
<td>5931</td>
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<tr>
<td>autoignition temperature</td>
<td>&gt;482°F</td>
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<td>autodecomposition temperature</td>
<td>&gt;250°C</td>
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<tr>
<td>former UL Classification</td>
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<tr>
<td>Practically nonflammable (withdrawn)</td>
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<tr>
<td>(for revision of classification system)</td>
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<tr>
<td>category SBQ72</td>
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<tr>
<td>appearance</td>
<td>clear, colorless gas</td>
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<td>odor</td>
<td>slight ethereal</td>
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<td>first commercial use as a refrigerant</td>
<td>November 1993</td>
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<td>last year production allowed</td>
<td>unrestricted</td>
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</tbody>
</table>
R-508A

R-508A  R-23/116 (39.0/61.0) see
azeotrope  binary blend  RDB#  ----

COMMON USE(S)
replacement for refrigerant 503; extremely low temperature refrigeration as in freezers for biological, medical, and pharmaceutical use

IDENTIFIERS

common name(s):  R-508A; R508A; R 508A  6801
also R-508; R508; R 508  6101
HFC/HFC-508A, not HFC-508A  6801
also HFC/HFC-508, not HFC-508  6101

trade name(s):  ICI Klea(R) 508  CSDS
ICI Klea(R) 508A  MSDS
ICI Klea(R) 5R3  MSDS
ICI Arcon(R) 5R3  MSDS
ICI Arcon(R) TP5R3

historical name(s):  ICI Arcon(R) 5R3  MSDS

name used in U.S. EPA SNAP Rule:  PFC Blend Alpha
ARI container color / Pantone number:  none, use light green grey/413  6601

PHYSICAL

· nominal blend formulation ---------
  composition:  R-23/116  6101
  component weight fractions:  39.0 / 61.0 %  6101
  component mole fractions:  55.758 / 44.242 %  8820

· properties --------------------------
  molar mass:  100.09772 g/mol (0.220678 lb/mol)  8820
  normal boiling point ----------------
  bubble point temperature:  -87.4 °C (-125.3 °F)  8401
dew point temperature:  -87.4 °C (-125.3 °F)  8401
maximum temperature glide:  0.00 °C (0.0 °F)  8401
density, saturated liquid:  1544 kg/m3 (96.36 lb/cf)  8401
density, saturated vapor:  6.88 kg/m3 (0.429 lb/cf)  8401
specific volume, saturated liquid:  0.648 L/kg (0.0104 cf/lb)  8401
specific volume, saturated vapor:  145.1 L/kg (2.3244 cf/lb)  8401
heat of vaporization:  157.0 kJ/kg (67.5 Btu/lb)  8401
  velocity of sound, saturated liquid:  635 m/s (2083 ft/s)  8401
  velocity of sound, saturated vapor:  130 m/s (427 ft/s)  8401
viscosity, saturated liquid:  346 µPa·s (0.346 cp)  8401
viscosity, saturated vapor:  8.96 µPa·s (0.00896 cp)  8401
  thermal conductivity, liquid:  0.0915 W/m·K (0.0529 Btu/hr·ft°F)  8401
  thermal conductivity, vapor:  0.0063 W/m·K (0.0036 Btu/hr·ft°F)  8401

· normal pressure, 20 °C (68 °F) -----
density, vapor:  4.196 kg/m3 (0.2620 lb/cf)  8401

· normal pressure, 21.1 °C (70 °F) ---
density, vapor:  4.180 kg/m3 (0.2609 lb/cf)  8401

· 20 °C (68 °F) --------------------
  pressure, saturated vapor:  3860.0 kPa (559.85 psia)
critical point

- temperature: 11.0 °C (51.8 °F) 8401
- pressure: 3701 kPa (536.8 psia) 8401
- density: 573 kg/m³ (35.8 lb/ft³) 8401
- specific volume: 1.74 L/kg (0.0279 ft³/lb) 8401

ENVIRONMENTAL

- ODP (ozone depletion potential): <0.00016 mass-weighted average 9501
  (model-derived relative to R-11)
- GWP (global warming potential): 12,700 mass-weighted average 9501
  relative to CO₂ for 100 yr integration
- HGWP (halocarbon GWP): 128 mass-weighted average DW
  relative to R-11 for infinite integration period

SAFETY

- classification
  - safety group (ASHRAE Standard 34): A1 8601
  - long-term occupational limit -------
    - exposure limit consistent to OSHA PEL: ICI OEL: 1,000 ppm v/v TWA for MSDS 8 hr/day and 40 hr/wk
  - emergency exposure limit
    - Refrigerant Concentration Limit (RCL): 55,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)
  - flammability
    - LFL-UFL (flammability limits in air): ICI: nonflammable MSDS
      - flash point: ICI: does not flash MSDS
      - autoignition temperature: >750 °C (>1382 °F) 6938
      - former UL Classification: nonflammable (withdrawn for 6938
        revision of the classification system, category SBQT2)
  - detection
    - appearance: ICI: colorless MSDS
    - odor: ICI: slight ethereal CSDS

PRODUCTION

- first commercial use as a refrigerant: 1994
- last year production allowed: unrestricted 8C01
R-508B

--- REFRIGERANT DATA SUMMARY ---

R-508B R-23/116 (46.0/54.0) see
azotrope binary blend RDB#

COMMON USE(S)
replacement for refrigerants 13 and 503 in extremely low temperature
refrigeration with evaporator temperatures of -90 to -40 °C (-130 to
-40 °F), as in freezers for biological, medical, and pharmaceutical
use or the low stage of cascaded systems

IDENTIFIERS
common name(s): R-508B; R508B; R 508
HFC/HFC-508B, not HFC-508B 6801
historical name(s): DuPont Suva(R) 95 5C07
ARI container color / Pantone number: dark blue (navy) / 302 ARI

PHYSICAL
- nominal blend formulation -----
composition: R-23/116 6801
component weight fractions: 46.0 / 54.0 % 6801
component mole fractions: 62.675 / 37.325 % 8820
azeotropic temperature: -45.6 °C (-50.1 °F) mfr

properties ---------------------
molar mass: 95.39402 g/mol (0.210308 8820
lb/mol)

- normal boiling point --------
  bubble point temperature: -87.4 °C (-125.3 °F) 8401
  dew point temperature: -87.0 °C (-124.6 °F) 8401
  maximum temperature glide: 0.36 °C (0.6 °F) 8401
  density, saturated liquid: 1533 kg/m3 (95.69 lb/cf) 8401
  density, saturated vapor: 6.55 kg/m3 (0.409 lb/cf) 8401
  specific volume, saturated liquid: 0.652 L/kg (0.0105 cf/lb) 8401
  specific volume, saturated vapor: 152.8 L/kg (2.4471 cf/lb) 8401
  heat of vaporization: 166.0 kJ/kg (71.4 Btu/lb) 8401
  velocity of sound, saturated liquid: 656 m/s (2152 ft/s) 8401
  velocity of sound, saturated vapor: 134 m/s (440 ft/s) 8401
  viscosity, saturated liquid: 352 μPa·s (0.352 cp) 8401
  viscosity, saturated vapor: 8.98 μPa·s (0.00989 cp) 8401
  thermal conductivity, liquid: 0.0964 W/m·K (0.0557 8401
  Btu/hr·ft°F)
  thermal conductivity, vapor: 0.0063 W/m·K (0.0036 8401
  Btu/hr·ft°F)

- normal pressure, 20 °C (68 °F) ----
  density, vapor: 3.983 kg/m3 (0.2487 lb/cf) 8401
  3.999 kg/m3 (0.2496 lb/cf) 8401

- critical point -----------------
temperature: 12.1 °C (53.7 °F) 8401
  14.0 °C (57.2 °F) 6C14
  pressure: 3834 kPa (556.1 psia) 8401
  3926 kPa (569.4 psia) 5C07
  density: 571 kg/m3 (35.6 lb/cf) 8401
  586 kg/m3 (36.6 lb/cf) 5C07
  specific volume: 1.71 L/kg (0.0273 cf/lb) 5C07

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
ENVIRONMENTAL

ODP (ozone depletion potential): <0.00019 mass-weighted average 9501 (model-derived relative to R 11)

GWP (global warming potential): 13,000 mass-weighted average 9501 relative to CO2 for 100 yr integration

HGWP (halocarbon GWP): 115 mass-weighted average DW relative to R 11 for infinite integration period

SAFETY

· classification ----------------------------
  safety group (ASHRAE Standard 34): A1/A1
  NPCA HMIS hazard ratings (H-F-R): DuPont: 1-0-1
  health-flammability-reactivity
  0=insignificant, 4=extreme

· long-term occupational limit --------
  exposure limit consistent to OSHA PEL:
  DuPont: 1,000 ppm v/v TWA for 5909 8 hr/day and 40 hr/wk

· emergency exposure limit ----------
  Refrigerant Concentration Limit (RCL):
  52,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

· flammability ------------------------
  LFL-UFL (flammability limits in air):
  flash point: none (nonflammable as tested) 5909
  autoignition temperature: none (nonflammable as tested) mfr
  former UL Classification: >750 °C (>1382 °F) 5C10
  nonflammable (withdrawn for 5C10 revision of the classification system, category SBQT2)

· detection --------------------------
  appearance: DuPont: clear, colorless
  odor: DuPont: slight ethereal

PRODUCTION

first commercial use as a refrigerant: 1996
last year production allowed: unrestricted
R-509A

REFRIGERANT DATA SUMMARY

R-509A  R-22/218 (44.0/56.0)  see
azeotrope  binary blend  RDB#  ----

COMMON USE(S)
very low temperature refrigeration with hermetic compressors in the
range of approximately -40 to -30 °C (-40 to -22 °F), especially for
biomedical and pharmaceutical uses; replacement for refrigerant 502
in these applications

IDENTIFIERS
common name(s):  R-509A; R509A; R 509A  6801
also R-509; R509; R 509  6101
HCFC/HFC 509A, not HCFC-509A  6801
also HCFC/FC-509, not HCFC-509  6101
not FC-509A or FC-509  6101
trade name(s):  ICI Arcton(R) 509  MSDS
ICI Arcton(R) TP5R2  MSDS
ARI container color / Pantone number:  none, use light green grey/413  6601

PHYSICAL

- nominal blend formulation --------
  composition:  R-22/218  6101
  component weight fractions:  44.0 / 56.0 %  6101
  component mole fractions:  63.079 / 36.921 %  8820
  azeotropic temperature:  0.0 °C (32.0 °F)  4C51

- properties ----------------------
molar mass:  123.96188 g/mol (0.273289 lb/mol)  8820
normal freezing/melting/triple point:
  bubble point temperature:  -40.4 °C (-40.8 °F)  8814
  dew point temperature:  -40.4 °C (-40.7 °F)  8814
  maximum temperature glide:  0.06 °C (0.1 °F)  8814
  0.40 °C (0.7 °F)  mfr
density, saturated liquid:  1522 kg/m³ (95.03 lb/cf)  8814
density, saturated vapor:  6.77 kg/m³ (0.423 lb/cf)  8814
specific volume, saturated liquid:  0.657 L/kg (0.0105 cf/lb)  8814
specific volume, saturated vapor:  147.6 L/kg (2.3645 cf/lb)  8814
heat of vaporization:  160.9 kJ/kg (69.2 Btu/lb)  8814
velocity of sound, saturated liquid:  685 m/s (2246 ft/s)  8814
velocity of sound, saturated vapor:  128 m/s (420 ft/s)  8814
viscosity, saturated liquid:  10.09 µPa·s (0.01009 cp)  8814
viscosity, saturated liquid:  332 µPa·s (0.332 cp)  8814
thermal conductivity, liquid:  0.0816 W/m·K (0.0472 Btu/hr·ft·°F)  8814
thermal conductivity, vapor:  0.0074 W/m·K (0.0043 Btu/hr·ft·°F)  8814

- normal pressure, 20 °C (68 °F) ----
density, vapor:  5.248 kg/m³ (0.3276 lb/cf)  8814

- normal pressure, 21.1 °C (70 °F) ---
density, vapor:  5.227 kg/m³ (0.3263 lb/cf)  8814

- 20 °C (68 °F) ---------------------

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
pressure, liquid (bubble point): 877.6 kPa (127.28 psia) 8814
pressure, vapor (dew point): 1103.0 kPa (159.98 psia) mfr
density, saturated liquid: 1289 kg/m³ (80.45 lb/cf) 8814
density, saturated vapor: 54.59 kg/m³ (3.408 lb/cf) 8814
specific volume, saturated liquid: 0.776 L/kg (0.0124 lb/cf) 8814
specific volume, saturated vapor: 18.3 L/kg (0.2934 cf/lb) 8814
maximum temperature glide: 0.02 °C (0.0 °F) mfr
velocity of sound, saturated liquid: 417 m/s (1369 ft/s) 8814
velocity of sound, saturated vapor: 125 m/s (409 ft/s) 8814
viscosity, saturated liquid: 157 µPa·s (0.157 cp) 8814
viscosity, saturated vapor: 12.9 µPa·s (0.0129 cp) 8814
thermal conductivity, saturated liquid: 0.0608 W/m·K (0.0351 Btu/hr·ft·°F) 8814
thermal conductivity, saturated vapor: 0.0116 W/m·K (0.00670 Btu/hr·ft·°F) 8814

60 °C (140 °F) ---------------------
pressure, liquid (bubble point): 2319 kPa (336.3 psia) 8814
pressure, vapor (dew point): 2314 kPa (335.6 psia) 8814
heat of vaporization: 83.8 kJ/kg for liquid and vapor both at nominal composition (36.0 Btu/lb) 8814
82.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (35.6 Btu/lb) 8814

critical point ---------------------
temperature: 87.2 °C (188.9 °F) 8814
pressure: 4027 kPa (584.1 psia) 8814
density: 578 kg/m³ (36.1 lb/cf) 8814
specific volume: 1.73 L/kg (0.0277 cf/lb) 8814

ENVIRONMENTAL
ODP (ozone depletion potential): 0.015 mass-weighted average (model-derived relative to R 11) 9501
0.022 mass-weighted average (semi-empirical relative to R 11) 9501
GWP (global warming potential): 5650 mass-weighted average relative to CO₂ for 100 yr integration 9501
HGWP (halocarbon GWP): 23 mass-weighted average relative to R 11 for infinite integration period DW

SAFETY
classification ---------------------
safety group (ASHRAE Standard 34): Al 8601
long-term occupational limit --------
exposure limit consistent to OSHA PEL: ICI exposure limit: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk MSDS
emergency exposure limit --------
Refrigerant Concentration Limit (RCL): 38,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa) MSDS
flammability ---------------------
LFL-UFL (flammability limits in air): ICI: none (nonflammable at STP) MSDS
<table>
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<th>Property</th>
<th>ICI: does not flash</th>
<th>MSDS</th>
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<tr>
<td>flash point</td>
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<tr>
<td>autoignition temperature</td>
<td>ICI: not applicable</td>
<td>MSDS</td>
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<tr>
<td>detection</td>
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<tr>
<td>appearance</td>
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<tr>
<td>odor</td>
<td>ICI: faint ether-like odor</td>
<td>MSDS</td>
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**PRODUCTION**

- **first commercial use as a refrigerant:** circa 1994
- **last year production allowed:** 2029 based on refrigerant 22 in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
Refrigerant Profiles: Blends without Assigned Designations
R-12/40

--------------- REFRIGERANT DATA SUMMARY ---------------

unassigned  R-12/40 (??/??)  see
zeotrope     binary blend     RDB#

COMMON USE(S)
proposed as a substitute for refrigerant 12 to respond to wartime
shortages in 1944 and 1945

IDENTIFIERS
  common name(s):  R-12/40 (??/??)
                    R12/40 (??/??)
                    R 12/40 (??/??)
                    CFC-12/HCC-40 (??/??)
                    not CFC-12/40 (??/??)

  ARI container color / Pantone number: none, use light green grey/413 6601
                                        possibly with red / 185 band

PHYSICAL
  nominal blend formulation ---------
    composition:  R-12/40
    component weight fractions:  formulation must be indicated %

SAFETY
  classification ---------------------
    safety group (ASHRAE Standard 34):  none (no application pending) 8601
                                             components are A1 and B2 8601
  flammability ----------------------
    LFL-UFL (flammability limits in air):  nonflammable for ≥35% m/m R12 6633

PRODUCTION
  first commercial use as a refrigerant: 1944
  last year production allowed: 1995 based on refrigerant 12 8C01
                                  in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-12/764 (92.0/8.0)

--- ----------------- REFRIGERANT DATA SUMMARY ----------------- ---
unassigned R-12/764 (92.0/8.0) see RDB# 3 ---
zeotrope blend

COMMON USE(S)
developmental blend, proposed in the 1930s, to facilitate leak
detection for refrigerant 12 in its early years; not known to have
been used commercially

IDENTIFIERS
common name(s): R-12/764 (92.0/8.0)
R12/764 (92.0/8.0)
R 12/764 (92.0/8.0)
trade name(s): Frigidaire DL-8 2113

PHYSICAL
nominal blend formulation ---------
composition: R-12/764 2
component weight fractions: 92.0 / 8.0 % 8820
component mole fractions: 83.782 / 16.218 %

properties -----------------------
molar mass: 111.69324 g/mol (0.246241 8820
lb/mol)

ENVIRONMENTAL
ODP (ozone depletion potential): 0.640 (model-derived relative 9501
to R 11)
0.702 (semi-empirical relative 9501
to R 11)

SAFETY
classification -----------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized
last year production allowed: 2113
1995 based on refrigerant 12 8C01
in developed countries under
the Montreal Protocol
R-22/12 (90.0/10.0)

----------------------------- REFRIGERANT DATA SUMMARY -----------------------------

unassigned R-22/12 (90.0/10.0) see RDB#
azeotrope binary blend

COMMON USE(S)
field mixture to improve oil return in systems with flooded
systems, especially in systems with evaporator temperature
below -20 °C (-4 °F); also used to lower condensing pressures and
temperatures

IDENTIFIERS

common name(s): R-22/12 (90/10)
R22/12 (90/10)
R 22/12 (90/10)
HCFC-22/CFC-12
not CFC-22/12 or HCFC-22/12
candidate for R-501 series

ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

- nominal blend formulation -------
  composition: R-22/12
  component weight fractions: 90.0 / 10.0 %
  component weight tolerances: ±5.0 / ±5.0
  component mole fractions: 92.639 / 7.361 % 8820

- properties ------------------------
  molar mass: 89.00361 g/mol (0.196219 lb/mol) 8820

- normal boiling point ------------
  bubble point temperature: -41.3 °C (-42.3 °F) 4101
dew point temperature: -41.2 °C (-42.2 °F) 4101
maximum temperature glide: 0.05 °C (0.1 °F) 4101
density, saturated liquid: 1409 kg/m³ (87.96 lb/ft³) 4101
density, saturated vapor: 4.84 kg/m³ (0.302 lb/ft³) 4101
heat of vaporization: 225.6 kJ/kg (97.0 Btu/lb) 4101

- normal pressure, 20 °C (68 °F) -----
  density, vapor: 3.759 kg/m³ (0.2347 lb/ft³) 4101

- normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 3.744 kg/m³ (0.2337 lb/ft³) 4101

- 20 °C (68 °F) ---------------------
  pressure, liquid (bubble point): 913.5 kPa (132.49 psia) 4101
density, saturated liquid: 1209 kg/m³ (75.48 lb/ft³) 4101
density, saturated vapor: 39.69 kg/m³ (2.478 lb/ft³) 4101
specific volume, saturated liquid: 0.827 L/kg (0.0132 cf/lb) 4101
specific volume, saturated vapor: 25.2 L/kg (0.4037 cf/lb) 4101
velocity of sound, saturated vapor: 159 m/s (523 ft/s) 4101
viscosity, saturated liquid: 183 µPa·s (0.183 cp) 4101
viscosity, saturated vapor: 12.8 µPa·s (0.0128 cp) 4101
thermal conductivity, saturated liquid: 0.0863 W/m·K (0.0499 Btu/hr·ft·°F) 4101
thermal conductivity, saturated vapor: 0.01310 W/m·K (0.00757 Btu/hr·ft·°F) 4101
**ENVIRONMENTAL**

- ODP (ozone depletion potential):
  - 0.113 mass-weighted average (model-derived relative to R 11)
  - 0.135 mass-weighted average (semi-empirical relative to R 11)

- GWP (global warming potential):
  - 2770 mass-weighted average relative to CO2 for 100 yr integration

- HGWP (halocarbon GWP):
  - 0.58 mass-weighted average relative to R 11 for infinite integration period

**SAFETY**

- Classification:
  - Safety group (ASHRAE Standard 34): none (no application pending) components are both A1

- Long-term occupational limit:
  - OSHA PEL (permissible exposure limit): none, both components 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk

- Flammability:
  - LFL-UFL (flammability limits in air): none (nonflammable as tested)

**PRODUCTION**

- First commercial use as a refrigerant: circa 1960
- Last year production allowed: 1995 based on refrigerant 12 in developed countries under the Montreal Protocol
### R-22/12/142b (25.0/15.0/60.0)

---

**REFRIGERANT DATA SUMMARY**

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<th>Value</th>
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<tr>
<td>zeotrope</td>
<td>ternary blend</td>
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**COMMON USE(S)**


Note: The trade name "R-176" was derived from the sum of 22, 12, and 142 from the component designations.

**IDENTIFIERS**

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<td>not HCFC-22/12/142b (25/15/60)</td>
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</table>

<table>
<thead>
<tr>
<th>historical name(s)</th>
<th>Alaskan Cool &quot;R-176&quot;</th>
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<td>2A20</td>
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<td>Blend 60/25/15&quot;</td>
<td>MSDS</td>
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**ARI container color / Pantone number:** none, use light green grey/413 6601 with red / 185 band

**PHYSICAL**

- **nominal blend formulation**
  - composition: R-22/12/142b
  - component weight fractions: 25.0 / 15.0 / 60.0 %
  - component mole fractions: 28.620 / 12.280 / 59.100 %

- **properties**
  - molar mass: 98.98772 g/mol (0.218231 lb/mol)
  - normal freezing/melting/triple point: -149.6 °C (-237.3 °F)
  - normal boiling point: -26.9 °C (-16.5 °F)
  - dew point temperature: -17.7 °C (0.1 °F)
  - maximum temperature glide: 9.19 °C (16.5 °F)
  - density, saturated liquid: 1288 kg/m³ (80.39 lb/ft³)
  - density, saturated vapor: 4.91 kg/m³ (0.307 lb/ft³)
  - specific volume, saturated liquid: 0.777 L/kg (0.0124 cf/lb)
  - specific volume, saturated vapor: 203.6 L/kg (3.2614 cf/lb)
  - heat of vaporization: 214.5 kJ/kg (92.2 Btu/lb)
  - 223.9 kJ/kg (96.3 Btu/lb)
  - velocity of sound, saturated liquid: 798 m/s (2619 ft/s)
  - velocity of sound, saturated vapor: 152 m/s (499 ft/s)
  - viscosity, saturated liquid: 370 µPa·s (0.370 cp)
  - viscosity, saturated vapor: 9.23 µPa·s (0.00923 cp)
  - thermal conductivity, liquid: 0.0991 W/m·K (0.0573 Btu/hr·ft°F)
  - thermal conductivity, vapor: 0.0084 W/m·K (0.0049 Btu/hr·ft°F)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
normal pressure, 20 °C (68 °F) -----
density, vapor: 4.212 kg/m³ (0.2630 lb/cf) 8814

normal pressure, 21.1 °C (70 °F) ---
density, vapor: 4.195 kg/m³ (0.2619 lb/cf) 8814

20 °C (68 °F) ------------------------
presure, liquid (bubble point): 516.8 kPa (74.96 psia) 8814
pressure, vapor (dew point): 403.7 kPa (58.56 psia) 8814
density, saturated liquid: 1164 kg/m³ (72.67 lb/cf) 8814
density, saturated vapor: 18.20 kg/m³ (1.136 lb/cf) 8814
specific volume, saturated liquid: 0.859 L/kg (0.0138 cf/lb) 8814
specific volume, saturated vapor: 0.1 L/kg (0.0009 cf/lb) 8814
velocity of sound, saturated liquid: 601 m/s (1970 ft/s) 8814
velocity of sound, saturated vapor: 154 m/s (505 ft/s) 8814
viscosity, saturated liquid: 215 μPa·s (0.215 cp) 8814
viscosity, saturated vapor: 10.7 μPa·s (0.0107 cp) 8814
thermal conductivity, saturated liquid: 0.0804 W/m·K (0.0464 Btu/hr·ft·°F) 8814
thermal conductivity, saturated vapor: 0.01083 W/m·K (0.00625 Btu/hr·ft·°F) 8814

60 °C (140 °F) -----------------------
presure, liquid (bubble point): 1410 kPa (204.5 psia) 8814
pressure, vapor (dew point): 1206 kPa (174.8 psia) 8814
heat of vaporization: 157.8 kJ/kg for liquid and 8814
vapor both at nominal 8814
composition (67.8 Btu/lb) 8814
152.1 kJ/kg coexisting liquid and vapor at bubble-point 8814
pressure (65.4 Btu/lb) 8814

critical point -----------------------
temperature: 123.2 °C (253.8 °F) 8814
129.4 °C (265.0 °F) 2A20
pressure: 4528 kPa (656.7 psia) 8814
5102 kPa (740.0 psia) 2A20
density: 471 kg/m³ (29.4 lb/cf) 8814
specific volume: 2.12 L/kg (0.0340 cf/lb) 8814

ENVIRONMENTAL

ODP (ozone depletion potential): 0.157 mass-weighted average 9501
(model-derived relative to R 11)
0.187 mass-weighted average (semi-empirical relative to R 11)
GWP (global warming potential): 3450 mass-weighted average 9501
relative to CO₂ for 100 yr integration
HGWP (halocarbon GWP): 0.77 mass-weighted average DW
relative to R 11 for infinite integration period

SAFETY

· classification -------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601
components are A1, A1, and A2 8601
NFPA 704 degrees of hazard (H-F-R-S): Pennwalt: 2-1-0 8601
health-flammability-reactivity [-special]: 0=no, 4=severe

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
exposure limit consistent to OSHA PEL: Pennwalt: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk

· flammability ---------------------- none (nonflammable as tested) 2A20 worst fractionation flammable MSDS Elf Atochem: nonflammable MSDS

LFL-UFL (flammability limits in air):

· detection ------------------------ appearance: Elf Atochem: clear, colorless MSDS odor: Kali-Chemie: faint ethereal MSDS

flash point:

PRODUCTION

first commercial use as a refrigerant: 1983 by AlaskanAirConditioning

last year production allowed: 1995 based on refrigerant 12 8C01 in developed countries under the Montreal Protocol
R-22/124/600 (50.0/47.0/3.0)

REFRIGERANT DATA SUMMARY

unassigned  R-22/124/600 (50.0/47.0/3.0)  see
zeotrope  tetrary blend  RDB#

COMMON USE(S)
alternative for refrigerant 12, primarily for aftermarket use to service or retrofit existing medium temperature refrigeration equipment without a lubricant change (not suited for use with centrifugal compressors or flooded evaporators)

IDENTIFIERS
common name(s):  R-22/124/600 (50/47/3)
                  R22/124/600 (50/47/3)
                  R22/124/600 (50/47/3)
                  HCFC-22/HCF-124/HC-600  2909
                  (50/47/3)
trade name(s):  not HCFC-22/124/600 (50/47/3)  2909
ARI container color / Pantone number:  Ausimont Meforex(R) DI-36  7202
                        none, use light green grey/413  6601

PHYSICAL

  nominal blend formulation ----------
    composition:  R-22/124/600
    component weight fractions:  50.0 / 47.0 / 3.0 %
    component mole fractions:  59.353 / 35.349 / 5.298 %  8820
  properties -----------------------
    molar mass:  102.64340 g/mol (0.226290 lb/mol)  8820
  normal boiling point ---------
    bubble point temperature:  -34.8 °C (-30.6 °F)  8401
    dew point temperature:  -26.9 °C (-16.4 °F)  8401
    maximum temperature glide:  7.90 °C (14.2 °F)  8401
    density, saturated liquid:  1393 kg/m³ (86.93 lb/ft³)  8401
    density, saturated vapor:  5.27 kg/m³ (0.329 lb/ft³)  8401
    specific volume, saturated liquid:  0.718 L/kg (0.0115 cf/lb)  8401
    specific volume, saturated vapor:  189.7 L/kg (3.0379 cf/lb)  8401
    heat of vaporization:  209.9 kJ/kg (90.2 Btu/lb)  8401
    velocity of sound, saturated liquid:  784 m/s (2572 ft/s)  8401
    velocity of sound, saturated vapor:  147 m/s (482 ft/s)  8401
    viscosity, saturated liquid:  357 µPa·s (0.357 cp)  8401
    viscosity, saturated vapor:  9.94 µPa·s (0.00994 cp)  8401
    thermal conductivity, liquid:  0.0982 W/m·K (0.0567 Btu/hr·ft·°F)  8401
    thermal conductivity, vapor:  0.0080 W/m·K (0.0046 Btu/hr·ft·°F)  8401
  normal pressure, 20 °C (68 °F) -----
    density, vapor:  4.352 kg/m³ (0.2717 lb/ft³)  8401
  normal pressure, 21.1 °C (70 °F) ----
    density, vapor:  4.334 kg/m³ (0.2706 lb/ft³)  8401
  20 °C (68 °F) ---------------------
    pressure, liquid (bubble point):  704.6 kPa (102.19 psia)  8401
    pressure, vapor (dew point):  578.7 kPa (83.93 psia)  8401
    density, saturated liquid:  122 kg/m³ (76.20 lb/ft³)  8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
### Refrigerant Database

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>density, saturated vapor:</td>
<td>27.61 kg/m³ (1.736 lb/cf)</td>
<td>8401</td>
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<tr>
<td>specific volume, saturated liquid:</td>
<td>0.819 L/kg (0.0131 cf/lb)</td>
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<td>36.0 L/kg (0.5759 cf/lb)</td>
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<td>velocity of sound, saturated liquid:</td>
<td>540 m/s (1773 ft/s)</td>
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<tr>
<td>velocity of sound, saturated vapor:</td>
<td>148 m/s (486 ft/s)</td>
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<td>viscosity, saturated liquid:</td>
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<td>viscosity, saturated vapor:</td>
<td>11.9 µPa·s (0.0119 cp)</td>
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<tr>
<td>thermal conductivity, saturated liquid:</td>
<td>0.0766 W/m·K (0.0442 Btu/hr·ft·°F)</td>
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<tr>
<td>thermal conductivity, saturated vapor:</td>
<td>0.01102 W/m·K (0.00637 Btu/hr·ft·°F)</td>
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</tr>
<tr>
<td>60 °C (140 °F)</td>
<td>-------------------------------------------</td>
<td>------</td>
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<tr>
<td>pressure, liquid (bubble point):</td>
<td>1887 kPa (273.7 psia)</td>
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<tr>
<td>pressure, vapor (dew point):</td>
<td>1675 kPa (242.9 psia)</td>
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<tr>
<td>heat of vaporization:</td>
<td>133.4 kJ/kg for liquid and vapor at nominal temperature and pressure (57.4 Btu/lb)</td>
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<tr>
<td>critical point</td>
<td>-------------------------------------------</td>
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<tr>
<td>temperature:</td>
<td>102.6 °C (216.7 °F)</td>
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<tr>
<td>pressure:</td>
<td>4559 kPa (661.2 psia)</td>
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<tr>
<td>density:</td>
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<tr>
<td>specific volume:</td>
<td>507 kg/m³ (31.7 lb/cf)</td>
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<td>507 kg/m³ (31.7 lb/cf)</td>
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<tr>
<td></td>
<td>1.97 L/kg (0.0316 cf/lb)</td>
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</tr>
<tr>
<td></td>
<td>2.17 L/kg (0.0348 cf/lb)</td>
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</tr>
</tbody>
</table>

### Environmental

- **ODP (ozone depletion potential):** 0.029 mass-weighted average (model-derived relative to R-11)
- **GWP (global warming potential):** 1240 mass-weighted average relative to CO₂ for 100 yr integration

### Safety

- **classification:**
  - none (no application pending)
  - Ausimont AEL: 900 ppm v/v TWA for 8 hr/day and 40 hr/wk

### Production

- **first commercial use as a refrigerant:** 1996
- **last year production allowed:** 2029 by refrigerants 22, 124

---

**SEE DATA LIMITATIONS AND NOTES ON PAGE 2**
in developed countries under the Montreal Protocol
R-22/124/600a/142b (55.0/24.0/3.0/18.0)

<table>
<thead>
<tr>
<th>assigned</th>
<th>REFRIGERANT DATA SUMMARY</th>
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</thead>
<tbody>
<tr>
<td>R-22/124/600a/142b (55.0/24.0/3.0/18.0)</td>
<td>see RDB#</td>
</tr>
<tr>
<td>tetray blend</td>
<td></td>
</tr>
</tbody>
</table>

**COMMON USE(S)**

service alternative for refrigerants 12 and 134a, primarily for aftermarket use to retrofit automobile and other mobile air conditioning systems (MACS)

This blend was marketed by ICOR International, Incorporated (Indianapolis, IN, USA) and others from late 1995 through March 1996 under the name "HOT SHOT." This product was reformulated to settle a claim of patent infringement.

**IDENTIFIERS**

| common name(s): | R-22/124/600a/142b (55/24/3/18) 2909 R22/124/600a/142b (55/24/3/18) 2909 R 22/124/600a/142b (55/24/3/18) 2909 candidate for R-414 series HCFC-22/HCFC-124/HC-600a/ HCFC-142b (55/24/3/18) not HCFC-22/124/600a/142b 2909 |
| historical name(s): | before March 1996: AMI Automotive KAR KOOL(TM) ESP (Canada) KAR KOOL ICOR HOT SHOT |
| name used in U.S. EPA SNAP Rule: | HCFC Blend Omicron |
| ARI container color / Pantone number: | none, use light green grey/413 6601 |

**PHYSICAL**

- **nominal blend formulation**
  - composition: R-22/124/600a/142b
  - component weight fractions: 55.0 / 24.0 / 3.0 / 18.0 %
  - component weight tolerances: ±1.5 / ±1.5 / ±1.0 / ±1.0
  - component mole fractions: 61.005 / 16.866 / 4.950 / 17.179 8820 %
  - properties molar mass: 95.90880 g/mol (0.211443 8820 lb/mol)
  - normal boiling point
    - bubble point temperature: -34.5 °C (-30.1 °F) 8401
    - dew point temperature: -26.4 °C (-15.4 °F) 8401
    - maximum temperature glide: 8.17 °C (14.7 °F) 8401
    - density, saturated liquid: 1333 kg/m³ (83.24 lb/cf) 8401
    - density, saturated vapor: 4.92 kg/m³ (0.307 lb/cf) 8401
    - specific volume, saturated liquid: 0.750 L/kg (0.0120 cf/lb) 8401
    - specific volume, saturated vapor: 203.5 L/kg (3.2590 cf/lb) 8401
    - heat of vaporization: 224.2 kJ/kg (96.4 Btu/lb) 8401
    - velocity of sound, saturated liquid: 810 m/s (2657 ft/s) 8401
    - velocity of sound, saturated vapor: 153 m/s (502 ft/s) 8401
    - viscosity, saturated liquid: 357 µPa·s (0.357 cp) 8401
    - viscosity, saturated vapor: 9.69 µPa·s (0.00969 cp) 8401
    - thermal conductivity, liquid: 0.1025 W/m·K (0.0592 8401)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>thermal conductivity, vapor</td>
<td>Btu/hr·ft°F</td>
<td>0.0080 W/m·K (0.0046 Btu/hr·ft°F)</td>
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<tr>
<td>density, vapor</td>
<td>4.066 kg/m³ (0.2538 lb/cf)</td>
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<tr>
<td>normal pressure, 20 °C (68 °F)</td>
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<tr>
<td>density, vapor</td>
<td>4.050 kg/m³ (0.2528 lb/cf)</td>
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<tr>
<td>20 °C (68 °F)</td>
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<tr>
<td>pressure, liquid (bubble point)</td>
<td>659.9 kPa (95.71 psia)</td>
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<tr>
<td>pressure, vapor (dew point)</td>
<td>563.2 kPa (81.69 psia)</td>
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<tr>
<td>density, saturated liquid</td>
<td>1173 kg/m³ (73.21 lb/cf)</td>
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<tr>
<td>density, saturated vapor</td>
<td>25.18 kg/m³ (1.572 lb/cf)</td>
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<tr>
<td>specific volume, saturated liquid</td>
<td>0.853 L/kg (0.0137 cf/lb)</td>
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<tr>
<td>specific volume, saturated vapor</td>
<td>39.7 L/kg (0.6363 cf/lb)</td>
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<tr>
<td>velocity of sound, saturated liquid</td>
<td>566 m/s (1855 ft/s)</td>
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<td>velocity of sound, saturated vapor</td>
<td>155 m/s (507 ft/s)</td>
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<td>viscosity, saturated liquid</td>
<td>190 µPa·s (0.190 cp)</td>
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<td>viscosity, saturated vapor</td>
<td>11.6 µPa·s (0.0116 cp)</td>
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<td>thermal conductivity, saturated liquid</td>
<td>0.0799 W/m·K (0.0462 Btu/hr·ft°F)</td>
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<tr>
<td>thermal conductivity, saturated vapor</td>
<td>0.01099 W/m·K (0.00635 Btu/hr·ft°F)</td>
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<tr>
<td>60 °C (140 °F)</td>
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<tr>
<td>pressure, liquid (bubble point)</td>
<td>1862 kPa (270.0 psia)</td>
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</tr>
<tr>
<td>pressure, vapor (dew point)</td>
<td>1631 kPa (236.6 psia)</td>
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<tr>
<td>heat of vaporization</td>
<td>145.4 kJ/kg for liquid and vapor both at nominal composition (62.5 Btu/lb)</td>
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</tr>
<tr>
<td>environmental</td>
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</tr>
<tr>
<td>ODP (ozone depletion potential)</td>
<td>0.033 mass-weighted average</td>
<td>9501</td>
</tr>
<tr>
<td>GWP (global warming potential)</td>
<td>1610 mass-weighted average relative to CO2 for 100 yr integration</td>
<td>9501</td>
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<tr>
<td>HGWP (halocarbon GWP)</td>
<td>0.27 mass-weighted average relative to R 11 for infinite integration period</td>
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<td>safety</td>
<td>research and development</td>
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<tr>
<td>classification</td>
<td>ASHRAE Standard 34</td>
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<td>safety group (ASHRAE Standard 34)</td>
<td>none (requested January 1996, withdrawn March 1996)</td>
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<td>long-term occupational limit</td>
<td>ICOR: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk</td>
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<tr>
<td>exposure limit consistent to OSHA PEL</td>
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</tbody>
</table>
Refrigerant Database

- Flammability
  - LFL-UFL (flammability limits in air): ICOR: will not burn
  - Autoignition temperature: ICOR: 632 °C (1170 °F)
- Detection
  - Appearance: ICOR: colorless, liquified gas
  - Odor: ICOR: faint ethereal odor

Production
- First commercial use as a refrigerant: late 1995
- Last year production allowed: 2029 by refirg 22, 124, and 142b 8C01 in developed countries under the Montreal Protocol
R-22/134a/21 (65.0/15.0/20.0)

unassigned | REFRIGERANT DATA SUMMARY | see
zeotrope | ternary blend | RDB#

COMMON USE(S)
alternative for refrigerant 12, primarily in Russia, tested since 1996 as a service fluid for domestic refrigerators and commercial refrigeration

IDENTIFIERS
common name(s): R-22/134a/21 (65.0/15.0/20.0)
R22/134a/21 (65.0/15.0/20.0)
R 22/134a/21 (65.0/15.0/20.0)
HCFC-22/HFC-134a/HCFC-21 8601 (65/15/20)
not HCFC-22/134a/21 (65/15/20) 8601 (Russia) C10M2, in C10M series (Russia) S10-M2
trade name(s): Astor (Russia) "ASTRON-12"
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL
- nominal blend formulation ---------
  composition: R-22/134a/21
  component weight fractions: 65.0 / 15.0 / 20.0 %
  component mole fractions: 68.772 / 13.450 / 17.778 %
- properties -------------------------
  molar mass: 91.48651 g/mol (0.201693 lb/mol)
- normal boiling point -------------
  bubble point temperature: -35.9 °C (-32.7 °F)
  dew point temperature: -22.5 °C (-8.4 °F)
  maximum temperature glide: 13.45 °C (24.2 °F)
  density, saturated liquid: 1415 kg/m3 (88.32 lb/cf)
  density, saturated vapor: 4.60 kg/m3 (0.287 lb/cf)
  specific volume, saturated liquid: 0.707 L/kg (0.0113 cf/lb)
  specific volume, saturated vapor: 217.6 L/kg (3.4859 cf/lb)
  heat of vaporization: 240.9 kJ/kg (103.6 Btu/lb)
  velocity of sound, saturated liquid: 837 m/s (2745 ft/s)
  velocity of sound, saturated vapor: 160 m/s (525 ft/s)
  viscosity, saturated liquid: 10.10 μPa·s (0.01010 cp)
  viscosity, saturated liquid: 386 μPa·s (0.386 cp)
  thermal conductivity, liquid: 0.1126 W/m·K (0.0651 Btu/hr·ft·°F)
  thermal conductivity, vapor: 0.0079 W/m·K (0.0046 Btu/hr·ft·°F)
- normal pressure, 20 °C (68 °F) ----
  density, vapor: 3.874 kg/m3 (0.2418 lb/cf)
- normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 3.858 kg/m3 (0.2408 lb/cf)
- 20 °C (68 °F) -----------------------
  pressure, liquid (bubble point): 743.4 kPa (107.82 psia)
  pressure, vapor (dew point): 532.5 kPa (77.23 psia)
density, saturated liquid: 1243 kg/m³ (77.60 lb/cf) 8814
density, saturated vapor: 22.30 kg/m³ (1.392 lb/cf) 8814
specific volume, saturated liquid: 0.804 L/kg (0.0129 cf/lb) 8814
specific volume, saturated vapor: 44.8 L/kg (0.7184 cf/lb) 8814
velocity of sound, saturated liquid: 590 m/s (1935 ft/s) 8814
velocity of sound, saturated vapor: 163 m/s (534 ft/s) 8814
viscosity, saturated liquid: 203 μPa·s (0.203 cp) 8814
viscosity, saturated vapor: 11.8 μPa·s (0.0118 cp) 8814
thermal conductivity, saturated liquid: 0.0877 W/m·K (0.0507 Btu/hr·ft·°F) 8814
thermal conductivity, saturated vapor: 0.01041 W/m·K (0.00602 Btu/hr·ft·°F) 8814

- 60 °C (140 °F) ---------------------
  pressure, liquid (bubble point): 1991 kPa (288.8 psia) 8814
  pressure, vapor (dew point): 1629 kPa (236.3 psia) 8814
  heat of vaporization: 157.6 kJ/kg for liquid and 8814
  vapor both at nominal 8814
  composition (67.8 Btu/lb) 8814
  150.0 kJ/kg coexisting liquid 8814
  and vapor at bubble-point 8814
  pressure (64.5 Btu/lb) 8814

- critical point ---------------------
  temperature: 111.0 °C (231.8 °F) 8814
  pressure: 5101 kPa (739.8 psia) 8814
  density: 521 kg/m³ (32.5 lb/cf) 8814
  specific volume: 1.92 L/kg (0.0308 cf/lb) 8814

ENVIRONMENTAL

ODP (ozone depletion potential): 0.030 mass-weighted average 9501
(model-derived relative to R 8814
11) 8814
0.041 mass-weighted average 9501
(semi-empirical relative to R 8814
11) 8814

GWP (global warming potential): 1520 mass-weighted average 9501
relative to CO2 for 100 yr 8814
integration

SAFETY

- classification ---------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A1, A1, and B1 8601

PRODUCTION

last year production allowed: 2029 by refrigerants 21 and 22 8814
in developed countries under 8814
the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-22/142b (40.0/60.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-22/142b (40.0/60.0) see
zeotrope binary blend RDB#

COMMON USE(S)
under consideration as a refrigerant, blowing agent, and aerosol propellant

IDENTIFIERS

common name(s): R-22/142b (40.0/60.0)
R22/142b (40.0/60.0)
R 22/142b (40.0/60.0)
HCFC-22/HCFC-142b (40/60)
not HCFC-22/142b (40/60)

trade name(s): AlliedSignal Genetron(R) MSDS
22/142b Blend

ARI container color / Pantone number: none, use light green grey/413 6601
with red / 185 band

PHYSICAL

• nominal blend formulation -------
  composition: R-22/142b
  component weight fractions: 40.0 / 60.0 %
  component mole fractions: 43.656 / 56.344 %

• properties ------------------------
  molar mass: 94.37129 g/mol (0.208053 lb/mol)

  normal boiling point ---------------
  bubble point temperature: -27.9 °C (-18.3 °F)
  dew point temperature: -18.3 °C (-1.0 °F)
  maximum temperature glide: 9.61 °C (17.3 °F)
  density, saturated liquid: 1280 kg/m³ (79.88 lb/cf)
  density, saturated vapor: 4.69 kg/m³ (0.293 lb/cf)
  specific volume, saturated liquid: 0.781 L/kg (0.0125 cf/lb)
  specific volume, saturated vapor: 213.2 L/kg (3.4156 cf/lb)
  heat of vaporization: 236.1 kJ/kg (101.5 Btu/lb)
  velocity of sound, saturated liquid: 819 m/s (2688 ft/s)
  velocity of sound, saturated vapor: 156 m/s (512 ft/s)
  viscosity, saturated liquid: 372 µPa·s (0.372 cp)
  viscosity, saturated vapor: 9.29 µPa·s (0.00929 cp)
  thermal conductivity, liquid: 0.1035 W/m·K (0.0598 Btu/hr·ft·°F)
  thermal conductivity, vapor: 0.0084 W/m·K (0.0049 Btu/hr·ft·°F)

• normal pressure, 20 °C (68 °F) ------
  density, vapor: 4.013 kg/m³ (0.2505 lb/cf)

• normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 3.997 kg/m³ (0.2495 lb/cf)

• 20 °C (68 °F) ------------------------
  pressure, liquid (bubble point): 543.6 kPa (78.84 psia)
  pressure, vapor (dew point): 414.9 kPa (60.18 psia)
  density, saturated liquid: 1154 kg/m³ (72.02 lb/cf)
  density, saturated vapor: 17.82 kg/m³ (1.113 lb/cf)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
specific volume, saturated liquid: 0.867 L/kg (0.0139 cf/lb) 8401
specific volume, saturated vapor: 56.1 L/kg (0.8988 cf/lb) 8401
velocity of sound, saturated liquid: 614 m/s (2013 ft/s) 8401
velocity of sound, saturated vapor: 158 m/s (520 ft/s) 8401
viscosity, saturated liquid: 214 μPa·s (0.214 cp) 8401
viscosity, saturated vapor: 10.7 μPa·s (0.0107 cp) 8401
thermal conductivity, saturated liquid: 0.0837 W/m·K (0.0483 Btu/hr·ft²°F) 8401
thermal conductivity, saturated vapor: 0.01087 W/m·K (0.00628 Btu/hr·ft²°F) 8401

60 °C (140 °F) -------------------
pressure, liquid (bubble point): 1485 kPa (215.3 psia) 8401
pressure, vapor (dew point): 1243 kPa (180.3 psia) 8401
heat of vaporization: 165.6 kJ/kg for liquid and vapor both at nominal composition (71.2 Btu/lb) 8401
158.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (68.3 Btu/lb) 8401

critical point ---------------------
temperature: 123.1 °C (253.6 °F) 8401
pressure: 4723 kPa (685.0 psia) 8401
density: 466 kg/m³ (29.1 lb/ft³) 8401
specific volume: 2.15 L/kg (0.0344 cf/lb) 8401

ENVIRONMENTAL
ODP (ozone depletion potential): 0.039 mass-weighted average (model-derived relative to R 11) 9501
0.060 mass-weighted average (semi-empirical relative to R 11) 9501
GWP (global warming potential): 2140 mass-weighted average relative to CO₂ for 100 yr integration 9501
HGWP (halocarbon GWP): 0.37 mass-weighted average relative to R 11 for infinite integration period 9501

SAFETY
classification ----------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601
NFPA 704 degrees of hazard (H-F-R-S): components are A1 and A2 8601
AlliedSignal: 2-4-0 MSDS
health-flammability-reactivity [-special]: 0=no, 4=severe
NPCA HMIS hazard ratings (H-F-R): AlliedSignal: 2-1-0 MSDS
health-flammability-reactivity
0=insignificant, 4=extreme
flammability ---------------------
LFL-UFL (flammability limits in air): none (nonflammable as tested) 0520
flash point: worst fractionation flammable MSDS
autoignition temperature: AlliedSignal: not applicable MSDS
none (nonflammable as tested) 0520
AlliedSignal: ~630°C (~1166°F) 0520
odor: AlliedSignal: faint ethereal MSDS
appearance: Elf Atochem: clear, colorless MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
PRODUCTION

last year production allowed: 2029 by components in RCO1
developed countries under the
Montreal Protocol
R-22/142b (60.0/40.0)

REFRIGERANT DATA SUMMARY

unassigned  R-22/142b (60.0/40.0)  see
zeotrope  binary blend  RDB#

COMMON USE(S)
examined (circa 1993) as a refrigerant

IDENTIFIERS
common name(s):  R-22/142b (60.0/40.0)
R22/142b (60.0/40.0)
R 22/142b (60.0/40.0)
HCFC-22/HCFC-142b (60/40)
not HCFC-22/142b (60/40)
historical name(s):  Elf Atochem Forane(R) FX-55
ARI container color / Pantone number:  none, use light green grey/413 6601
with red / 185 band

PHYSICAL
nominal blend formulation -------
composition:  R-22/142b
component weight fractions:  60.0 / 40.0 %
component mole fractions:  63.548 / 36.452 %  8820
properties ------------------------
molar mass:  91.58113 g/mol (0.201902 lb/mol)

normal boiling point ----------
bubble point temperature:  -33.4 °C (-28.1 °F)  8401
dew point temperature:  -24.0 °C (-11.2 °F)  8401
maximum temperature glide:  9.37 °C (16.9 °F)  8401
density, saturated liquid:  1321 kg/m³ (82.48 lb/cf)  8401
density, saturated vapor:  4.65 kg/m³ (0.290 lb/cf)  8401
specific volume, saturated liquid:  0.757 L/kg (0.0121 cf/lb)  8401
specific volume, saturated vapor:  215.2 L/kg (3.4477 cf/lb)  8401
heat of vaporization:  237.4 kJ/kg (102.1 Btu/lb)  8401
velocity of sound, saturated liquid:  833 m/s (2732 ft/s)  8401
velocity of sound, saturated vapor:  158 m/s (519 ft/s)  8401
viscosity, saturated liquid:  366 µPa·s (0.366 cp)  8401
viscosity, saturated vapor:  9.52 µPa·s (0.00952 cp)  8401
thermal conductivity, liquid:  0.1070 W/m·K (0.0618 Btu/hr·ft·°F)  8401
thermal conductivity, vapor:  0.0080 W/m·K (0.0046 Btu/hr·ft·°F)  8401

normal pressure, 20 °C (68 °F) ----
density, vapor:  3.884 kg/m³ (0.2425 lb/cf)  8401
density, vapor:  3.868 kg/m³ (0.2415 lb/cf)  8401

20 °C (68 °F) -------------------
pressure, liquid (bubble point):  667.5 kPa (96.82 psia)  8401
pressure, vapor (dew point):  516.6 kPa (74.92 psia)  8401
density, saturated liquid:  1171 kg/m³ (73.07 lb/cf)  8401
density, saturated vapor:  21.81 kg/m³ (1.361 lb/cf)  8401
specific volume, saturated liquid:  0.854 L/kg (0.0137 cf/lb)  8401
specific volume, saturated vapor:  45.9 L/kg (0.7346 cf/lb)  8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
velocity of sound, saturated liquid: 596 m/s (1956 ft/s) 8401
velocity of sound, saturated vapor: 116 m/s (526 ft/s) 8401
viscosity, saturated liquid: 199 µPa·s (0.199 cp) 8401
viscosity, saturated vapor: 11.3 µPa·s (0.0113 cp) 8401
thermal conductivity, saturated liquid: 0.0842 W/m·K (0.0487 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01080 W/m·K (0.00624 Btu/hr·ft·°F) 8401

- 60 °C (140 °F) ------------------------
  pressure, liquid (bubble point): 1792 kPa (259.9 psia) 8401
  pressure, vapor (dew point): 1518 kPa (220.2 psia) 8401
  heat of vaporization:
    vapor both at nominal composition (68.5 Btu/lb) 152.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (65.6 Btu/lb) 8401

- critical point -----------------------
  temperature: 114.8 °C (238.6 °F) 8401
  pressure: 4899 kPa (710.5 psia) 8401
  density: 482 kg/m³ (30.1 lb/cf) 8401
  specific volume: 2.08 L/kg (0.0333 cf/lb) 8401

ENVIRONMENTAL

  ODP (ozone depletion potential): 0.038 mass-weighted average (model-derived relative to R 11) 9501
  GWP (global warming potential): 2060 mass-weighted average relative to CO₂ for 100 yr integration 9501
  HGWP (halocarbon GWP): 0.35 mass-weighted average relative to R 11 for infinite integration period DW

SAFETY

- classification ----------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A1 and A2 8601

- flammability ------------------------
  LFL-UFL (flammability limits in air):
    flash point: Atochem: nonflammable as tested MSDS

- detection --------------------------
  appearance: Elf Atochem: clear, colorless MSDS
  odor: Elf Atochem: faint ether-like MSDS

PRODUCTION

  last year production allowed: 2029 by components in developed countries under the Montreal Protocol 8401
### R-22/142b/21 (65.0/20.0/15.0)

**Common Use(s)**
alternative for refrigerant 12, primarily in Russia, tested since 1996 as a service fluid for domestic refrigerators and commercial refrigeration.

**Identifiers**
- **Common name(s):** R-22/142b/21 (65.0/20.0/15.0)
- **Composition:** R-22/142b/21 (65.0/20.0/15.0)
- **Component weight fractions:** 65.0 / 20.0 / 15.0 %
- **Component mole fractions:** 68.558 / 18.150 / 13.292 %
- **Trade name(s):** Astor (Russia) "ASTRON-12"
- **ARI container color / Pantone number:** none, use light green grey/413 6601

**Physical**

- **Nominal blend formulation**
  - **Composition:** R-22/142b/21
  - **Component weight fractions:** 65.0 / 20.0 / 15.0 %
  - **Component mole fractions:** 68.558 / 18.150 / 13.292 %

- **Properties**
  - **Molar mass:** 91.20109 g/mol (0.201064 lb/mol)
  - **Normal boiling point**
    - **Bubble point temperature:** -34.5 °C (-30.0 °F)
    - **Dew point temperature:** -21.2 °C (-6.2 °F)
    - **Maximum temperature glide:** 13.23 °C (23.8 °F)
    - **Density, saturated liquid:** 1371 kg/m³ (85.57 lb/ft³)
    - **Density, saturated vapor:** 4.56 kg/m³ (0.285 lb/ft³)
    - **Specific volume, saturated liquid:** 0.730 L/kg (0.0117 ft³/lb)
    - **Specific volume, saturated vapor:** 219.2 L/kg (3.5106 ft³/lb)
    - **Heat of vaporization:** 242.1 kJ/kg (104.1 Btu/lb)
    - **Velocity of sound, saturated liquid:** 845 m/s (2774 ft/s)
    - **Velocity of sound, saturated vapor:** 160 m/s (526 ft/s)
    - **Viscosity, saturated liquid:** 381 µPa·s (0.381 cp)
    - **Viscosity, saturated vapor:** 9.88 µPa·s (0.00988 cp)
    - **Thermal conductivity, liquid:** 0.1107 W/m·K (0.0640 Btu/hr·ft °F)
    - **Thermal conductivity, vapor:** 0.0079 W/m·K (0.0046 Btu/hr·ft °F)
  - **Normal pressure, 20 °C (68 °F)**
    - **Density, vapor:** 3.865 kg/m³ (0.2413 lb/ft³)
  - **Normal pressure, 21.1 °C (70 °F)**
    - **Density, vapor:** 3.849 kg/m³ (0.2403 lb/ft³)
  - **20 °C (68 °F)**
    - **Pressure, liquid (bubble point):** 692.4 kPa (100.43 psia)
    - **Pressure, vapor (dew point):** 487.5 kPa (70.70 psia)
density, saturated liquid: 1213 kg/m³ (75.74 lb/cf) 8814
density, saturated vapor: 20.25 kg/m³ (1.264 lb/cf) 8814
specific volume, saturated liquid: 0.824 L/kg (0.0132 cf/lb) 8814
specific volume, saturated vapor: 49.4 L/kg (0.7912 cf/lb) 8814
velocity of sound, saturated liquid: 607 m/s (1991 ft/s) 8814
velocity of sound, saturated vapor: 163 m/s (536 ft/s) 8814
viscosity, saturated liquid: 206 μPa·s (0.206 cp) 8814
viscosity, saturated vapor: 11.5 μPa·s (0.0115 cp) 8814
thermal conductivity, saturated liquid: 0.0871 W/m·K (0.0503 Btu/hr·ft°F) 8814
thermal conductivity, saturated vapor: 0.01032 W/m·K (0.00596 Btu/hr·ft°F) 8814

- 60 °C (140 °F) ------------------------
  pressure, liquid (bubble point): 1847 kPa (267.9 psia) 8814
  pressure, vapor (dew point): 1477 kPa (214.3 psia) 8814
  heat of vaporization: 162.9 kJ/kg for liquid and vapor both at nominal composition (70.0 Btu/lb) 8814
  154.8 kJ/kg coexisting liquid and vapor at bubble-point pressure (66.5 Btu/lb) 8814

- critical point ---------------------
  temperature: 116.0 °C (240.8 °F) 8814
  pressure: 5073 kPa (735.8 psia) 8814
  density: 502 kg/m³ (31.3 lb/cf) 8814
  specific volume: 1.99 L/kg (0.0319 cf/lb) 8814

ENVIRONMENTAL
  ODP (ozone depletion potential): 0.037 mass-weighted average (model-derived relative to R-11) 9501
  0.052 mass-weighted average (semi-empirical relative to R-11) 9501
  GWP (global warming potential): 1730 mass-weighted average relative to CO₂ for 100 yr integration 9501

SAFETY
- classification ---------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A1, A1, and B1 8601

PRODUCTION
- last year production allowed: 2029 by components in developed countries under the Montreal Protocol 8C01
R-22/152a

------------------------- REFRIGERANT DATA SUMMARY -------------------------

unassigned  R-22/152a (formulation not disclosed)  see
zeotrope  binary blend  RDB#

COMMON USE(S)
interim alternative for refrigerant 12 in refrigerator-freezers in
China

The following information is preliminary and may be incomplete or
incorrect. Data on this blend may be available from Tsinghua
University (Beijing, Peoples Republic of China), Hangzhou First
Chemical Company, Limited (Hangzhou, Zhejiang, Peoples Republic of
China), and other refrigerant manufacturers. The blend is described
as a near-azeotropic blend.

IDENTIFIERS
common name(s):  R-22/152a (??/??)
R22/152a (??/??)
R 22/152a (??/??)
trade name(s):  (China) THR01
Hangzhou (China) First-12  8331

PHYSICAL
nominal blend formulation
composition:  R-22/152a

ENVIRONMENTAL
ODP (ozone depletion potential):  <0.03 (model-derived relative 8331
to R 11)
GWP (global warming potential):  0.3 (probably 0.3x3800 = 1140) 8331
relative to CO2 for 100 yr integration
probably intended:  1140  8331
relative to CO2 for 100 yr integration

SAFETY
classification
safety group (ASHRAE Standard 34):  none (no application pending) 8601
components are A1 and A2 8601

PRODUCTION
first commercial use as a refrigerant:  circa 1997 in China
last year production allowed:  2029 based on refrigerant 22  8C01
in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
--- REFRIGERANT DATA SUMMARY ---

unassigned  R-22/152a (formulation not disclosed)  see RDB#
zeotrope  binary blend

COMMON USE(S)
used as a replacement for refrigerant 12 in refrigerator-freezers in China

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from the Zhejiang Chemical Industry Research Institute (Hangzhou, Zhejiang, Peoples Republic of China) and refrigerant manufacturers. The blend formulation has not been disclosed and data inconsistencies preclude precise determination; it appears to be approximately R-22/152a (23/77).

IDENTIFIERS

common name(s):  R-22/152a (??/??)
                 R22/152a (??/??)
                 R 22/152a (??/??)
trade name(s):  Zhejiang (China) ZC-1

PHYSICAL

- nominal blend formulation -------
  composition:  R-22/152a
  component mole fractions:  18.7 / 81.3 estimated %

- properties ---------------------
  molar mass:  69.9 estimated g/mol (0.154103 lb/mol)

- normal boiling point ---------
  temperature:  -28.4 °C (-19.1 °F)

ENVIRONMENTAL

ODP (ozone depletion potential):
  0.008 estimated mass average (model-derived relative to R 11)
  0.01 (model-derived relative to R 11)
  0.012 estimated mass average (semi-empirical relative to R 11)

GWP (global warming potential):
  456 relative to CO2 for 100 yr integration
  590 estimated mass average relative to CO2 for 100 yr integration

SAFETY

- classification ---------------
  safety group (ASHRAE Standard 34):  none (no application pending)
  components are A1 and A2

- long-term occupational limit ------
  exposure limit consistent to OSHA PEL:  1000 ppm v/v TWA for 8 hr/day

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LFL (lower flammability limit in air)</td>
<td></td>
<td>6.6 % v/v</td>
</tr>
</tbody>
</table>

**Production**
- First commercial use as a refrigerant: circa 1995 in China
- Last year production allowed: 2029 based on refrigerant 22 in developed countries under the Montreal Protocol

and 40 hr/wk
R-22/152a

------------------------ REFRIGERANT DATA SUMMARY ------------------------
unassigned  R-22/152a (formulation not disclosed)  see  RDB#
zeotrope  binary blend  

COMMON USE(S)
used as a replacement for refrigerant 12 in refrigerator-freezers in China

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from the Zhejiang Chemical Industry Research Institute (Hangzhou, Zhejiang, Peoples Republic of China) and refrigerant manufacturers. The blend formulation has not been disclosed and data inconsistencies preclude precise determination; it appears to be approximately R-22/152a (50/42).

IDENTIFIERS

common name(s):  R-22/152a (??/??)
R22/152a (??/??)
R 22/152a (??/??)

trade name(s):  Zhejiang (China) ZC-2  8B15

PHYSICAL

- nominal blend formulation
- composition:  R-22/152a
- component mole fractions:  51.0 / 49.0 estimated %  8820
- properties
- molar mass:  76.5 estimated g/mol (0.168654 8820 lb/mol)
- normal boiling point
- temperature:  -24.1 °C (-11.4 °F)  8B15

ENVIRONMENTAL

ODP (ozone depletion potential):  0.020 estimated mass average (model-derived relative to R 11)
0.029 (model-derived relative to R 11)
0.029 estimated mass average (semi-empirical relative to R 11)

GWP (global warming potential):  925 relative to CO2 for 100 yr integration
1180 estimated mass average relative to CO2 for 100 yr integration  9501

SAFETY

- classification
- safety group (ASHRAE Standard 34):  none (no application pending)  8601
components are A1 and A2  8601

- long-term occupational limit
- exposure limit consistent to OSHA PEL:  1000 ppm v/v TWA for 8 hr/day  8B15

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
- flammability
  LFL-UFL (flammability limits in air): none

PRODUCTION
first commercial use as a refrigerant: circa 1995 in China
last year production allowed: 2029 based on refrigerant 22 in developed countries under the Montreal Protocol

and 40 hr/wk
R-22/152a/114 (30.0/23.0/47.0)

--------------- REFRIGERANT DATA SUMMARY ------------------

unassigned  R-22/152a/114 (30.0/23.0/47.0)  see
zeotrope  ternary blend  RDB#

COMMON USE(S)

developmental formulation of an alternative to refrigerant 12,
primarily for aftermarket use to service or retrofit existing
automobile air conditioners and other mobile air-conditioning (MAC)
systems; tested circa 1990 pending commercial availability and Toxic
Substances Control Act (TSCA) listing of refrigerant 124 for
successor blends, such as KCD-9452

The following information is preliminary and may be incomplete or
incorrect. Data may be available from DuPont Chemicals (Wilmington,
DE, USA) and other refrigerant manufacturers.

IDENTIFIERS

common name(s):  R-22/152a/114 (30/23/47)
                 HCFC-22/HFC-152a/CFC-114
                 not CFC-22/152a/114
                 not HCFC-22/152a/114
trade name(s):  DuPont KCD-9451

PHYSICAL

  nominal blend formulation  ---------
  composition:  R-22/152a/114
  component weight fractions:  30.0 / 23.0 / 47.0 %

ENVIRONMENTAL

  HGWP (halocarbon GWP):  1.94 relative to R 11 for
                 infinite integration period

SAFETY

  classification  -------------------
  safety group (ASHRAE Standard 34):  none (no application pending)

PRODUCTION

  first commercial use as a refrigerant:  not known to be commercialized

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-22/152a/114 (36.0/24.0/40.0)

---------------------- REFRIGERANT DATA SUMMARY ----------------------
unassigned R-22/152a/114 (36.0/24.0/40.0) see RDB#
zeotrope ternary blend

COMMON USE(S)
developmental formulation of an alternative to refrigerant 12,
primarily for aftermarket use to service or retrofit existing
equipment; tested circa 1989 pending commercial availability and
Toxic Substances Control Act (TSCA) listing of refrigerant 124 for
successor blends, such as KCD-9433

The following information is preliminary and may be incomplete or
incorrect. Data may be available from DuPont Chemicals (Wilmington,
DE, USA) and other refrigerant manufacturers.

IDENTIFIERS
common name(s): R-22/152a/114 (36/24/40)
HCFC-22/HFC-152a/CFC-114
not CFC-22/152a/114
not HCFC-22/152a/114
trade name(s): DuPont KCD-9430 2206

PHYSICAL
· nominal blend formulation -------
composition: R-22/152a/114
component weight fractions: 36.0 / 24.0 / 40.0 %

ENVIRONMENTAL
HGWP (halocarbon GWP): 1.61 relative to R 11 for
infinite integration period

SAFETY
· classification ---------------------
safety group (ASHRAE Standard 34): none (no application pending)

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-22/152a/124 (31.0/24.0/45.0)

Common Use(s)
Developmental formulation for mobile air-conditioning (MAC) systems, primarily for aftermarket use to service or retrofit existing automobile air conditioners and other equipment as an alternative for refrigerant 12; tested circa 1990; largely superseded by other blends including refrigerant 401C.

Identifiers
- common name(s): R-22/152a/124 (31/24/45)
- candidate for R-401 series HCFC-22/HFC-152a/HCFC-124
- trade name(s): DuPont KCD-9452

Physical
- nominal blend formulation
  - component weight fractions: 31.0 / 24.0 / 45.0 %
  - component mole fractions: 34.092 / 34.553 / 31.355 %
- properties
  - molar mass: 95.09283 g/mol (0.209644 lb/mol)
- normal boiling point
  - bubble point temperature: -29.6 °C (-21.3 °F)
  - dew point temperature: -24.1 °C (-11.5 °F)
  - maximum temperature glide: 5.44 °C (9.8 °F)
  - density, saturated liquid: 1318 kg/m³ (82.31 lb/cf)
  - density, saturated vapor: 4.85 kg/m³ (0.302 lb/cf)
  - specific volume, saturated liquid: 0.759 L/kg (0.0122 cf/lb)
  - specific volume, saturated vapor: 206.4 L/kg (3.3060 cf/lb)
  - heat of vaporization: 230.2 kJ/kg (99.0 Btu/lb)
  - velocity of sound, saturated liquid: 796 m/s (2611 ft/s)
  - velocity of sound, saturated vapor: 153 m/s (503 ft/s)
  - viscosity, saturated liquid: 349 μPa·s (0.349 cp)
  - viscosity, saturated vapor: 9.79 μPa·s (0.00979 cp)
  - thermal conductivity, liquid: 0.1024 W/m·K (0.0592 Btu/hr·ft·°F)
  - thermal conductivity, vapor: 0.0085 W/m·K (0.0049 Btu/hr·ft·°F)
- normal pressure, 20 °C (68 °F)
  - density, vapor: 4.040 kg/m³ (0.2522 lb/cf)
- normal pressure, 21.1 °C (70 °F)
  - density, vapor: 4.023 kg/m³ (0.2512 lb/cf)
- 20 °C (68 °F)
  - pressure, liquid (bubble point): 596.4 kPa (86.50 psia)
  - pressure, vapor (dew point): 520.2 kPa (75.44 psia)
  - density, saturated liquid: 1173 kg/m³ (73.25 lb/cf)
  - density, saturated vapor: 23.09 kg/m³ (1.441 lb/cf)
  - specific volume, saturated liquid: 0.852 L/kg (0.0137 cf/lb)

See data limitations and notes on page 2.
specific volume, saturated vapor: 43.3 L/kg (0.6939 cf/lb) 8401
velocity of sound, saturated liquid: 573 m/s (1879 ft/s) 8401
velocity of sound, saturated vapor: 154 m/s (507 ft/s) 8401
viscosity, saturated liquid: 191 μPa·s (0.191 cp) 8401
viscosity, saturated vapor: 11.6 μPa·s (0.0116 cp) 8401
thermal conductivity, saturated liquid: 0.0826 W/m·K (0.0477 Btu/hr·ft°F) 8401
thermal conductivity, saturated vapor: 0.01195 W/m·K (0.00690 Btu/hr·ft°F) 8401

- 60 °C (140 °F) -------------------
  pressure, liquid (bubble point): 1654 kPa (239.9 psia) 8401
  pressure, vapor (dew point): 1523 kPa (220.9 psia) 8401
  heat of vaporization: 153.1 kJ/kg for liquid and 148.2 kJ/kg for liquid and vapor both at nominal composition (65.8 Btu/lb) vapor both at nominal composition (65.8 Btu/lb) and vapor at bubble-point pressure (63.7 Btu/lb) and vapor at bubble-point pressure (63.7 Btu/lb)

- critical point ------------------
  temperature: 110.4 °C (230.7 °F) 8401
  pressure: 4433 kPa (643.0 psia) 8401
density: 477 kg/m3 (29.8 lb/cf) 8401
  specific volume: 2.10 L/kg (0.0336 cf/lb) 8401

ENVIRONMENTAL
ODP (ozone depletion potential): 0.022 mass-weighted average (model-derived relative to R 9501
11) 0.027 mass-weighted average (semi-empirical relative to R 9501
11)
GWP (global warming potential): 910 mass-weighted average relative to CO2 for 100 yr integration
HGWP (halocarbon GWP): 0.14 relative to R 11 for infinite integration period 2206
0.14 mass-weighted average DW relative to R 11 for infinite integration period

SAFETY
- classification -------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601

PRODUCTION
first commercial use as a refrigerant: last year production allowed: not known to be commercialized 8C01
2029 by refrigerants 22, 124 in developed countries under the Montreal Protocol
R-22/152a/124 (36.0/24.0/40.0)

--------------------------- REFRIGERANT DATA SUMMARY ---------------------------

unassigned R-22/152a/124 (36.0/24.0/40.0) see
zeotrope ternary blend RDB#

COMMON USE(S)
developmental formulation of an alternative to refrigerant 12, primarily for aftermarket use to service or retrofit existing equipment; tested circa 1989; largely superseded by other blends, such as refrigerants 401A, 401B, 401C, and MP33

IDENTIFIERS
common name(s): R-22/152a/124 (36/24/40)
candidate for R-401 series
HCFC-22/HFC-152a/CFC-124
not HCFC-22/152a/124
trade name(s): DuPont KCD-9433 2206

PHYSICAL
• nominal blend formulation ---------
  composition: R-22/152a/124
  component weight factions: 36.0 / 24.0 / 40.0 %
  component mole fractions: 38.809 / 33.871 / 27.321 % 8820
• properties ------------------------
  molar mass: 93.21470 g/mol (0.205503 lb/mol) 8820
  normal boiling point -------------
  bubble point temperature: -30.7 °C (-23.2 °F) 8401
dew point temperature: -25.3 °C (-13.6 °F) 8401
  maximum temperature glide: 5.33 °C (9.6 °F) 8401
density, saturated liquid: 1315 kg/m³ (82.11 lb/ft³) 8401
density, saturated vapor: 4.77 kg/m³ (0.298 lb/ft³) 8401
  specific volume, saturated liquid: 0.760 L/kg (0.0122 cf/lb) 8401
  specific volume, saturated vapor: 209.6 L/kg (3.3579 cf/lb) 8401
  heat of vaporization: 233.5 kJ/kg (100.4 Btu/lb) 8401
  velocity of sound, saturated liquid: 804 m/s (2637 ft/s) 8401
  velocity of sound, saturated vapor: 155 m/s (508 ft/s) 8401
  viscosity, saturated liquid: 347 µPa·s (0.347 cp) 8401
  viscosity, saturated vapor: 9.77 µPa·s (0.00977 cp) 8401
  thermal conductivity, liquid: 0.1039 W/m·K (0.0600 Btu/hr·ft°F) 8401
  thermal conductivity, vapor: 0.0084 W/m·K (0.0049 Btu/hr·ft°F) 8401
• normal pressure, 20 °C (68 °F) ----
  density, vapor: 3.958 kg/m³ (0.2471 lb/cf) 8401
• normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 3.942 kg/m³ (0.2461 lb/cf) 8401
• 20 °C (68 °F) -----------------------
  pressure, liquid (bubble point): 620.1 kPa (89.94 psia) 8401
  pressure, vapor (dew point): 543.1 kPa (78.77 psia) 8401
density, saturated liquid: 1167 kg/m³ (72.85 lb/ft³) 8401
density, saturated vapor: 23.69 kg/m³ (1.479 lb/cf) 8401
  specific volume, saturated liquid: 0.857 L/kg (0.0137 cf/lb) 8401
  specific volume, saturated vapor: 42.2 L/kg (0.6761 cf/lb) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
velocity of sound, saturated liquid: 574 m/s (1884 ft/s) 8401
velocity of sound, saturated vapor: 156 m/s (512 ft/s) 8401
viscosity, saturated liquid: 189 μPa·s (0.189 cp) 8401
viscosity, saturated vapor: 11.6 μPa·s (0.0116 cp) 8401
thermal conductivity, saturated liquid: 0.0834 W/m·K (0.0482 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01190 W/m·K (0.00688 Btu/hr·ft·°F) 8401

- 60 °C (140 °F) ---------------------
  pressure, liquid (bubble point): 1712 kPa (248.4 psia) 8401
  pressure, vapor (dew point): 1582 kPa (229.4 psia) 8401
  heat of vaporization: 154.2 kJ/kg for liquid and 8401
  vapor both at nominal composition (66.3 Btu/lb) 8401
  149.4 kJ/kg coexisting liquid and vapor at bubble-point 8401
  pressure (64.2 Btu/lb)

critical point ---------------------
temperature: 109.3 °C (228.7 °F) 8401
pressure: 4492 kPa (651.5 psia) 8401
density: 475 kg/m³ (29.7 lb/cf) 8401
specific volume: 2.10 L/kg (0.0337 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): 0.023 mass-weighted average 9501
  (model-derived relative to R 11)
  0.028 mass-weighted average (semi-empirical relative to R 11) 9501

GWP (global warming potential): 980 mass-weighted average 9501
  relative to CO₂ for 100 yr integration

HGWP (halocarbon GWP): 0.16 relative to R 11 for 0535
  infinite integration period
  0.16 mass-weighted average relative to R 11 for DW
  infinite integration period

SAFETY

classification ---------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized 8C01
last year production allowed: 2029 by refrigerants 22, 124 in developed countries under the Montreal Protocol
R-22/152a/124 (40.0/17.0/43.0)

R-22/152a/124 (40.0/17.0/43.0) see RDB#

derived from (40.0/17.0/43.0)

COMMON USE(S)

developmental formulation of an alternative to refrigerants 12 and 500, primarily for aftermarket use to service or retrofit existing equipment; tested circa 1990

IDENTIFIERS

common name(s): R-22/152a/124 (40.0/17.0/43)
R22/152a/124 (40.0/17.0)
R 22/152a/124 (40.0/17.0/43)
candidate for R-401 series
HCFC-22/HFC-152a/HCFC-124
(40.0/17.0)
not HCFC-22/152a/124

trade name(s): DuPont Suva(R) MP33

ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

nominal blend formulation --------

composition: R-22/152a/124

component weight fractions: 40.0 / 17.0 / 43.0 %

component mole fractions: 44.693 / 24.866 / 30.440 %

molar mass: 96.6136 g/mol (0.212996 lb/mol)

normal boiling point ----------

bubble point temperature: -28.8 °C (-19.8 °F) 2A19
-31.9 °C (-25.4 °F) 8401

dew point temperature: -25.8 °C (-14.4 °F) 8401

maximum temperature glide: 6.09 °C (11.0 °F) 8401

density, saturated liquid: 1353 kg/m3 (84.44 lb/cf) 8401

density, saturated vapor: 4.95 kg/m3 (0.309 lb/cf) 8401

specific volume, saturated liquid: 0.739 L/kg (0.0118 cf/lb) 8401

specific volume, saturated vapor: 202.0 L/kg (3.2360 cf/lb) 8401

heat of vaporization: 224.9 kJ/kg (96.7 Btu/lb) 8401

velocity of sound, saturated liquid: 796 m/s (2610 ft/s) 8401

velocity of sound, saturated vapor: 152 m/s (499 ft/s) 8401

viscosity, saturated liquid: 354 μPa·s (0.354 cp) 8401

viscosity, saturated vapor: 9.86 μPa·s (0.00986 cp) 8401

thermal conductivity, liquid: 0.1020 W/m·K (0.0589 Btu/hr·ft·°F) 8401

thermal conductivity, vapor: 0.0083 W/m·K (0.0048 Btu/hr·ft·°F)

normal pressure, 20 °C (68 °F) -----

density, vapor: 4.100 kg/m3 (0.2560 lb/cf) 8401

normal pressure, 21.1 °C (70 °F) ---

density, vapor: 4.084 kg/m3 (0.2549 lb/cf) 8401

20 °C (68 °F) -----------------------

pressure, liquid (bubble point): 644.2 kPa (93.43 psia) 8401

pressure, vapor (dew point): 554.2 kPa (80.38 psia) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
density, saturated liquid: 1196 kg/m³ (74.65 lb/ft³) 8401
density, saturated vapor: 25.07 kg/m³ (1,565 lb/ft³) 8401
specific volume, saturated liquid: 0.836 L/kg (0.0134 cf/lb) 8401
specific volume, saturated vapor: 39.9 L/kg (0.6390 cf/lb) 8401
velocity of sound, saturated liquid: 562 m/s (1845 ft/s) 8401
velocity of sound, saturated vapor: 153 m/s (502 ft/s) 8401
viscosity, saturated liquid: 190 µPa·s (0.190 cp) 8401
viscosity, saturated vapor: 11.8 µPa·s (0.0118 cp) 8401
thermal conductivity, saturated liquid: 0.0812 W/m·K (0.0469 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01160 W/m·K (0.00670 Btu/hr·ft·°F) 8401

- **60 °C (140 °F) -----------------------**
  - pressure, liquid (bubble point): 1764 kPa (255.8 psia) 8401
  - pressure, vapor (dew point): 1612 kPa (233.8 psia) 8401
  - heat of vaporization: 146.9 kJ/kg for liquid and vapor both at nominal composition (63.2 Btu/lb) 8401
  - 141.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (60.9 Btu/lb) 8401

- **Critical point --------------------**
  - temperature: 108.3 °C (226.9 °F) 8401
  - pressure: 4497 kPa (652.2 psia) 8401
  - density: 490 kg/m³ (30.6 lb/ft³) 8401
  - specific volume: 2.04 L/kg (0.0327 cf/lb) 8401

**Environmental**

- ODP (ozone depletion potential): 0.025 mass-weighted average (model-derived relative to R 11) 9501
- 0.031 mass-weighted average (semi-empirical relative to R 11) 9501

- GWP (global warming potential): 1060 mass-weighted average relative to CO2 for 100 yr integration 9501
- HGWP (halocarbon GWP): 0.17 mass-weighted average relative to R 11 for infinite integration period DW 9501

**Safety**

- **Classification ------------------------**
  - safety group (ASHRAE Standard 34): none (no application pending) 8601
  - emergency exposure limit --------
    - Refrigerant Concentration Limit (RCL): 19,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa) 8601

- flammability --------------------------
  - LFL-UFL (flammability limits in air): none (nonflammable as tested) 2A19
  - heat of combustion (by ASHRAE 34-92): -3.7 MJ/kg (-1598 Btu/lb) UL
  - flash point: DuPont, TOC: will not burn MSDS
  - autoignition temperature: 678 °C (1252 °F) 5931
  - former UL Classification: practically nonflammable (withdrawn for revision of the classification system, category SBQT2) 5931

- detection -----------------------------
  - appearance: DuPont: clear, colorless MSDS
PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
last year production allowed: 2029 by refrigerants 22, 124 8C01 in developed countries under the Montreal Protocol
R-22/152a/124 (52.0/15.0/33.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-22/152a/124 (52.0/15.0/33.0) see RDB#
zeotrope ternary blend ----

COMMON USE(S)

developmental formulation of an alternative for refrigerant 12, primarily for aftermarket use to service or retrofit existing, medium-temperature, commercial refrigeration equipment and home refrigerators; tested circa 1990-1995

IDENTIFIERS

common name(s): R-22/152a/124 (52/15/33)
R22/152a/124 (52/15/33)
R 22/152a/124 (52/15/33)
candidate for R-401 series
HCFC-22/HFC-152a/HCFC-124 (52/15/33)
not HCFC-22/152a/124

historical name(s): before 1995: DuPont Suva(R) MSDS
MP39 (later reformulated) MSDS

ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

nominal blend formulation --------

composition: R-22/152a/124
component weight fractions: 52.0 / 15.0 / 33.0 %
component mole fractions: 56.189 / 21.219 / 22.592 %

properties ---------------------
molar mass: 93.43352 g/mol (0.205986 lb/mol)

normal boiling point ----------

bubble point temperature: -34.1 °C (-29.4 °F)
dew point temperature: -28.7 °C (-19.6 °F)
maximum temperature glide: 5.45 °C (9.8 °F)
density, saturated liquid: 1356 kg/m³ (84.64 lb/cf)
density, saturated vapor: 4.84 kg/m³ (0.302 lb/cf)
specific volume, saturated liquid: 0.738 L/kg (0.0118 cf/lb)
specific volume, saturated vapor: 206.6 L/kg (3.3101 cf/lb)
heat of vaporization: 229.3 kJ/kg (99.8 Btu/lb)
velocity of sound, saturated liquid: 810 m/s (2656 ft/s)
velocity of sound, saturated vapor: 155 m/s (507 ft/s)
viscosity, saturated liquid: 351 µPa·s (0.351 cp)
viscosity, saturated vapor: 9.84 µPa·s (0.00984 cp)
thermal conductivity, liquid: 0.1048 W/m·K (0.0606 Btu/hr·ft°F)
thermal conductivity, vapor: 0.0080 W/m·K (0.0046 Btu/hr·ft°F)

normal pressure, 20 °C (68 °F) ----
density, vapor: 3.961 kg/m³ (0.2472 lb/cf)

normal pressure, 21.1 °C (70 °F) ----
density, vapor: 3.945 kg/m³ (0.2462 lb/cf)

20 °C (68 °F) ---------------------

pressure, liquid (bubble point): 700.3 kPa (101.57 psia)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>pressure, vapor (dew point)</td>
<td>614.2 kPa (89.08 psia)</td>
<td>8814</td>
</tr>
<tr>
<td>density, saturated liquid</td>
<td>1191 kg/m³ (74.32 lb/ft³)</td>
<td>8814</td>
</tr>
<tr>
<td>density, saturated vapor</td>
<td>27.06 kg/m³ (1.689 lb/ft³)</td>
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<tr>
<td>specific volume, saturated liquid</td>
<td>0.840 L/kg (0.0135 cf/lb)</td>
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<tr>
<td>specific volume, saturated vapor</td>
<td>37.0 L/kg (0.5919 cf/lb)</td>
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<td>velocity of sound, saturated liquid</td>
<td>564 m/s (1849 ft/s)</td>
<td>8814</td>
</tr>
<tr>
<td>velocity of sound, saturated vapor</td>
<td>156 m/s (511 ft/s)</td>
<td>8814</td>
</tr>
<tr>
<td>viscosity, saturated liquid</td>
<td>186 μPa·s (0.186 cp)</td>
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</tr>
<tr>
<td>viscosity, saturated vapor</td>
<td>11.9 μPa·s (0.0119 cp)</td>
<td>8814</td>
</tr>
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<td>thermal conductivity, saturated liquid</td>
<td>0.0824 W/m·K (0.0476 Btu/hr·ft°F)</td>
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<td>thermal conductivity, saturated vapor</td>
<td>0.01146 W/m·K (0.00662 Btu/hr·ft°F)</td>
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<tr>
<td>• 60 °C (140 °F)</td>
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<tr>
<td>pressure, liquid (bubble point)</td>
<td>1902 kPa (275.9 psia)</td>
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<td>pressure, vapor (dew point)</td>
<td>1760 kPa (255.3 psia)</td>
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<tr>
<td>heat of vaporization</td>
<td>147.2 kJ/kg for liquid and vapor both at nominal composition (63.3 Btu/lb)</td>
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<tr>
<td></td>
<td>142.5 kJ/kg for coexisting liquid and vapor at bubble-point pressure (61.3 Btu/lb)</td>
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</tr>
<tr>
<td>• critical point</td>
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<tr>
<td>temperature</td>
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<tr>
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<tr>
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<td>491 kg/m³ (30.6 lb/ft³)</td>
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<tr>
<td>specific volume</td>
<td>2.04 L/kg (0.0326 cf/lb)</td>
<td>8814</td>
</tr>
</tbody>
</table>

**ENVIRONMENTAL**

- ODP (ozone depletion potential):
  - 0.026 mass-weighted average (model-derived relative to R-11) 9501
  - 0.035 mass-weighted average (semi-empirical relative to R-11) 9501

- GWP (global warming potential):
  - 1220 mass-weighted average relative to CO2 for 100 yr integration 9501

- HGWP (halocarbon GWP):
  - 0.20 mass-weighted average relative to R-11 for infinite integration period

**SAFETY**

- classification ------------------------------- none (no application pending) 8601

- flammability --------------------------------- Elf Atochem: nonflammable MSDS
  - flash point: Elf Atochem: will not burn MSDS
  - autodecomposition temperature: Elf Atochem: >427 °C (>800 °F) MSDS

- detection -------------------------------
  - appearance: Elf Atochem: clear, colorless MSDS
  - odor: Elf Atochem: slight ethereal MSDS

**PRODUCTION**

- first commercial use as a refrigerant: not known to be commercialized
- last year production allowed: 2029 by refrigerants 22, 124 8C01
  - in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-22/152a/124 (60.0/13.0/27.0)

R-22/152a/124 (60.0/13.0/27.0)  see RDB#

COMMON USE(S)
developmental formulation of an alternative to refrigerants 12 and 500, primarily for aftermarket use to service or retrofit existing, low-temperature equipment; tested circa 1990-1992

IDENTIFIERS

| common name(s): | R-22/152a/124 (60/13/27) |
| R22/152a/124 (60/13/27) |
| R 22/152a/124 (60/13/27) |
| candidate for R-401 series |
| HCFC-22/HFC-152a/HCFC-124 |
| (60/13/27) |
| not HCFC-22/152a/124 |
| historical name(s): | before 1993: DuPont Suva(R) |
| MSDS |
| MP66 (later reformulated) |
| MSDS |
| ARI container color / Pantone number: | none, use light green grey/413 6601 |

PHYSICAL

nominal blend formulation --------

composition: R-22/152a/124

component weight fractions: 60.0 / 13.0 / 27.0 %

component mole fractions: 63.745 / 18.081 / 18.174 % 8820

properties ------------------------

molar mass: 91.86488 g/mol (0.202527 lb/mol) 8820

normal boiling point -------------

bubble point temperature: -35.4 °C (-31.8 °F) 8814

dew point temperature: -30.6 °C (-23.0 °F) 8814

maximum temperature glide: 4.87 °C (8.8 °F) 8814

density, saturated liquid: 1362 kg/m³ (85.00 lb/cf) 8814

density, saturated vapor: 4.79 kg/m³ (0.299 lb/cf) 8814

specific volume, saturated liquid: 0.734 L/kg (0.0118 cf/lb) 8814

specific volume, saturated vapor: 208.6 L/kg (3.3421 cf/lb) 8814

heat of vaporization: 231.0 kJ/kg (99.3 Btu/lb) 8814

velocity of sound, saturated liquid: 817 m/s (2682 ft/s) 8814

velocity of sound, saturated vapor: 156 m/s (511 ft/s) 8814

viscosity, saturated liquid: 350 µPa·s (0.350 cp) 8814

viscosity, saturated vapor: 9.84 µPa·s (0.00984 cp) 8814

thermal conductivity, liquid: 0.1064 W/m·K (0.0615 Btu/hr·ft·°F) 8814

thermal conductivity, vapor: 0.0078 W/m·K (0.0045 Btu/hr·ft·°F) 8814

normal pressure, 20 °C (68 °F) -----

density, vapor: 3.891 kg/m³ (0.2429 lb/cf) 8814

normal pressure, 21.1 °C (70 °F) ----

density, vapor: 3.876 kg/m³ (0.2419 lb/cf) 8814

20 °C (68 °F) -----------------------

pressure, liquid (bubble point): 736.4 kPa (106.81 psia) 8814

pressure, vapor (dew point): 656.2 kPa (95.17 psia) 8814

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
density, saturated liquid: 1191 kg/m³ (74.33 lb/cf) 8814
density, saturated vapor: 28.57 kg/m³ (1.784 lb/cf) 8814
specific volume, saturated liquid: 0.840 L/kg (0.0135 cf/lb) 8814
specific volume, saturated vapor: 35.0 L/kg (0.5606 cf/lb) 8814
velocity of sound, saturated liquid: 564 m/s (1850 ft/s) 8814
velocity of sound, saturated vapor: 157 m/s (515 ft/s) 8814
viscosity, saturated liquid: 183 μPa·s (0.183 cp) 8814
viscosity, saturated vapor: 12.0 μPa·s (0.0120 cp) 8814
thermal conductivity, saturated liquid: 0.0831 W/m·K (0.0480 Btu/hr·ft·°F) 8814
thermal conductivity, saturated vapor: 0.01136 W/m·K (0.00656 Btu/hr·ft·°F) 8814

- 60 °C (140 °F) -------------------
pessayure, liquid (bubble point): 1992 kPa (288.9 psia) 8814
pressure, vapor (dew point): 1862 kPa (270.0 psia) 8814
heat of vaporization: 146.6 kJ/kg for liquid and vapor both at nominal composition (63.0 Btu/lb) 8814
142.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (61.3 Btu/lb) 8814

- critical point ------------
temtature: 104.0 °C (219.2 °F) 8814
pressure: 4686 kPa (679.6 psia) 8814
density: 494 kg/m³ (30.8 lb/cf) 8814
specific volume: 2.03 L/kg (0.0325 cf/lb) 8814

ENVIRONMENTAL
ODP (ozone depletion potential): 0.027 mass-weighted average (model-derived relative to R 11) 9501
0.037 mass-weighted average (semi-empirical relative to R 11) 9501
GWP (global warming potential): 1330 mass-weighted average relative to CO₂ for 100 yr integration 9501
HGWP (halocarbon GWP): 0.22 mass-weighted average relative to R 11 for infinite integration period DW

SAFETY
- classification -------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601
- flammability ---------------------
   LFL-UFL (flammability limits in air):
   flash point: DuPont: none (not flammable as tested) MSDS
   DuPont, TOC: will not burn MSDS
- detection ------------------------
   appearance: DuPont: clear, colorless MSDS
   odor: DuPont: slight ethereal MSDS

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized
last year production allowed: 2029 by refrigerants 22, 124 8601
in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-22/227ea/600a/142b (41.0/40.0/4.0/15.0)

----------------------------- REFRIGERANT DATA SUMMARY -----------------------------
unassigned R-22/227ea/600a/142b (41.0/40.0/4.0/15.0) see RDB#
zeotrope tetryary blend

COMMON USE(S)
alternative for refrigerants 12 and 134a for centrifugal chillers, primarily for aftermarket use to service or retrofit existing equipment

The following information is preliminary and may be incomplete or incorrect. Further data may be available from GHG Dev Labs (West Lafayette, IN, USA) or refrigerant manufacturers.

IDENTIFIERS
common name(s): R-22/227ea/600a/142b
R22/227ea/600a/142b
R 22/227ea/600a/142b
(41/40/4/15)
HCFC/HFC/HC/HCFC-
22/227ea/600a/142b
(41/40/4/15)
not HCFC-22/227ea/600a/142b
(41/40/4/15)
trade name(s): Autofrost-X5
GHG-X5 8354

PHYSICAL
nominal blend formulation ---------
composition: R-22/227ea/600a/142b
component weight fractions: 41.0 / 40.0 / 4.0 / 15.0 %
component mole fractions: 51.123 / 25.364 / 7.420 / 16.093 8820%

properties ------------------------
molar mass: 107.81679 g/mol (0.237695 lb/mol)

normal boiling point --------------
bubble point temperature: -32.4 °C (-26.3 °F) 8401
dew point temperature: -24.8 °C (-12.6 °F) 8401
maximum temperature glide: 7.62 °C (13.7 °F) 8401
density, saturated liquid: 1354 kg/m3 (84.53 lb/cf) 8401
density, saturated vapor: 5.51 kg/m3 (0.344 lb/cf) 8401
specific volume, saturated liquid: 0.738 L/kg (0.0118 cf/lb) 8401
specific volume, saturated vapor: 181.6 L/kg (2.9093 cf/lb) 8401
heat of vaporization: 203.7 kJ/kg (87.6 Btu/lb) 8401
velocity of sound, saturated liquid: 737 m/s (2417 ft/s) 8401
velocity of sound, saturated vapor: 143 m/s (467 ft/s) 8401
thermal conductivity, liquid: 0.0927 W/m·K (0.0535 Btu/hr·ft·°F) 8401
thermal conductivity, vapor: 0.0083 W/m·K (0.0048 Btu/hr·ft·°F) 8401

normal pressure, 20 °C (68 °F) ---
density, vapor: 4.579 kg/m3 (0.2859 lb/cf) 8401

normal pressure, 21.1 °C (70 °F) ---

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
### Refrigerant Database

**Density, Vapor:**
- **20 °C (68 °F)**
  - Pressure, Liquid (bubble point): 647.2 kPa (93.86 psia)
  - Pressure, Vapor (dew point): 537.9 kPa (78.02 psia)
  - Density, Saturated Liquid: 1193 kg/m³ (74.48 lb/ft³)
  - Velocity of Sound, Saturated Liquid: 513 m/s (1683 ft/s)
  - Velocity of Sound, Saturated Vapor: 143 m/s (469 ft/s)

**60 °C (140 °F)**
- Pressure, Liquid (bubble point): 1748 kPa (253.5 psia)
- Pressure, Vapor (dew point): 1566 kPa (227.1 psia)
- Heat of Vaporization: 127.7 kJ/kg for liquid and vapor both at nominal composition (54.9 Btu/lb)
- 109.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (47.1 Btu/lb)

**Critical Point**
- Temperature: 108.2 °C (226.8 °F)
- Pressure: 4366 kPa (633.2 psia)
- Density: 500 kg/m³ (31.2 lb/ft³)
- Specific Volume: 2.00 L/kg (0.0320 cf/lb)

**Environmental**
- **ODP (ozone depletion potential):** 0.020 mass-weighted average
  - Model-derived relative to R11
- **GWP (global warming potential):** 2.640 mass-weighted average
  - Relative to CO₂ for 100 yr integration
- **HGWP (halocarbon GWP):** 0.47 mass-weighted average
  - Relative to R11 for infinite integration period

**Safety**
- Classification
  - Safety Group (ASHRAE Standard 34): none (no application pending)
  - Components are A1, ??, A3, A2

**Production**
- First Commercial Use as a Refrigerant: circa 1997
- Last Year Production Allowed: 2029 by refrigerants 22, 142b
- In developed countries under the Montreal Protocol
R-22/600a/142b (55.0/8.0/37.0)

--------------------------- REFRIGERANT DATA SUMMARY ---------------------------

R-22/600a/142b (55.0/8.0/37.0)  

COMMON USE(S)
this blend was a developmental version of what evolved into GHG Refrigerant 12 Substitute (R-406A), with a revised formulation, as a service fluid to replace refrigerant 12; further data may be available from GHG Dev Labs and refrigerant manufacturers

IDENTIFIERS

common name(s):  
R-22/600a/142b (55/8/37)  
R22/600a/142b (55/8/37)  
R 22/600a/142b (55/8/37)  
candidate for R-406 series  
HCFC-22/HC-600a/HCFC-142b  
HCFC/HC/HCFC-22/600a/142b  
historical name(s): GHG-X3

PHYSICAL

nominal blend formulation

composition:  
R-22/600a/142b  

component weight fractions:  
55.0 / 8.0 / 37.0 %

component mole fractions:  
55.703 / 12.054 / 32.243 %

properties

molar mass: 87.57396 g/mol (0.193068 lb/mol)

ENVIRONMENTAL

ODP (ozone depletion potential): 0.035 mass-weighted average (model-derived relative to R 11)  
0.052 mass-weighted average (semi-empirical relative to R 11)  

GWP (global warming potential): 1900 mass-weighted average relative to CO2 for 100 yr integration  
HGWP (halocarbon GWP): 0.32 mass-weighted average relative to R 11 for infinite integration period

SAFETY

classification

safety group (ASHRAE Standard 34): none (no application pending)

PRODUCTION

first commercial use as a refrigerant: May 1992 (until March 1993)  
last year production allowed: 2029 by refrigerants 22, 142b in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
### Refrigerant Database

**R-22/600a/142b (65.0/4.0/31.0)**

---

**REFRIGERANT DATA SUMMARY**

<table>
<thead>
<tr>
<th>Unassigned</th>
<th>R-22/600a/142b (65.0/4.0/31.0)</th>
<th>See</th>
<th>RDB#</th>
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<tbody>
<tr>
<td>Zeotrope</td>
<td>ternary blend</td>
<td></td>
<td>----</td>
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</tbody>
</table>

**COMMON USE(S)**

The following information is preliminary and may be incomplete or incorrect. Further data may be available from GHG Dev Labs (West Lafayette, IN, USA) or refrigerant manufacturers.

**IDENTIFIERS**

- **common name(s):** R-22/600a/142b (65/4/31)
- **R22/600a/142b (65/4/31)**
- **R 22/600a/142b (65/4/31)**
- **candidate for R-406_series**
- **HCFC/HC/HCFC-22/600a/142b (65/4/31)**
- **not HCFC-22/600a/142b (65/4/31)**
- **trade name(s):** GHG High Performance
- **GHG-HP**
- **historical name(s):** GHG-HP Refrig. 12 Substitute
- **name used in U.S. EPA SNAP Rule:** HCFC Blend Lambda

**PHYSICAL**

- **nominal blend formulation**
  - **composition:** R-22/600a/142b
  - **component weight fractions:** 65.0 / 4.0 / 31.0 %
  - **component mole fractions:** 66.582 / 6.096 / 27.322 %

- **properties**
  - **molar mass:** 88.57268 g/mol (0.195269 lb/mol)

- **normal boiling point**
  - **bubble point temperature:** -35.0 °C (-30.9 °F)
  - **dew point temperature:** -26.7 °C (-16.1 °F)
  - **maximum temperature glide:** 8.25 °C (14.8 °F)
  - **density, saturated liquid:** 1274 kg/m3 (79.54 lb/cf)
  - **density, saturated vapor:** 4.54 kg/m3 (0.284 lb/cf)
  - **specific volume, saturated liquid:** 0.785 L/kg (0.0126 cf/lb)
  - **specific volume, saturated vapor:** 220.1 L/kg (3.5257 cf/lb)
  - **heat of vaporization:** 241.4 kJ/kg (103.8 Btu/lb)
  - **velocity of sound, saturated liquid:** 841 m/s (2760 ft/s)
  - **velocity of sound, saturated vapor:** 160 m/s (525 ft/s)
  - **viscosity, saturated liquid:** 351 μPa·s (0.351 cp)
  - **viscosity, saturated vapor:** 9.45 μPa·s (0.00945 cp)
  - **thermal conductivity, liquid:** 0.1080 W/m·K (0.0624 Btu/hr·ft·°F)

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2
### Thermal Conductivity, Vapor

- Normal pressure, 20 °C (68 °F)
  - Density, vapor: 3.754 kg/m³ (0.2343 lb/cf) 8401
- Normal pressure, 21.1 °C (70 °F)
  - Density, vapor: 3.739 kg/m³ (0.2334 lb/cf) 8401
- 20 °C (68 °F)
  - Pressure, liquid (bubble point): 706.7 kPa (102.50 psia) 8401
  - Pressure, vapor (dew point): 567.0 kPa (82.24 psia) 8401
  - Density, saturated liquid: 112 kg/m³ (70.02 lb/cf) 8401
  - Density, saturated vapor: 23.35 kg/m³ (1.458 lb/cf) 8401
  - Specific volume, saturated liquid: 0.892 L/kg (0.0143 cf/lb) 8401
  - Specific volume, saturated vapor: 42.8 L/kg (0.6859 cf/lb) 8401
  - Velocity of sound, saturated liquid: 592 m/s (1942 ft/s) 8401
  - Velocity of sound, saturated vapor: 162 m/s (532 ft/s) 8401
  - Viscosity, saturated liquid: 187 μPa·s (0.187 cp) 8401
  - Viscosity, saturated vapor: 11.3 μPa·s (0.0113 cp) 8401
- Thermal conductivity, saturated vapor: 0.0841 W/m·K (0.0486 Btu/hr·ft·°F) 8401
- Thermal conductivity, saturated vapor: 0.01102 W/m·K (0.00637 Btu/hr·ft·°F) 8401

### 60 °C (140 °F)

- Pressure, liquid (bubble point): 1886 kPa (273.5 psia) 8401
- Pressure, vapor (dew point): 1638 kPa (237.5 psia) 8401
- Heat of vaporization: 168.6 kJ/kg for liquid and vapor both at nominal composition (72.5 Btu/lb) 8401

### Critical Point

- Temperature: 112.2 °C (234.0 °F) 8401
- Pressure: 4950 kPa (717.9 psia) 8401
- Density: 467 kg/m³ (29.1 lb/cf) 8401
- Specific volume: 2.14 L/kg (0.0343 cf/lb) 8401

### Environmental

- ODP (ozone depletion potential): 0.035 mass-weighted average (model-derived relative to R 11) 9501
- GWP (global warming potential): 1950 mass-weighted average relative to CO2 for 100 yr integration 6695
- HGWP (halocarbon GWP): 0.33 mass-weighted average relative to R 11 for infinite integration period DW

### Safety

- Classification
  - Safety group (ASHRAE Standard 34): none (no application pending) 8601
  - Components are A1, A3, and A2 8601
- Emergency Exposure Limit
  - Refrigerant Concentration Limit (RCL): 25,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)
LFL-UFL (flammability limits in air): worst fractionation flammable

PRODUCTION
first commercial use as a refrigerant: 1997
last year production allowed: 2029 by refrigerants 22, 142b 8C01
in developed countries under the Montreal Protocol
R-23/22 (10.0/90.0, 15.0/85.0, and 20.0/80.0)

----------------------------- REFRIGERANT DATA SUMMARY -----------------------------
unassigned R-23/22 (10.0/90.0, 15.0/85.0, and 20.0/80.0) see
zeotrope binary blend RDB#

COMMON USE(S)
considered as an alternative for refrigerant 22, especially for heat
pumps, in the early 1980s to improve performance

Data may be available from the Institut Français du Pétrole (IFP,
Rueil Malmaison, France), Elf Atochem (Levallois-Perret, France), and
other refrigerant manufacturers.

IDENTIFIERS
trade name(s): Elf Atochem Frimip
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL
• nominal blend formulation --------
  composition: R-23/22
  component weight fractions: 10.0/90.0, 15.0/85.0, and 20.0/80.0

SAFETY
• classification -------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are both A1 8601

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized
last year production allowed: 2029 based on HCFC component 8C01
in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-23/22/152a (5.0/65.0/30.0)

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**REFRIGERANT DATA SUMMARY**

unassigned R-23/22/152a (5.0/65.0/30.0) see
zeotrope ternary blend RDB#

**COMMON USE(S)**

under consideration as a replacement for refrigerant 12, primarily for aftermarket use to retrofit commercial and transport refrigeration systems

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from Moncton Refrigerants Incorporated (Toronto, ON, Canada) and refrigerant manufacturers.

**IDENTIFIERS**

common name(s): R-23/22/152a (5/65/30)
R 23/22/152a (5/65/30)
HFC-23/HCFC-22/HF-152a (5/65/30)

trade name(s): Moncton Refrigerants NARM-12

name used in U.S. EPA SNAP Rule: HCFC Blend Kappa

ARI container color / Pantone number: none, use light green grey/413 6601

**PHYSICAL**

nominal blend formulation -------

composition: R-23/22/152a

component weight fractions: 5.0 / 65.0 / 30.0 %

component mole fractions: 5.591 / 56.851 / 35.558 %

molar mass: 78.28782 g/mol (0.172595 lb/mol)

normal boiling point  

bubble point temperature: -44.8 °C (-48.7 °F)

dew point temperature: -33.2 °C (-27.8 °F)

maximum temperature glide: 11.57 °C (20.8 °F)

density, saturated liquid: 1281 kg/m³ (79.97 lb/ft³)

density, saturated vapor: 4.13 kg/m³ (0.258 lb/ft³)

specific volume, saturated liquid: 0.781 L/kg (0.0125 cf/lb)

specific volume, saturated vapor: 242.3 L/kg (3.8806 cf/lb)

heat of vaporization: 276.2 kJ/kg (118.7 Btu/lb)

velocity of sound, saturated liquid: 898 m/s (2947 ft/s)

velocity of sound, saturated vapor: 170 m/s (557 ft/s)

viscosity, saturated liquid: 376 μPa·s (0.376 cp)

viscosity, saturated vapor: 9.52 μPa·s (0.00952 cp)

thermal conductivity, liquid: 0.1211 W/m·K (0.0699 Btu/hr·ft°F)

thermal conductivity, vapor: 0.0078 W/m·K (0.0045 Btu/hr·ft°F)

normal pressure, 20 °C (68 °F)  

density, vapor: 3.312 kg/m³ (0.2068 lb/ft³)

normal pressure, 21.1 °C (70 °F) ---

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2
density, vapor: 3.299 kg/m³ (0.2059 lb/cf) 8401

- 20 °C (68 °F) ----------------
  pressure, liquid (bubble point): 924.8 kPa (134.14 psia) 8401
  pressure, vapor (dew point): 727.1 kPa (105.45 psia) 8401
  density, saturated liquid: 1096 kg/m³ (68.40 lb/cf) 8401
  density, saturated vapor: 27.15 kg/m³ (1.695 lb/cf) 8401
  specific volume, saturated liquid: 0.913 L/kg (0.0146 cf/lb) 8401
  specific volume, saturated vapor: 36.8 L/kg (0.5900 cf/lb) 8401
  velocity of sound, saturated liquid: 589 m/s (1932 ft/s) 8401
  velocity of sound, saturated vapor: 171 m/s (562 ft/s) 8401
  viscosity, saturated liquid: 170 µPa·s (0.170 cp) 8401
  viscosity, saturated vapor: 11.8 µPa·s (0.0118 cp) 8401
  thermal conductivity, saturated liquid: 0.0908 W/m·K (0.0525 Btu/hr·ft°F) 8401
  thermal conductivity, saturated vapor: 0.01210 W/m·K (0.00699 Btu/hr·ft°F) 8401

- 60 °C (140 °F) ---------------
  pressure, liquid (bubble point): 2353 kPa (341.2 psia) 8401
  pressure, vapor (dew point): 2054 kPa (297.9 psia) 8401
  heat of vaporization: 166.8 kJ/kg for liquid and vapor both at nominal composition (71.7 Btu/lb) 8401
  160.1 kJ/kg coexisting liquid and vapor at bubble-point pressure (68.8 Btu/lb)

- critical point ------------------------
  temperature: 100.8 °C (213.4 °F) 8401
  pressure: 4951 kPa (718.1 psia) 8401
  density: 459 kg/m³ (28.7 lb/cf) 8401
  specific volume: 2.18 L/kg (0.0349 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): 0.022 mass-weighted average (model-derived relative to R 11) 9501
0.033 mass-weighted average (semi-empirical relative to R 11) 9501

GWP (global warming potential): 2030 mass-weighted average relative to CO₂ for 100 yr integration 9501

HGWP (halocarbon GWP): 0.63 mass-weighted average relative to R 11 for infinite integration period

SAFETY

- classification ------------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A1, A1, and A2 8601

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
last year production allowed: 2029 by HCFC component in 8C01 developed countries under the Montreal Protocol
R-23/22/152a (5.0/80.0/15.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-23/22/152a (5.0/80.0/15.0) see RDB#
zeotrope ternary blend

COMMON USE(S)
under consideration as a replacement for refrigerant 22

IDENTIFIERS
common name(s): HFC-23/HFC-22/HFC-152a
not HCFC-23/22/152a (5/80/15)
alternative chemical names/formulae: R-23/22/152a (5/80/15)
R23/22/152a (5/80/15)
R 23/22/152a (5/80/15)
trade name(s): Moncton Refrigerants NARM-22 MSDS
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL
nominal blend formulation ---------
composition: R-23/22/152a
component weight fractions: 5.0 / 80.0 / 15.0 %
component weight tolerances: ±2.0 / ±2.0 / +0.0, -1.0
component mole fractions: 5.836 / 75.606 / 18.558 %

properties ------------------------
molar mass: 81.71861 g/mol (0.180159 lb/mol)

normal boiling point -----------
bubble point temperature: -47.0 °C (-52.7 °F)
dew point temperature: -36.7 °C (-34.1 °F)
maximum temperature glide: 10.30 °C (18.5 °F)
density, saturated liquid: 1351 kg/m³ (84.31 lb/cf)
density, saturated vapor: 4.37 kg/m³ (0.273 lb/cf)
specific volume, saturated liquid: 0.740 L/kg (0.0119 cf/lb)
specific volume, saturated vapor: 229.0 L/kg (3.6674 cf/lb)
heat of vaporization: 259.2 kJ/kg (111.5 Btu/lb)
velocity of sound, saturated liquid: 887 m/s (2910 ft/s)
velocity of sound, saturated vapor: 166 m/s (543 ft/s)
viscosity, saturated liquid: 375 μPa·s (0.375 cp)
viscosity, saturated vapor: 9.71 μPa·s (0.00971 cp)
thermal conductivity, liquid: 0.1193 W/m·K (0.0689 Btu/hr·ft·°F)
thermal conductivity, vapor: 0.0074 W/m·K (0.0043 Btu/hr·ft·°F)

normal pressure, 20 °C (68 °F) -----
density, vapor: 3.453 kg/m³ (0.2156 lb/cf)

normal pressure, 21.1 °C (70 °F) ---
density, vapor: 3.439 kg/m³ (0.2147 lb/cf)

20 °C (68 °F) ------------------------
pressure, liquid (bubble point): 1010.2 kPa (146.52 psia)
pressure, vapor (dew point): 819.8 kPa (118.90 psia)
density, saturated liquid: 1145 kg/m³ (71.48 lb/cf)
density, saturated vapor: 32.28 kg/m³ (2.015 lb/cf)
specific volume, saturated liquid: 0.873 L/kg (0.0140 cf/lb)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
specific volume, saturated vapor: 31.0 L/kg (0.4962 cf/lb)
velocity of sound, saturated liquid: 569 m/s (1867 ft/s)
velocity of sound, saturated vapor: 167 m/s (548 ft/s)
viscosity, saturated liquid: 169 μPa·s (0.169 cp)
viscosity, saturated vapor: 12.2 μPa·s (0.0122 cp)
thermal conductivity, saturated liquid: 0.0881 W/m·K (0.000509 Btu/hr·ft²°F)
thermal conductivity, saturated vapor: 0.0116 W/m·K (0.000671 Btu/hr·ft²°F)

- 60 °C (140 °F) -------------------
  pressure, liquid (bubble point): 2552 kPa (370.2 psia)
  pressure, vapor (dew point): 2271 kPa (329.4 psia)
  heat of vaporization: 151.8 kJ/kg for liquid and vapor both at nominal composition (65.3 Btu/lb)
  140.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (60.5 Btu/lb)

- critical point -------------------
  temperature: 97.2 °C (206.9 °F)
  pressure: 5036 kPa (730.4 psia)
  density: 488 kg/m³ (30.5 lb/cf)
  specific volume: 2.05 L/kg (0.0328 cf/lb)

ENVIRONMENTAL
  ODP (ozone depletion potential): 0.027 mass-weighted average (model-derived relative to R 11)
                                 0.040 mass-weighted average (semi-empirical relative to R 11)
  GWP (global warming potential): 2290 mass-weighted average relative to CO2 for 100 yr integration
  HGWP (halocarbon GWP): 0.67 mass-weighted average relative to R 11 for infinite integration period

SAFETY
  classification -------------------
  safety group (ASHRAE Standard 34): none (no application pending)
  components are A1, A1, and A2

  long-term occupational limit -------
  exposure limit consistent to OSHA PEL: Moncton AEL: 1,000 ppm v/v TWA 1ltr for 8 hr/day and 40 hr/wk

  emergency exposure limit -------
  Refrigerant Concentration Limit (RCL): 29,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

  flammability -------------------
  LFL-UFL (flammability limits in air): none (nonflammable as tested)
                                      worst fractionation flammable
  flash point: Univ Moncton: will not burn

  detection -------------------
  appearance: University of Moncton: clear, colorless
  odor: Univ Moncton: slight ethereal

PRODUCTION

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
first commercial use as a refrigerant: not known to be commercialized
last year production allowed: 2029 by refrigerant 22 in developed countries under the Montreal Protocol
R-23/22/152a (5.0/90.0/5.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned: R-23/22/152a (5.0/90.0/5.0)
zzeotrope: ternary blend

COMMON USE(S)
under consideration as a replacement for refrigerant 502, primarily for aftermarket use to retrofit commercial and transport refrigeration systems

IDENTIFIERS

common name(s): R-23/22/152a (5/90/5)
                 R23/22/152a (5/90/5)
                 R 23/22/152a (5/90/5)
                 HFC-23/HFC-22/HFC-152a
                 (5/90/5)

trade name(s): Moncton Refrigerants NARM-502 MSDS

name used in U.S. EPA SNAP Rule: HCFC Blend Iota

ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

- nominal blend formulation -------
  composition: R-23/22/152a
  component weight fractions: 5.0 / 90.0 / 5.0 %
  component weight tolerances: ±2.0 / ±2.0 / ±1.0
  component mole fractions: 6.012 / 87.616 / 6.372 %
  molar mass: 84.17789 g/mol (0.185580 lb/mol)

- normal boiling point ------------
  bubble point temperature: -48.4 °C (-55.2 °F)
  dew point temperature: -38.9 °C (-38.1 °F)
  maximum temperature glide: -40.3 °C (-40.6 °F)
  density, saturated liquid: 1401 kg/m³ (87.44 lb/cf)
  density, saturated vapor: 4.56 kg/m³ (0.285 lb/cf)
  specific volume, saturated liquid: 0.714 L/kg (0.0114 cf/lb)
  specific volume, saturated vapor: 219.3 L/kg (3.5135 cf/lb)
  heat of vaporization: 247.2 kJ/kg (106.3 Btu/lb)
  velocity of sound, saturated liquid: 878 m/s (2880 ft/s)
  velocity of sound, saturated vapor: 163 m/s (533 ft/s)
  viscosity, saturated liquid: 373 μPa·s (0.373 cp)
  viscosity, saturated vapor: 9.77 μPa·s (0.00977 cp)
  thermal conductivity, liquid: 0.1178 W/m·K (0.0681 Btu/hr·ft·°F)
  thermal conductivity, vapor: 0.0072 W/m·K (0.0042 Btu/hr·ft·°F)

- normal pressure, 20 °C (68 °F) -----
  density, vapor: 3.554 kg/m³ (0.2219 lb/cf)

- normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 3.540 kg/m³ (0.2210 lb/cf)

- 20 °C (68 °F) ----------------------
  pressure, liquid (bubble point): 1073.4 kPa (155.68 psia)
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<th>Property</th>
<th>Value</th>
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<td>Pressure, vapor (dew point)</td>
<td>907.6 kPa (131.64 psia)</td>
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<tr>
<td>Density, saturated liquid</td>
<td>1180 kg/m³ (73.65 lb/cf)</td>
<td>8401</td>
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<tr>
<td>Density, saturated vapor</td>
<td>37.22 kg/m³ (2.324 lb/cf)</td>
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<tr>
<td>Specific volume, saturated liquid</td>
<td>0.848 L/kg (0.0136 cf/lb)</td>
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<td>Specific volume, saturated vapor</td>
<td>554 m/s (1818 ft/s)</td>
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<tr>
<td>Velocity of sound, saturated liquid</td>
<td>26.9 L/kg (0.4304 cf/lb)</td>
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<tr>
<td>Velocity of sound, saturated vapor</td>
<td>164 m/s (537 ft/s)</td>
<td>8401</td>
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<tr>
<td>Viscosity, saturated liquid</td>
<td>169 μPa·s (0.169 cp)</td>
<td>8401</td>
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<tr>
<td>Viscosity, saturated vapor</td>
<td>12.4 μPa·s (0.0124 cp)</td>
<td>8401</td>
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<tr>
<td>Thermal conductivity, saturated liquid</td>
<td>0.0860 W/m·K (0.0497 Btu/hr·ft°F)</td>
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<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01132 W/m·K (0.00654 Btu/hr·ft°F)</td>
<td>8401</td>
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<tr>
<td>· 60 °C (140 °F)</td>
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<tr>
<td>Pressure, liquid (bubble point)</td>
<td>2704 kPa (392.2 psia)</td>
<td>8401</td>
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<tr>
<td>Pressure, vapor (dew point)</td>
<td>2465 kPa (357.5 psia)</td>
<td>8401</td>
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<tr>
<td>Heat of vaporization</td>
<td>140.8 kJ/kg for liquid and vapor both at nominal composition (60.5 Btu/lb) 130.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (56.1 Btu/lb)</td>
<td>8401</td>
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<tr>
<td>Critical point</td>
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<tr>
<td>Temperature</td>
<td>94.4 °C (201.8 °F)</td>
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<tr>
<td>Pressure</td>
<td>5095 kPa (739.0 psia)</td>
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<tr>
<td>Density</td>
<td>511 kg/m³ (31.9 lb/cf)</td>
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<tr>
<td>Specific volume</td>
<td>1.96 L/kg (0.0314 cf/lb)</td>
<td>8401</td>
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<tr>
<td><strong>Environmental</strong></td>
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<tr>
<td>ODP (ozone depletion potential)</td>
<td>0.031 mass-weighted average (model-derived relative to R 11) 0.045 mass-weighted average (semi-empirical relative to R 11)</td>
<td>9501</td>
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<tr>
<td>GWP (global warming potential)</td>
<td>2460 mass-weighted average relative to CO₂ for 100 yr integration</td>
<td>9501</td>
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<tr>
<td>HGWP (halocarbon GWP)</td>
<td>0.70 mass-weighted average DW relative to R 11 for infinite integration period</td>
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<tr>
<td><strong>Safety</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classification</td>
<td>none (no application pending) components are A1, A1, and A2 8601</td>
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<tr>
<td>Long-term occupational limit</td>
<td>Moncton AEL: 1,000 ppm v/v TWA 1tr for 8 hr/day and 40 hr/wk</td>
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<tr>
<td>Emergency exposure limit</td>
<td>27,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)</td>
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<tr>
<td>Refrigerant Concentration Limit (RCL)</td>
<td>Moncton: will not burn MSDS Moncton: slight ethereal odor MSDS</td>
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<tr>
<td>Flammability</td>
<td>none (nonflammable as tested) MSDS Moncton: will not burn MSDS</td>
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<tr>
<td>LFL-UFL (flammability limits in air)</td>
<td>Moncton: clear, colorless MSDS Moncton: slight ethereal odor MSDS</td>
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<tr>
<td>Flash Point</td>
<td>Moncton: clear, colorless MSDS Moncton: slight ethereal odor MSDS</td>
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</table>

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
last year production allowed: 2029 by refrigerant 22 in 8CO1
developed countries under the Montreal Protocol
R-23/22/152a

------------------------ REFRIGERANT DATA SUMMARY ------------------------
unassigned  R-23/22/152a (formulation not disclosed)  see
zeotrope  ternary blend  RDB#

COMMON USE(S)
under consideration for use in unitary heat pumps and other
applications

The following information is preliminary and may be incomplete or
incorrect. Data on this blend may be available from the University
of Moncton (Moncton, ON, Canada) and refrigerant manufacturers. The
name "NARM/UM" probably indicates "nonazeotropic refrigerant mixture
/ University of Moncton." Contradictory information on whether this
refrigerant is a binary or ternary blend may reflect reformulation
with further development.

IDENTIFIERS
common name(s):  R-23/22/152a (>20/50/<30)  6743
alternative chemical names/formulae:  binary HFC/HCFC blend  6715
contradiction, see note above
trade name(s):  University of Moncton NARM/UM  6715
ARI container color / Pantone number:  none, use light green grey/413 6601

PHYSICAL
  * nominal blend formulation ---------
    composition:  R-23/22/152a  6743
    component weight fractions:  >20.0 / 50.0 / <30.0 %  6743
    formulation must be indicated  2909
  * 20 °C (68 °F) ----------------------
    pressure, vapor (dew point):  1079.3 kPa (156.54 psia)  6715
    specific volume, saturated liquid:  1.198 L/kg (0.0192 cf/lb)  6715
    specific volume, saturated vapor:  22.0 L/kg (0.3529 cf/lb)  6715

ENVIRONMENTAL
  ODP (ozone depletion potential):  0.025 (model-derived relative to R 11)  6715

SAFETY
  * classification ---------------------
    safety group (ASHRAE Standard 34):  none (no application pending)  8601

PRODUCTION
  first commercial use as a refrigerant:  not known to be commercialized
  last year production allowed:  2029 by HCFC component in developed countries under the
                                 Montreal Protocol  8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-23/32/134a (4.5/21.5/74.0)

-------------------------- REFRIGERANT DATA SUMMARY --------------------------

unassigned  R-23/32/134a (4.5/21.5/74.0) see RDB#
zeotrope  ternary blend ----

COMMON USE(S)
considered (circa 1993-1995) as an alternative for refrigerant 22

IDENTIFIERS

common name(s):  R-23/32/134a (4.5/21.5/74.0)
R23/32/134a (4.5/21.5/74.0)
R 23/32/134a (4.5/21.5/74.0)
HFC-23/HFC-32/HFC-134a
(4.5/21.5/74.0)
not HFC-23/32/134a
(4.5/21.5/74.0)
historical name(s):  Elf Atochem Forane(R) FX-220 3A28

PHYSICAL

• nominal blend formulation --------
  composition:  R-23/32/134a
  component weight fractions:  4.5 / 21.5 / 74.0 %
  component mole fractions:  5.344 / 34.359 / 60.298 %  8820

• properties ------------------------
  molar mass:  83.13801 g/mol (0.183288 lb/mol)  8820
  normal boiling point ---------------
  bubble point temperature:  -42.2 °C (-44.0 °F)  3A28
dew point temperature:  -33.4 °C (-28.1 °F)  3A28
density, saturated vapor:  4.10 kg/m³ (0.256 lb/cf)  3A28
  heat of vaporization:  292.0 kJ/kg (125.5 Btu/lb)  3A28
  25 °C (77 °F) -----------------------
  pressure, saturated vapor:  1150.0 kPa (166.79 psia)  3A28
density, saturated liquid:  1130 kg/m³ (70.54 lb/cf)  3A28
  critical point ---------------------
  temperature:  89.0 °C (192.2 °F)  3A28
  pressure:  4900 kPa (710.7 psia)  3A28

ENVIRONMENTAL

ODP (ozone depletion potential):  <0.00003 mass-weighted average 9501
(model-derived relative to R 11)
<0.00039 mass-weighted average 9501
(semi-empirical relative to R 11)
GWP (global warming potential):  2040 mass-weighted average 9501
relative to CO2 for 100 yr integration
HGWP (halocarbon GWP):  0.61 mass-weighted average DW
relative to R 11 for infinite integration period

SAFETY

• classification ---------------------

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
safety group (ASHRAE Standard 34): none (no application pending) 8601
components are A1, A2, and A1 8601

- emergency exposure limit
  Refrigerant Concentration Limit (RCL): 69,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

- flammability
  LFL-UFL (flammability limits in air): none (nonflammable as tested) 3A28

PRODUCTION
  first commercial use as a refrigerant: not known to be commercialized
  last year production allowed: unrestricted 8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-23/125/143a (20.0/36.0/44.0)

REFRIGERANT DATA SUMMARY

unassigned  R-23/125/143a (20.0/36.0/44.0)  see RDB#
zeotrope  ternary blend

COMMON USE(S)

very low temperature applications, including industrial refrigeration, primarily for aftermarket use to retrofit existing systems as an alternative for refrigerant 13B1

Note: Conversion from refrigerant 13B1 to this refrigerant may require changing to a polyol ester lubricant.

IDENTIFIERS

common name(s):  R-23/125/143a (20.0/36.0/44.0)
R23/125/143a (20.0/36.0/44.0)
R 23/125/143a (20.0/36.0/44.0)
HFC-23/HFC-125/HFC-143a
(20/36/44)
HFC-23/HFC-125/HFC-143a
not HFC-23/125/143a (20/36/44)
trade name(s):  Dehon Service Mixiflon ES20  mfr

PHYSICAL

- nominal blend formulation

  composition:  R-23/125/143a
  component weight fractions:  20.0 / 36.0 / 44.0 %
  component weight tolerances:  ±1.0 / ±1.0 / ±1.0
  component mole fractions:  25.754 / 27.043 / 47.203 %

- properties

  molar mass:  90.15816 g/mol (0.198765 lb/mol)

  normal boiling point

    bubble point temperature:  -63.0 °C (-81.4 °F)
    dew point temperature:  -64.8 °C (-84.6 °F)
    maximum temperature glide:  12.50 °C (22.5 °F)
    density, saturated liquid:  1354 kg/m³ (84.52 lb/cf)
    density, saturated vapor:  5.19 kg/m³ (0.324 lb/cf)
    specific volume, saturated liquid:  0.739 L/kg (0.0118 cf/lb)
    specific volume, saturated vapor:  192.8 L/kg (3.0876 cf/lb)
    heat of vaporization:  219.5 kJ/kg (94.4 Btu/lb)
    velocity of sound, saturated liquid:  796 m/s (2611 ft/s)
    velocity of sound, saturated vapor:  149 m/s (488 ft/s)
    viscosity, saturated liquid:  377 µPa·s (0.377 cp)
    viscosity, saturated vapor:  9.17 µPa·s (0.00917 cp)
    thermal conductivity, liquid:  0.1083 W/m·K (0.0626 Btu/hr·ft·°F)
    thermal conductivity, vapor:  0.0083 W/m·K (0.0048 Btu/hr·ft·°F)

- normal pressure, 20 °C (68 °F)

  density, vapor:  3.803 kg/m³ (0.2374 lb/cf)

- normal pressure, 21.1 °C (70 °F)

  density, vapor:  3.788 kg/m³ (0.2365 lb/cf)

- 20 °C (68 °F)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
pressure, liquid (bubble point): 1785.0 kPa (258.89 psia) 8401
1818.7 kPa (263.78 psia) 8401
pressure, vapor (dew point): 1440.4 kPa (208.91 psia) 8401
density, saturated liquid: 1025 kg/m3 (64.01 lb/cf) 8401
density, saturated vapor: 71.12 kg/m3 (4.440 lb/cf) 8401
specific volume, saturated liquid: 0.975 L/kg (0.0156 cf/lb) 8401
specific volume, saturated vapor: 14.1 L/kg (0.2252 cf/lb) 8401
velocity of sound, saturated liquid: 358 m/s (1174 ft/s) 8401
velocity of sound, saturated vapor: 140 m/s (460 ft/s) 8401
viscosity, saturated liquid: 116 μPa·s (0.116 cp) 8401
viscosity, saturated vapor: 12.8 μPa·s (0.0128 cp) 8401
thermal conductivity, saturated liquid: 0.6708 W/m·K (0.3876 Btu/hr·ft°F) 8401
thermal conductivity, saturated vapor: 0.01564 W/m·K (0.00903 Btu/hr·ft°F) 8401

critical point ------------------
temperature: 59.2 °C (138.6 °F) 8401
67.3 °C (153.1 °F) MSDS
pressure: 4025 kPa (583.8 psia) 8401
density: 493 kg/m3 (30.8 lb/cf) 8401
specific volume: 2.03 L/kg (0.0325 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): <0.00009 mass-weighted average 9501
(model-derived relative to R 11)
GWP (global warming potential): 6700 mass-weighted average 9501
relative to CO2 for 100 yr integration
HGWP (halocarbon GWP): 2.3 mass-weighted average 9501
relative to R 11 for infinite integration period

SAFETY

classification -------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601
components are A1, A1, and A2 8601

flammability ---------------------
flash point: Dehon: not applicable 8601

appearance: Dehon: colorless 8601
odor: Dehon: faint 8601

detection -----------------------

PRODUCTION

first commercial use as a refrigerant: 1994 8C01
last year production allowed: unrestricted 8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
### R-32/125 (32.0/68.0)

--- REFRIGERANT DATA SUMMARY ---

<table>
<thead>
<tr>
<th>unassigned</th>
<th>R-32/125 (32.0/68.0)</th>
<th>see RDB#</th>
</tr>
</thead>
<tbody>
<tr>
<td>zeotrope</td>
<td>binary blend</td>
<td>----</td>
</tr>
</tbody>
</table>

#### COMMON USE(S)
- Replacement for refrigerant 13B1 for very low temperature refrigeration

#### IDENTIFIERS
- **common name(s):** R-32/125 (32/68), R32/125 (32/68), R 32/125 (32/68), candidate for R-410 series, HFC-32/HFC-125 (32/68), not HFC-32/125 (32/68)
- **trade name(s):** Elf Atotech Forane(R) FX-80, MSDS
- **ARI container color / Pantone number:** none, use light green grey/413 6601

#### PHYSICAL
- **nominal blend formulation**
  - **composition:** R-32/125
  - **component weight fractions:** 32.0 / 68.0 \%
  - **component mole fractions:** 52.054 / 47.946 \% 8820
- **properties**
  - **molar mass:** 84.62572 g/mol (0.186568 lb/mol) 8820
- **normal boiling point**
  - **bubble point temperature:** -51.1 °C (-60.0 °F) 8814
  - **dew point temperature:** -50.9 °C (-59.7 °F) 8814
  - **maximum temperature glide:** 0.17 °C (0.3 °F) 8814
  - **density, saturated liquid:** 1408 kg/m³ (87.91 lb/cf) 8814
  - **density, saturated vapor:** 4.85 kg/m³ (0.303 lb/cf) 8814
  - **specific volume, saturated liquid:** 0.710 L/kg (0.0114 cf/lb) 8814
  - **specific volume, saturated vapor:** 206.1 L/kg (3.3008 cf/lb) 8814
  - **heat of vaporization:** 232.6 kJ/kg (100.0 Btu/lb) 8814
  - **velocity of sound, saturated liquid:** 787 m/s (2581 ft/s) 8814
  - **velocity of sound, saturated vapor:** 155 m/s (509 ft/s) 8814
  - **viscosity, saturated liquid:** 342 μPa·s (0.342 cp) 8814
  - **viscosity, saturated vapor:** 9.88 μPa·s (0.00988 cp) 8814
  - **thermal conductivity, liquid:** 0.1272 W/m·K (0.0735 Btu/hr·ft·°F) 8814
  - **thermal conductivity, vapor:** 0.0082 W/m·K (0.0047 Btu/hr·ft·°F) 8814
- **normal pressure, 20 °C (68 °F)**
  - **density:** 3.570 kg/m³ (0.2229 lb/cf) 8814
- **normal pressure, 21.1 °C (70 °F)**
  - **density:** 3.556 kg/m³ (0.2220 lb/cf) 8814
- **20 °C (68 °F)**
  - **pressure, liquid (bubble point):** 1401.8 kPa (203.31 psia) 8814
  - **pressure, vapor (dew point):** 1391.3 kPa (201.79 psia) 8814
  - **density, saturated liquid:** 1129 kg/m³ (70.49 lb/cf) 8814
  - **density, saturated vapor:** 64.03 kg/m³ (3.997 lb/cf) 8814
  - **specific volume, saturated liquid:** 0.886 L/kg (0.0142 cf/lb) 8814

---

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
**Refrigerant Database**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific volume, saturated vapor</td>
<td>15.6 L/kg (0.2502 cf/lb)</td>
</tr>
<tr>
<td>Velocity of sound, saturated liquid</td>
<td>429 m/s (1407 ft/s)</td>
</tr>
<tr>
<td>Velocity of sound, saturated vapor</td>
<td>148 m/s (486 ft/s)</td>
</tr>
<tr>
<td>Viscosity, saturated liquid</td>
<td>134 μPa·s (0.134 cp)</td>
</tr>
<tr>
<td>Viscosity, saturated vapor</td>
<td>13.5 μPa·s (0.0135 cp)</td>
</tr>
<tr>
<td>Thermal conductivity, saturated liquid</td>
<td>0.0866 W/m·K (0.0501 Btu/hr·ft²°F)</td>
</tr>
<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01422 W/m·K (0.00822 Btu/hr·ft²°F)</td>
</tr>
</tbody>
</table>

- **60 °C (140 °F)**
  - Pressure, liquid (bubble point): 3716 kPa (539.0 psia)
  - Pressure, vapor (dew point): 3701 kPa (536.8 psia)
  - Heat of vaporization: 84.0 kJ/kg for liquid and vapor both at nominal composition (36.1 Btu/lb)
  - 83.2 kJ/kg for coexisting liquid and vapor at bubble-point pressure (35.8 Btu/lb)

- **Critical Point**
  - Temperature: 67.7 °C (153.8 °F)
  - Pressure: 4397 kPa (637.7 psia)
  - Density: 581 kg/m³ (36.3 lb/cf)
  - Specific volume: 1.72 L/kg (0.0276 cf/lb)

**Environmental**

- **ODP (ozone depletion potential):** <0.00002 mass-weighted average 9501 (model-derived relative to R11)
- **GWP (global warming potential):** 2870 mass-weighted average 9501 relative to CO₂ for 100 yr integration
- **HGWP (halocarbon GWP):** 0.49 mass-weighted average DW relative to R11 for infinite integration period

**Safety**

- **Classification:** none (no application pending) 8601
  - Safety group (ASHRAE Standard 34): components are A2 and A1 8601
- **Emergency Exposure Limit:** 69,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)
- **Detection:**
  - Appearance: Elf Atochem: colorless CSDS
  - Odor: Elf Atochem: ether-like (slighly) CSDS

**Production**

- First commercial use as a refrigerant: 1997
- Last year production allowed: unrestricted 8C01

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-32/125 (48.0/52.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-32/125 (48.0/52.0) see RDB#
zeotrope binary blend ___

COMMON USE(S)
under consideration as an alternative for refrigerant 22 in new air conditioners and heat pumps designed for higher discharge pressures

IDENTIFIERS

common name(s): R-32/125 (48/52)
R32/125 (48/52)
R 32/125 (48/52)
candidate for R-410 series
HFC-32/HFC-125 (48/52)
not HFC-32/125 (48/52)

trade name(s): Asahi Glass Asahiklin 32/125

ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

• nominal blend formulation -------
composition: R-32/125
component weight fractions: 48.0 / 52.0 %
component mole fractions: 68.047 / 31.953 % 8820

• properties ----------------------
molar mass: 73.75076 g/mol (0.162593 lb/mol) 8820

• normal boiling point ------------
bubble point temperature: -51.6 °C (-60.8 °F) 8401
dew point temperature: -51.5 °C (-60.7 °F) 8401
maximum temperature glide: 0.06 °C (0.1 °F) 8401
density, saturated liquid: 1357 kg/m³ (84.73 lb/ft³) 8401
density, saturated vapor: 4.24 kg/m³ (0.265 lb/ft³) 8401
specific volume, saturated liquid: 0.737 L/kg (0.0118 cf/lb) 8401
specific volume, saturated vapor: 235.8 L/kg (3.7776 cf/lb) 8401
heat of vaporization: 267.2 kJ/kg (114.9 Btu/lb) 8401
velocity of sound, saturated liquid: 840 m/s (2757 ft/s) 8401
velocity of sound, saturated vapor: 168 m/s (551 ft/s) 8401
viscosity, saturated liquid: 317 µPa·s (0.317 cp) 8401
viscosity, saturated vapor: 9.80 µPa·s (0.00980 cp) 8401
thermal conductivity, liquid: 0.1435 W/m·K (0.0829 Btu/hr·ft·°F) 8401
thermal conductivity, vapor: 0.0081 W/m·K (0.0047 Btu/hr·ft·°F) 8401

• normal pressure, 20 °C (68 °F) ------
density, vapor: 3.110 kg/m³ (0.1942 lb/ft³) 8401

• normal pressure, 21.1 °C (70 °F) ---
density, vapor: 3.098 kg/m³ (0.1934 lb/ft³) 8401

• 20 °C (68 °F) ----------------------
pressure, liquid (bubble point): 1439.4 kPa (208.77 psia) 8401
pressure, vapor (dew point): 1434.5 kPa (208.06 psia) 8401
density, saturated liquid: 1090 kg/m³ (68.03 lb/ft³) 8401
density, saturated vapor: 57.31 kg/m³ (3.577 lb/ft³) 8401
specific volume, saturated liquid: 0.918 L/kg (0.0147 cf/lb) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
specific volume, saturated vapor: 17.5 L/kg (0.2795 cf/lb) 8401
velocity of sound, saturated liquid: 467 m/s (1531 ft/s) 8401
velocity of sound, saturated vapor: 162 m/s (532 ft/s) 8401
viscosity, saturated liquid: 130 µPa·s (0.130 cp) 8401
viscosity, saturated vapor: 13.6 µPa·s (0.0136 cp) 8401
thermal conductivity, saturated liquid: 0.0997 W/m·K (0.0576 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01443 W/m·K (0.00834 Btu/hr·ft·°F) 8401

- 60 °C (140 °F) ------------------
  pressure, liquid (bubble point): 3823 kPa (554.5 psia) 8401
  pressure, vapor (dew point): 3815 kPa (553.3 psia) 8401
  heat of vaporization: 104.7 kJ/kg for liquid and vapor both at nominal composition (45.0 Btu/lb) 8401
  102.1 kJ/kg coexisting liquid and vapor at bubble-point pressure (43.9 Btu/lb) 8401

- critical point -----------------
  temperature: 69.9 °C (157.8 °F) 8401
  pressure: 4728 kPa (685.7 psia) 8401
  density: 556 kg/m³ (34.7 lb/ft³) 8401
  specific volume: 1.80 L/kg (0.0288 cf/lb) 8401

ENVIRONMENTAL
  ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
  (model-derived relative to R 11)
  GWP (global warming potential): 2400 mass-weighted average 9501
  relative to CO₂ for 100 yr integration
  HGWP (halocarbon GWP): 0.40 mass-weighted average 9501
  relative to R 11 for infinite integration period

SAFETY
  classification ---------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A2 and A1 8601
  emergency exposure limit ----------
  Refrigerant Concentration Limit (RCL): 56,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)
  flammability ---------------------
  LFL-UFL (flammability limits in air): none (nonflammable as tested)

PRODUCTION
  last year production allowed: unrestricted 8601

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
### R-32/125 (60.0/40.0)

**Common Use(s)**
Examined in early 1990s as a potential replacement for refrigerant 22, especially for residential air conditioners; this blend was a developmental version of AlliedSignal Genetron(R) AZ-20 (subsequently reformulated) and may be covered by U.S. patent 4,978,467; considered as a fire suppressant in aviation systems.

**Identifiers**
- **Common name(s):** R-32/125 (60/40)
- **R32/125 (60/40)**
- **R 32/125 (60/40)**
- **candidate for R-410 series**
- **HFC-32/HFC-125 (60/40)**
- **not HFC-32/125 (60/40)**

**ARI container color / Pantone number:** none, use light green grey/413 6601

**Physical**
- **Nominal blend formulation**
  - **Composition:** R-32/125
  - **Component weight fractions:** 60.0 / 40.0 %
  - **Component mole fractions:** 77.581 / 22.419 %
  - **Molar mass:** 67.26752 g/mol (0.148299 lb/mol)

- **Normal boiling point**
  - **Bubble point temperature:** -51.7 °C (-61.1 °F)
  - **Dew point temperature:** -51.7 °C (-61.1 °F)
  - **Maximum temperature glide:** 0.01 °C (0.0 °F)
  - **Density, saturated liquid:** 1321 kg/m³ (82.45 lb/cf)
  - **Density, saturated vapor:** 3.87 kg/m³ (0.242 lb/cf)
  - **Specific volume, saturated liquid:** 0.757 L/kg (0.0121 cf/lb)
  - **Specific volume, saturated vapor:** 258.4 L/kg (4.1390 cf/lb)
  - **Heat of vaporization:** 293.3 kJ/kg (126.1 Btu/lb)
  - **Velocity of sound, saturated liquid:** 869 m/s (2853 ft/s)
  - **Velocity of sound, saturated vapor:** 866 m/s (2840 ft/s)
  - **Viscosity, saturated liquid:** 302 μPa·s (0.302 cp)
  - **Viscosity, saturated vapor:** 9.74 μPa·s (0.00974 cp)
  - **Thermal conductivity, liquid:** 0.1550 W/m·K (0.0895 Btu/hr·ft·°F)
  - **Thermal conductivity, vapor:** 0.0081 W/m·K (0.0047 Btu/hr·ft·°F)

- **Normal pressure, 20 °C (68 °F)**
  - **Density, vapor:** 2.836 kg/m³ (0.1770 lb/cf)

- **Normal pressure, 21.1 °C (70 °F)**
  - **Density, vapor:** 2.825 kg/m³ (0.1763 lb/cf)

- **20 °C (68 °F)**
  - **Pressure, liquid (bubble point):** 1455.8 kPa (211.15 psia)
  - **Pressure, vapor (dew point):** 1453.6 kPa (210.83 psia)
  - **Density, saturated liquid:** 1062 kg/m³ (66.30 lb/cf)

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*See data limitations and notes on page 2*
density, saturated vapor: 52.83 kg/m³ (3.298 lb/cf) 8401
specific volume, saturated liquid: 0.942 L/kg (0.0151 cf/lb) 8401
specific volume, saturated vapor: 18.9 L/kg (0.3032 cf/lb) 8401
velocity of sound, saturated liquid: 494 m/s (1620 ft/s) 8401
velocity of sound, saturated vapor: 172 m/s (566 ft/s) 8401
viscosity, saturated liquid: 127 µPa·s (0.127 cp) 8401
viscosity, saturated vapor: 13.5 µPa·s (0.0135 cp) 8401
thermal conductivity, saturated vapor: 0.1093 W/m·K (0.0631 Btu/hr·ft²·°F) 8401
thermal conductivity, saturated liquid: 0.01450 W/m·K (0.00838 Btu/hr·ft²·°F) 8401

- 60 °C (140 °F) ----------------------
  pressure, liquid (bubble point): 3872 kPa (561.5 psia) 8401
  pressure, vapor (dew point): 3868 kPa (561.0 psia) 8401
  heat of vaporization: 120.0 kJ/kg for liquid and vapor both at nominal composition (51.6 Btu/lb) 8401
  vapor pressure of coexisting liquid at 118.2 kJ/kg (50.8 Btu/lb) 8401

- critical point ---------------------
  temperature: 71.6 °C (160.9 °F) 8401
  73.2 °C (163.8 °F) 3219
  pressure: 4974 kPa (721.4 psia) 8401
  5055 kPa (733.2 psia) 3219
  density: 479 kg/m³ (29.9 lb/cf) 3219
  532 kg/m³ (33.2 lb/cf) 8401
  specific volume: 1.88 L/kg (0.0301 cf/lb) 8401
  2.09 L/kg (0.0334 cf/lb) 3219

ENVIRONMENTAL

  ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
  (model-derived relative to R-11)
  GWP (global warming potential): 2050 mass-weighted average 9501
  relative to CO₂ for 100 yr integration
  HGWP (halocarbon GWP): 0.34 mass-weighted average DW
  relative to R-11 for infinite integration period

SAFETY

  classification ---------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A2 and A1 8601

  flammability ---------------------
  LFL-UFL (flammability limits in air): none (nonflammable as tested) 3219

PRODUCTION

  first commercial use as a refrigerant: not known to be commercialized
  last year production allowed: unrestricted 8C01
R-32/125 (75.0/25.0)

REFRIGERANT DATA SUMMARY

unassigned  R-32/125 (75.0/25.0)  see
azeotrope   binary blend  RDB#

COMMON USE(S)
under consideration circa 1999 as a potential replacement for refrigerant 22, especially for residential air conditioners; this blend may be covered by U.S. patent 4,978,467

IDENTIFIERS
common name(s):  R-32/125 (75.0/25.0)
                  R32/125 (75.0/25.0)
                  R 32/125 (75.0/25.0)
                  candidate for R-410 series
                  HFC-32/HFC-125 (75.0/25.0)
                  NOT HFC-32/125 (75.0/25.0)
ARI container color / Pantone number:  none, use light green grey/413 6601 with red / 185 band

PHYSICAL

• nominal blend formulation -------
  composition:  R-32/125
  component weight fractions:  75.0 / 25.0 %
  component mole fractions:   87.376 / 12.624 %
• properties ------------------------
  molar mass:  60.60769 g/mol (0.133617 lb/mol)
• normal boiling point --------------
  bubble point temperature:  -51.8 °C (-61.2 °F)
  dew point temperature:     -51.8 °C (-61.2 °F)
  maximum temperature glide: 0.00 °C (0.0 °F)
  density, saturated liquid:  1278 kg/m³ (79.78 lb/cf)
  density, saturated vapor:  3.49 kg/m³ (0.218 lb/cf)
  specific volume, saturated liquid: 0.783 L/kg (0.0125 cf/lb)
  specific volume, saturated vapor: 286.8 L/kg (4.5944 cf/lb)
  heat of vaporization: 326.2 kJ/kg (140.2 Btu/lb)
  velocity of sound, saturated liquid: 907 m/s (2976 ft/s)
  velocity of sound, saturated vapor: 189 m/s (619 ft/s)
  viscosity, saturated liquid: 289 µPa·s (0.289 cp)
  viscosity, saturated vapor: 9.61 µPa·s (0.00961 cp)
  thermal conductivity, liquid: 0.1686 W/m·K (0.0974 Btu/hr·ft·°F)
  thermal conductivity, vapor: 0.0082 W/m·K (0.0047 Btu/hr·ft·°F)
• normal pressure, 20 °C (68 °F) ----
  density, vapor: 2.554 kg/m³ (0.1595 lb/cf)
• normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 2.544 kg/m³ (0.1588 lb/cf)
• 20 °C (68 °F) ---------------------
  pressure, liquid (bubble point): 1467.7 kPa (212.87 psia)
  pressure, vapor (dew point): 1029.9 kPa (149.37 psia)
  density, saturated liquid: 1030 kg/m³ (64.29 lb/cf)
  density, saturated vapor: 47.82 kg/m³ (2.985 lb/cf)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
specific volume, saturated liquid: 0.971 L/kg (0.0156 cf/lb) 8401
specific volume, saturated vapor: 20.9 L/kg (0.3350 cf/lb) 8401
velocity of sound, saturated liquid: 528 m/s (1732 ft/s) 8401
velocity of sound, saturated vapor: 185 m/s (607 ft/s) 8401
viscosity, saturated liquid: 125 μPa·s (0.125 cp) 8401
viscosity, saturated vapor: 13.3 μPa·s (0.0133 cp) 8401
thermal conductivity, saturated liquid: 0.1209 W/m·K (0.0698 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01455 W/m·K (0.00841 Btu/hr·ft·°F) 8401

- 60 °C (140 °F) ---------------------
  pressure, liquid (bubble point): 3908 kPa (566.8 psia) 8401
  pressure, vapor (dew point): 3907 kPa (566.7 psia) 8401
  heat of vaporization: 140.0 kJ/kg for liquid and vapor both at nominal composition (60.2 Btu/lb) 8401
  139.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (60.1 Btu/lb) 8401

- critical point ---------------------
  temperature: 74.0 °C (165.1 °F) 8401
  pressure: 5274 kPa (764.9 psia) 8401
  density: 499 kg/m3 (31.2 lb/cf) 8401
  specific volume: 2.00 L/kg (0.0321 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): <0.00001 mass-weighted average (model-derived relative to R 11) 9501
GWP (global warming potential): 660 mass-weighted average relative to CO2 for 100 yr integration 9501
HGWPF (halocarbon GWP): 0.27 mass-weighted average relative to R 11 for infinite integration period DW

SAFETY

- classification ---------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A2 and A1 8601

- flammability ---------------------
  LFL-UFL (flammability limits in air): probably flammable

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized 8C01
last year production allowed: unrestricted 8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-32/125/134a (30.0/10.0/60.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned  R-32/125/134a (30.0/10.0/60.0)  see  RDB#
zeotrope  ternary blend  ----

COMMON USE(S)

under consideration as an alternative for refrigerant 22 both in new
equipment and as a service fluid; developmental formulation for both
DuPont Suva(R) AC9000 and ICI Klea(R) 66 (subsequently reformulated)

IDENTIFIERS

common name(s):  R-32/125/134a (30.0/10.0/60.0)
                  R32/125/134a (30/10/60)
                  R 32/125/134a (30/10/60)
                  candidate for R-407 series
                  HFC-32/HFC-125/HFC-134a
                  (30/10/60)
history name(s):  not HFC-32/125/134a (30/10/60) 2909
                  before 1996:
                  DuPont Suva(R) AC9000
                  ICI Klea(R) 66
ARI container color / Pantone number:  none, use light green grey/413 6601

PHYSICAL

* nominal blend formulation ------------
  composition:  R-32/125/134a
  component weight fractions:  30.0 / 10.0 / 60.0 %
  component mole fractions:  46.206 / 6.676 / 47.118 %
  molar mass:  80.125676 g/mol (0.176647 lb/mol)

* normal boiling point ---------------
  bubble point temperature:  -43.4 °C (-46.1 °F)
  dew point temperature:  -36.1 °C (-33.1 °F)
  maximum temperature glide:  7.26 °C (13.1 °F)
  density, saturated liquid:  1352 kg/m³ (84.42 lb/cf)
  density, saturated vapor:  4.29 kg/m³ (0.266 lb/cf)
  specific volume, saturated liquid:  0.739 L/kg (0.0118 cf/lb)
  specific volume, saturated vapor:  233.0 L/kg (3.7315 cf/lb)
  heat of vaporization:  267.8 kJ/kg (115.1 Btu/lb)
  velocity of sound, saturated liquid:  830 m/s (2725 ft/s)
  velocity of sound, saturated vapor:  165 m/s (541 ft/s)
  viscosity, saturated liquid:  360 µPa·s (0.360 cp)
  viscosity, saturated vapor:  9.47 µPa·s (0.00947 cp)
  thermal conductivity, liquid:  0.1318 W/m·K (0.0762 Btu/hr·ft°F)
  thermal conductivity, vapor:  0.0085 W/m·K (0.0049 Btu/hr·ft°F)

* normal pressure, 20 °C (68 °F) ----
  density, vapor:  3.389 kg/m³ (0.2116 lb/cf)

* normal pressure, 21.1 °C (70 °F) ---
  density, vapor:  3.776 kg/m³ (0.2107 lb/cf)

* 20 °C (68 °F) -----------------
  pressure, liquid (bubble point):  1024.7 kPa (148.62 psia)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure, vapor (dew point)</td>
<td>863.7 kPa (125.27 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Density, saturated liquid</td>
<td>1138 kg/m³ (71.04 lb/cf)</td>
<td>8401</td>
</tr>
<tr>
<td>Density, saturated vapor</td>
<td>34.11 kg/m³ (2.130 lb/cf)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated liquid</td>
<td>0.879 L/kg (0.0141 cf/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated vapor</td>
<td>29.3 L/kg (0.4696 cf/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Velocity of sound, saturated liquid</td>
<td>520 m/s (1706 ft/s)</td>
<td>8401</td>
</tr>
<tr>
<td>Velocity of sound, saturated vapor</td>
<td>164 m/s (538 ft/s)</td>
<td>8401</td>
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<tr>
<td>Viscosity, saturated liquid</td>
<td>162 µPa·s (0.162 cp)</td>
<td>8401</td>
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<tr>
<td>Viscosity, saturated vapor</td>
<td>12.3 µPa·s (0.0123 cp)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated liquid</td>
<td>0.0971 W/m·K (0.0561 Btu/hr·ft°F)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01294 W/m·K (0.00748 Btu/hr·ft°F)</td>
<td>8401</td>
</tr>
</tbody>
</table>

- 60 °C (140 °F) ---------------

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure, liquid (bubble point)</td>
<td>2743 kPa (397.9 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure, vapor (dew point)</td>
<td>2489 kPa (361.0 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Heat of vaporization</td>
<td>145.8 kJ/kg for liquid and vapor both at nominal composition (62.7 Btu/lb)</td>
<td>8401</td>
</tr>
<tr>
<td></td>
<td>136.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (58.9 Btu/lb)</td>
<td>8401</td>
</tr>
</tbody>
</table>

- Critical point -------------------

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>89.1 °C (192.3 °F)</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure</td>
<td>4873 kPa (706.8 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Density</td>
<td>490 kg/m³ (30.6 lb/cf)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume</td>
<td>2.04 L/kg (0.0327 cf/lb)</td>
<td>8401</td>
</tr>
</tbody>
</table>

**Environmental**

- ODP (ozone depletion potential): <0.00002 mass-weighted average 9501 (model-derived relative to R-11) <0.00031 mass-weighted average 9501 (semi-empirical relative to R-11)

- GWP (global warming potential): 1600 mass-weighted average 9501 relative to CO₂ for 100 yr integration

- HGWP (halocarbon GWP): 0.27 mass-weighted average DW relative to R-11 for infinite integration period

**Safety**

- Classification -----------------------
  - Safety group (ASHRAE Standard 34): none (no application pending) 8601 components are A2, A1, and A1 8601

- Emergency exposure limit ---------
  - Refrigerant Concentration Limit (RCL): 66,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

- Flammability -----------------------
  - LFL-UFL (flammability limits in air): none (nonflammable as tested) 3A63 worst fractionation flammable

**Production**

- First commercial use as a refrigerant: not known to be commercialized
- Last year production allowed: unrestricted 8C01

See data limitations and notes on page 2
R-32/125/143a (10.0/45.0/45.0)

R-32/125/143a (10.0/45.0/45.0)
R32/125/143a (10.0/45.0/45.0)
R 32/125/143a (10.0/45.0/45.0)
HFC-32/HFC-125/HFC-143a
(10/45/45)
not HFC=32/125/143a (10/45/45)
historical name(s): Elf Atochem Forane® FX-40 2A06

Identifiers

common name(s): R-32/125/143a (10.0/45.0/45.0)
R32/125/143a (10.0/45.0/45.0)
R 32/125/143a (10.0/45.0/45.0)
HFC-32/HFC-125/HFC-143a
(10/45/45)
not HFC=32/125/143a (10/45/45)
historical name(s): Elf Atochem Forane® FX-40 2A06

Physical

composition: R-32/125/143a
component weight fractions: 10.0 / 45.0 / 45.0 %
component mole fractions: 17.433 / 34.004 / 48.563 % 8820

properties

molar mass: 90.69381 g/mol (0.199946 lb/mol)

normal boiling point

bubble point temperature: -48.4 °C (-55.1 °F)
dew point temperature: -47.8 °C (-54.0 °F)
maximum temperature glide: 0.60 °C (1.1 °F)

density, saturated vapor: 5.06 kg/m3 (0.316 lb/cf)
heat of vaporization: 221.0 kJ/kg (95.0 Btu/lb)

25 °C (77 °F)

pressure, saturated vapor: 1410.0 kPa (204.50 psia)
density, saturated liquid: 1040 kg/m3 (64.93 lb/cf)

critical point

temperature: 71.3 °C (160.3 °F)
72.0 °C (161.6 °F)
pressure: 4050 kPa (587.4 psia)

Environmental

ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
(model-derived relative to R 11)

GWP (global warming potential): 4230 mass-weighted average relative to CO2 for 100 yr integration
9501

HGWP (halocarbon GWP): 0.74 mass-weighted average relative to R 11 for infinite integration period
0.89 relative to R 11 for infinite integration period

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
SAFETY

- classification -------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A2, A1, and A2 8601

- emergency exposure limit --------
  Refrigerant Concentration Limit (RCL): 29,000 ppm v/v (preliminary
  value under review, based on draft ASHRAE 34aa)

- flammability ---------------------
  LFL-UFL (flammability limits in air): none (nonflammable as tested) 4136
  flash point: Elf Atochem: nonflammable MSDS
  autodecomposition temperature: Elf Atochem: >427 °C (>800 °F) MSDS

- detection ------------------------
  appearance: Elf Atochem: clear, colorless MSDS
  odor: Elf Atochem: faint ethereal MSDS

PRODUCTION

last year production allowed: unrestricted 8C01
R-32/125/143a/134a (2.0/41.0/50.0/7.0)

UNASSIGNED

Zeotrope: tetrary blend

COMMON USE(S)

developmental blend (circa 1994-1996) as an alternative for refrigerant 502 in low-temperature refrigeration

IDENTIFIERS

common name(s): R-32/125/143a/134a (2/41/50/7)
8R2/125/143a/134a (2/41/50/7)
8R3/125/143a/134a (2/41/50/7)
HFC-32/HFC-125/HFC-143a/
HFC-134a (2/41/50/7)
not HFC-32/125/143a/134a 8601
(2/41/50/?)
historical name(s): Elf Atochem Forane(R) FX-48B MSDS

PHYSICAL

- nominal blend formulation ---------
  composition: R-32/125/143a/134a
  component weight fractions: 2.0 / 41.0 / 50.0 / 7.0 %
  component mole factions: 3.684/ 32.733/ 57.009/ 6.574 % 8820
- properties ------------------------
  molar mass: 95.82137 g/mol (0.211250 lb/mol) 8820
- normal boiling point -------------
  temperature: -45.8 °C (-50.4 °F) MSDS
  bubble point temperature: -46.8 °C (-52.2 °F) 8401
  dew point temperature: -45.2 °C (-49.3 °F) 8401
  maximum temperature glide: 1.61 °C (2.9 °F) 8401
  density, saturated liquid: 1307 kg/m3 (81.61 lb/cf) 8401
  density, saturated vapor: 5.36 kg/m3 (0.335 lb/cf) 8401
  specific volume, saturated liquid: 0.765 L/kg (0.0123 cf/lb) 8401
  specific volume, saturated vapor: 186.4 L/kg (2.9860 cf/lb) 8401
  heat of vaporization: 205.2 kJ/kg (88.2 Btu/lb) 8401
  velocity of sound, saturated liquid: 752 m/s (2466 ft/s) 8401
  velocity of sound, saturated vapor: 145 m/s (476 ft/s) 8401
  viscosity, saturated liquid: 330 µPa·s (0.330 cp) 8401
  viscosity, saturated vapor: 9.11 µPa·s (0.00911 cp) 8401
  thermal conductivity, liquid: 0.1009 W/m·K (0.0583 Btu/hr·ft·°F) 8401
  thermal conductivity, vapor: 0.0089 W/m·K (0.0052 Btu/hr·ft·°F) 8401
- normal pressure, 20 °C (68 °F)-----
  density, vapor: 4.055 kg/m3 (0.2531 lb/cf) 8401
- normal pressure, 21.1 °C (70 °F)---
  density, vapor: 4.038 kg/m3 (0.2521 lb/cf) 8401
- 20 °C (68 °F) ---------------------
  pressure, liquid (bubble point): 1111.3 kPa (161.18 psia) 8401
  pressure, vapor (dew point): 1080.6 kPa (156.73 psia) 8401
  density, saturated liquid: 1068 kg/m3 (66.68 lb/cf) 8401
specific volume, saturated liquid: 0.936 L/kg (0.0150 cf/lb) 8401
specific volume, saturated vapor: 18.3 L/kg (0.2929 cf/lb) 8401
velocity of sound, saturated liquid: 418 m/s (1370 ft/s) 8401
velocity of sound, saturated vapor: 138 m/s (453 ft/s) 8401
viscosity, saturated liquid: 136 μPa·s (0.136 cp) 8401
viscosity, saturated vapor: 12.2 μPa·s (0.0122 cp) 8401
thermal conductivity, saturated liquid: 0.0709 W/m·K (0.0410 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01515 W/m·K (0.00875 Btu/hr·ft·°F) 8401

- 60 °C (140 °F) ---------------------
  pressure, liquid (bubble point): 2905 kPa (421.3 psia) 8401
  pressure, vapor (dew point):
  heat of vaporization: 2869 kPa (416.1 psia) 8401
  85.8 kJ/kg for liquid and vapor both at nominal composition (36.9 Btu/lb) 8401
  84.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (36.2 Btu/lb) 8401

- critical point ---------------------
  temperature: 72.9 °C (163.3 °F) 8401
  pressure: 3809 kPa (552.4 psia) 8401
  density: 489 kg/m³ (30.5 lb/cf) 8401
  specific volume: 2.05 L/kg (0.0328 cf/lb) 8401

ENVIRONMENTAL
ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
(model-derived relative to R 11)
<0.00005 mass-weighted average 9501
(semi-empirical relative to R 11)
GWP (global warming potential): 4390 mass-weighted average 9501
relative to CO2 for 100 yr integration
HGWP (halocarbon GWP): 0.77 mass-weighted average DW
relative to R 11 for infinite integration period

SAFETY
- classification ---------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A2, A1, A2, A1 8601
- flammability ---------------------
  LFL-UFL (flammability limits in air):
  flash point: none (nonflammable as tested) MSDS
  autodecomposition temperature: Elf Atochem: nonflammable MSDS
  Elf Atochem: >427 °C (>800 °F) MSDS
- detection ----------------------
  appearance: Elf Atochem: clear, colorless MSDS
  odor: Elf Atochem: faint ethereal MSDS

PRODUCTION
first commercial use as a refrigerant: circa 1994
last year production allowed: unrestricted 8C01
R-32/125/143a/134a (10.0/33.0/36.0/21.0)

----------------- REFRIGERANT DATA SUMMARY -----------------
unassigned R-32/125/143a/134a (10.0/33.0/36.0/21.0) see
zeotrope tetrany blend RDB#

COMMON USE(S)
formerly marketed (circa 1994-1996), primarily in Germany, as an
alternative for refrigerants 22 and 502 in medium- and
low-temperature refrigeration

IDENTIFIERS
common name(s): R-32/125/143a/134a
(10/33/36/21)
R32/125/143a/134a
(10/33/36/21)
R 32/125/143a/134a
(10/33/36/21)
HFC-32/HFC-125/HFC-143a/
HFC-134a (10/33/36/21)
not HFC-32/125/143a/134a
historical name(s): Hoechst Reclin(R) HX4
Solvay Solkane(R) HX4
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL
- nominal blend formulation ------------
  composition: R-32/125/143a/134a
  component weight fractions: 10.0 / 33.0 / 36.0 / 21.0 %
  component mole fractions: 17.45 / 24.965 / 38.894 / 18.688 8820
- properties ---------------------------
  molar mass: 90.79703 g/mol (0.200173 lb/mol)
- normal boiling point ----------------
  bubble point temperature: -49.4 °C (-56.9 °F)
  maximum temperature glide: 5.00 °C (9.0 °F)
  heat of vaporization: 181.0 kJ/kg (77.8 Btu/lb)
- 20 °C (68 °F) ----------------------
  pressure, liquid (bubble point): 1105.1 kPa (160.28 psia)
  pressure, vapor (dew point): 1021.7 kPa (148.19 psia)
  density, saturated liquid: 1092 kg/m3 (68.17 lb/cf)
- 60 °C (140 °F) ---------------------
  pressure, liquid (bubble point): 2891 kPa (419.3 psia)
  pressure, vapor (dew point): 2790 kPa (404.7 psia)
- critical point ---------------------
  temperature: 77.5 °C (171.5 °F)
  pressure: 4010 kPa (581.6 psia)
  density: 490 kg/m3 (30.6 lb/cf)

ENVIRONMENTAL
ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
(model-derived relative to R
11)
<0.00012 mass-weighted average 9501
GWP (global warming potential): 3620 mass-weighted average relative to CO2 for 100 yr integration

HGWP (halocarbon GWP): 0.64 mass-weighted average relative to R 11 for infinite integration period

SAFETY

- classification -----------------
  safety group (ASHRAE Standard 34): none (no application pending) components are A2, A1, A2, A1

- flammability -----------------
  LFL-UFL (flammability limits in air): none (nonflammable as tested)

PRODUCTION

first commercial use as a refrigerant: circa 1994, ceased circa 1996
last year production allowed: unrestricted
R-32/125/290/134a (20.0/55.0/5.0/20.0)

---------------------------- REFRIGERANT DATA SUMMARY -----------------------------

unassigned  R-32/125/290/134a (20.0/55.0/5.0/20.0) see RDB#
zeotrope   tetrary blend

COMMON USE(S)
under consideration as an alternative for refrigerant 22 both in new
equipment and as a service fluid

IDENTIFIERS
common name(s):  R-32/125/290/134a (20/55/5/20)  RDB# 199
R32/125/290/134a (20/55/5/20)  R32/125/290/134a (20/55/5/20)  HFC-32/HFC-125/HC-290/HFC-134a
(20/55/5/20)  not HFC-32/125/290/134a

PHYSICAL
• nominal blend formulation ---------
  composition:   R-32/125/290/134a
  component weight fractions: 20.0 / 55.0 / 5.0 / 20.0 %
  component mole fractions:  33.369/ 39.775/ 9.842/ 17.014 8820 %

• properties ------------------------
  molar mass:  86.79777 g/mol (0.191356 lb/mol)  8820

• critical point ------------------
  temperature:  80.3 °C (176.5 °F)

ENVIRONMENTAL
  ODP (ozone depletion potential):  <0.00002 mass-weighted average 9501
  (model-derived relative to R
  11)
  <0.00012 mole-weighted average 9501
  (semi-empirical relative to R
  11)

  GWP (global warming potential):  1930 mass-weighted average 2590
  relative to CO2 for 100 yr
  integration

  HGWP (halocarbon GWP):  0.44 mass-weighted average  Dm
  relative to R 11 for infinite
  integration period

SAFETY
• classification ---------------------
  safety group (ASHRAE Standard 34):  none (no application pending)  8601
  components are A2,A1,A3,andA1  8601

PRODUCTION
  first commercial use as a refrigerant:  not known to be commercialized
  last year production allowed:  unrestricted  8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-32/134a (25.0/75.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned  R-32/134a (25.0/75.0)  see
zeotrope     binary blend  RDB#

COMMON USE(S)
under consideration as a replacement for refrigerant 22

IDENTIFIERS
common name(s):  R-32/134a (25.0/75.0)
R32/134a (25.0/75.0)
R 32/134a (25.0/75.0)
HFC-32/HFC-134a (25/75)
HFC-32/HFC-134a (25/75)

PHYSICAL
- nominal blend formulation ------
  composition:  R-32/134a
  component weight fractions:  25.0 / 75.0 %
  component mole fractions:  39.531 / 60.469 %  8820

- properties ---------------------
  molar mass:  82.26224 g/mol (0.181357 lb/mol)  8820
  normal boiling point ----------
    bubble point temperature:  -40.3 °C (-40.6 °F)  8401
    dew point temperature:  -33.2 °C (-27.8 °F)  8401
    maximum temperature glide:  7.06 °C (12.7 °F)  8401
    density, saturated liquid:  1350 kg/m3 (84.27 lb/cf)  8401
    density, saturated vapor:  4.36 kg/m3 (0.272 lb/cf)  8401
    specific volume, saturated liquid:  0.741 L/kg (0.0119 cf/lb)  8401
    specific volume, saturated vapor:  229.6 L/kg (3.6778 cf/lb)  8401
    heat of vaporization:  265.0 kJ/kg (113.9 Btu/lb)  8401
    velocity of sound, saturated liquid:  824 m/s (2704 ft/s)  8401
    velocity of sound, saturated vapor:  163 m/s (535 ft/s)  8401
    viscosity, saturated liquid:  367 µPa·s (0.367 cp)  8401
    viscosity, saturated vapor:  9.66 µPa·s (0.00966 cp)  8401
    thermal conductivity, liquid:  0.1281 W/m·K (0.0740 Btu/hr·ft·°F)  8401
    thermal conductivity, vapor:  0.0086 W/m·K (0.0050 Btu/hr·ft·°F)  8401

- normal pressure, 20 °C (68 °F) -----
  density, vapor:  3.483 kg/m3 (0.2174 lb/cf)  8401

- normal pressure, 21.1 °C (70 °F) ----
  density, vapor:  3.469 kg/m3 (0.2166 lb/cf)  8401

- 20 °C (68 °F) -----------------------
  pressure, liquid (bubble point):  914.4 kPa (132.62 psia)  8401
  pressure, vapor (dew point):  770.8 kPa (111.80 psia)  8401
  density, saturated liquid:  1150 kg/m3 (71.82 lb/cf)  8401
  density, saturated vapor:  30.85 kg/m3 (1.926 lb/cf)  8401
  specific volume, saturated liquid:  0.869 L/kg (0.0139 cf/lb)  8401
  specific volume, saturated vapor:  32.4 L/kg (0.5192 cf/lb)  8401
  velocity of sound, saturated liquid:  532 m/s (1746 ft/s)  8401
  velocity of sound, saturated vapor:  163 m/s (534 ft/s)  8401
  viscosity, saturated liquid:  172 µPa·s (0.172 cp)  8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
Refrigerant Database

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viscosity, saturated vapor</td>
<td>12.0 μPa·s (0.0120 cp)</td>
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<tr>
<td>Thermal conductivity, saturated liquid</td>
<td>0.0961 W/m·K (0.0555 Btu/hr·ft²·F)</td>
</tr>
<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01285 W/m·K (0.00742 Btu/hr·ft²·F)</td>
</tr>
<tr>
<td>Pressure, liquid (bubble point)</td>
<td>2478 kPa (359.4 psia)</td>
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<tr>
<td>Pressure, vapor (dew point)</td>
<td>2243 kPa (325.3 psia)</td>
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<tr>
<td>Heat of vaporization</td>
<td>151.6 kJ/kg for liquid and vapor both at nominal composition (65.2 Btu/lb) 142.3 kJ/kg coexisting liquid and vapor at bubble-point pressure (61.2 Btu/lb)</td>
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<tr>
<td>Critical point</td>
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</tr>
<tr>
<td>Temperature</td>
<td>93.7 °C (200.7 °F)</td>
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<tr>
<td>Pressure</td>
<td>4830 kPa (700.5 psia)</td>
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<tr>
<td>Density</td>
<td>481 kg/m³ (30.0 lb/ft³)</td>
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<tr>
<td>Specific volume</td>
<td>2.08 L/kg (0.0333 lb/ft³)</td>
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</table>

Environmental

ODP (ozone depletion potential): <0.00002 mass-weighted average 9501 (model-derived relative to R 11) <0.00038 mass-weighted average 9501 (semi-empirical relative to R 11)

GWP (global warming potential): 1420 mass-weighted average relative to CO₂ for 100 yr integration

HGWP (halocarbon GWP): 0.24 mass-weighted average DW relative to R 11 for infinite integration period

Safety

Classification

Safety group (ASHRAE Standard 34): none (no application pending) components are A2 and A1

Long-term occupational limit

AIHA WEEL (workplace envl exp limit): components are both 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk

Emergency exposure limit

Refrigerant Concentration Limit (RCL): 67,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)

Flammability

LFL-UFL (flammability limits in air): worst fractionation flammable

Production

First commercial use as a refrigerant: not known to be commercialized

Last year production allowed: unrestricted
R-32/134a (30.0/70.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-32/134a (30.0/70.0)
zotrope binary blend

COMMON USE(S)
under consideration, especially in Japan, as an alternative for refrigerant 22 both in new equipment and as a service fluid

IDENTIFIERS
common name(s): R-32/134a (30.0/70.0)
R32/134a (30.0/70.0)
R 32/134a (30.0/70.0)
HFC-32/HFC-134a (30/70)
not HFC-32/134a (30/70)
trade name(s): Daikin Daiflon(R) 32/134a
ARI container color / Pantone number: none, use light green grey/413 6601 with red / 185 band

PHYSICAL
• nominal blend formulation -------
  composition: R-32/134a
  component weight fractions: 30.0 / 70.0 %
  component mole fractions: 45.668 / 54.332 %
• properties ------------------------
  molar mass: 79.19347 g/mol (0.174592 lb/mol)
  normal boiling point --------------
  bubble point temperature: -41.8 °C (-43.3 °F)
  dew point temperature: -34.6 °C (-30.2 °F)
  maximum temperature glide: 7.25 °C (13.0 °F)
  density, saturated liquid: 1341 kg/m³ (83.73 lb/cf)
  density, saturated vapor: 4.22 kg/m³ (0.263 lb/cf)
  specific volume, saturated liquid: 0.746 L/kg (0.0119 cf/lb)
  specific volume, saturated vapor: 237.2 L/kg (3.8001 cf/lb)
  heat of vaporization: 273.4 kJ/kg (117.5 Btu/lb)
  velocity of sound, saturated liquid: 836 m/s (2742 ft/s)
  velocity of sound, saturated vapor: 166 m/s (546 ft/s)
  viscosity, saturated liquid: 360 µPa·s (0.360 cp)
  viscosity, saturated vapor: 9.67 µPa·s (0.00967 cp)
  thermal conductivity, liquid: 0.1325 W/m·K (0.0766 Btu/hr·ft·°F)
  thermal conductivity, vapor: 0.0086 W/m·K (0.0050 Btu/hr·ft·°F)
  normal pressure, 20 °C (68 °F) ----
  density, vapor: 3.351 kg/m³ (0.2092 lb/cf)
  normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 3.330 kg/m³ (0.2084 lb/cf)
  20 °C (68 °F) -----------------------
  pressure, liquid (bubble point): 968.1 kPa (140.41 psia)
  pressure, vapor (dew point): 813.3 kPa (117.96 psia)
  density, saturated liquid: 1137 kg/m³ (70.97 lb/cf)
  density, saturated vapor: 31.50 kg/m³ (1.966 lb/cf)
  specific volume, saturated liquid: 0.880 L/kg (0.0141 cf/lb)
specific volume, saturated vapor: 31.8 L/kg (0.5086 cf/lb) 8401
velocity of sound, saturated liquid: 534 m/s (1752 ft/s) 8401
velocity of sound, saturated vapor: 166 m/s (544 ft/s) 8401
viscosity, saturated liquid: 166 μPa·s (0.166 cp) 8401
viscosity, saturated vapor: 12.1 μPa·s (0.0121 cp) 8401
thermal conductivity, saturated liquid: 0.0989 W/m·K (0.0571 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01285 W/m·K (0.00742 Btu/hr·ft·°F) 8401

- 60 °C (140 °F) --------------------
  pressure, liquid (bubble point): 2609 kPa (378.4 psia) 8401
  pressure, vapor (dew point): 2358 kPa (342.0 psia) 8401
  heat of vaporization: 153.8 kJ/kg for liquid and vapor both at nominal composition (66.1 Btu/lb) 8401
  127.7 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.9 Btu/lb) 8401

- critical point -------------------
  temperature: 92.4 °C (198.3 °F) 8401
  pressure: 4942 kPa (716.8 psia) 8401
  density: 477 kg/m³ (29.8 lb/cf) 8401
  specific volume: 2.10 L/kg (0.0336 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
(model-derived relative to R 11)
<0.00035 mass-weighted average 9501
(semi-empirical relative to R 11)

GWP (global warming potential): 1380 mass-weighted average 9501
relative to CO2 for 100 yr integration

HGWP (halocarbon GWP): 0.24 mass-weighted average DW
relative to R 11 for infinite integration period

SAFETY

- classification -------------------
  components are A2 and A1 8601

- long-term occupational limit ------
  AIHA WEEL (workplace envl exp limit): components are both 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk 9503
  Daikin AEL: 1,000 ppm v/v TWA MSDS for 8 hr/day and 40 hr/wk

- flammability ---------------------
  LFL-UFL (flammability limits in air): worst fractionation flammable

- detection -----------------------
  appearance: colorless, transparent

PRODUCTION

first commercial use as a refrigerant: projected: 1998-2000
last year production allowed: unrestricted 8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-32/134a (33.8/66.2)

unassigned R-32/134a (33.8/66.2) see RDB#
zotrope binary blend ----

COMMON USE(S)
under consideration as an alternative for refrigerant 22

IDENTIFIERS
common name(s): R-32/134a (33.8/66.2)
R32/134a (33.8/66.2)
R 32/134a (33.8/66.2)
HFC-32/HFC-134a (33.8/66.2)
not HFC-32/134a (33.8/66.2)
R-32/134a (33.7695/66.2305)
R-32/134a (33.77/66.23)
R-32/134a (34/66)
R-32/134a (50/50 molar)
R-32/134a equimolar

ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL
nominal blend formulation ----------
composition: R-32/134a
component weight fractions: 33.8 / 66.2 %
component mole fractions: 50.000 / 50.000 % 8820

properties -----------------------------
molar mass: 77.02714 g/mol (0.169816 lb/mol) 8820

normal boiling point -----------------
bubble point temperature: -42.8 °C (-45.1 °F) 8401
dew point temperature: -35.6 °C (-32.0 °F) 8401
maximum temperature glide: 7.26 °C (13.1 °F) 8401
density, saturated liquid: 1335 kg/m³ (83.32 lb/cf) 8401
density, saturated vapor: 4.12 kg/m³ (0.257 lb/cf) 8401
specific volume, saturated liquid: 0.749 L/kg (0.0120 cf/lb) 8401
specific volume, saturated vapor: 243.0 L/kg (3.8922 cf/lb) 8401
heat of vaporization: 279.6 kJ/kg (120.2 Btu/lb) 8401
velocity of sound, saturated liquid: 844 m/s (2770 ft/s) 8401
velocity of sound, saturated vapor: 169 m/s (554 ft/s) 8401
viscosity, saturated liquid: 354 µPa·s (0.354 cp) 8401
viscosity, saturated vapor: 9.68 µPa·s (0.00968 cp) 8401
thermal conductivity, liquid: 0.1359 W/m·K (0.0785 Btu/hr·ft·°F) 8401
thermal conductivity, vapor: 0.0085 W/m·K (0.0049 Btu/hr·ft·°F) 8401

normal pressure, 20 °C (68 °F) ----- density, vapor: 3.258 kg/m³ (0.2034 lb/cf) 8401
density, vapor: 3.245 kg/m³ (0.2026 lb/cf) 8401

normal pressure, 21.1 °C (70 °F) --- density, vapor: 3.245 kg/m³ (0.2026 lb/cf) 8401

20 °C (68 °F) ------------------------ pressure, liquid (bubble point): 1006.6 kPa (146.00 psia) 8401
pressure, vapor (dew point): 846.2 kPa (122.72 psia) 8401
density, saturated liquid: 1127 kg/m³ (70.34 lb/cf) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
**Density, Saturated Vapor**: 31.99 kg/m³ (1.997 lb/cf)  8401

**Specific Volume, Saturated Liquid**: 0.888 L/kg (0.0142 cf/lb)  8401

**Specific Volume, Saturated Vapor**: 31.3 L/kg (0.5008 cf/lb)  8401

**Velocity of Sound, Saturated Liquid**: 536 m/s (1758 ft/s)  8401

**Velocity of Sound, Saturated Vapor**: 168 m/s (552 ft/s)  8401

**Viscosity, Saturated Liquid**: 163 μPa·s (0.163 cp)  8401

**Viscosity, Saturated Vapor**: 12.2 μPa·s (0.0122 cp)  8401

**Thermal Conductivity, Saturated Liquid**: 0.1011 W/m·K (0.0584 Btu/hr·ft²·°F)  8401

**Thermal Conductivity, Saturated Vapor**: 0.01286 W/m·K (0.00743 Btu/hr·ft²·°F)  8401

**Critical Point**

- Pressure, Liquid (Bubble Point): 2704 kPa (392.1 psia)  8401
- Pressure, Vapor (Dew Point): 2446 kPa (354.8 psia)  8401
- Heat of Vaporization: 155.5 kJ/kg for liquid and vapor both at nominal composition (66.8 Btu/lb)  8401
- 145.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (62.6 Btu/lb)  8401

**Environmental**

- ODP (Ozone Depletion Potential): <0.00001 mass-weighted average 9501
  (model-derived relative to R 11)  8401
- GWP (Global Warming Potential): 1360 mass-weighted average 9501
  relative to CO2 for 100 yr integration 8401
- HGWP (Halocarbon GWP): 0.23 mass-weighted average 8401
  relative to R 11 for infinite integration period 8401

**Safety**

- Classification
  - Safety Group (ASHRAE Standard 34): none (no application pending) 8601
    - Components are A2 and A1 8601
  - Long-term Occupational Limit
    - AIHA WEEL (Workplace Envl Exp Limit): components are both 1000 ppm 9503
      - v/v TWA for 8 hr/day and 40 hr/wk 8401
  - Detection
    - Appearance: colorless, transparent 8401

**Production**

- First Commercial Use as a Refrigerant: not known to be commercialized 8C01
- Last Year Production Allowed: unrestricted 8C01
R-32/152a

--- REFRIGERANT DATA SUMMARY ---

unassigned: R-32/152a (formulation not disclosed)
zeotrope: binary blend

COMMON USE(S)
used as a replacement for refrigerant 12 in refrigerator-freezers in China

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from the Zhejiang Chemical Industry Research Institute (Hangzhou, Zhejiang, Peoples Republic of China) and refrigerant manufacturers. The blend formulation has not been disclosed and data inconsistencies preclude precise determination; it appears to be approximately R-32/152a (5.5/94.5).

IDENTIFIERS
common name(s): R-32/152a (??/??)
                R32/152a (??/??)
                R 32/152a (??/??)
trade name(s): Zhejiang (China) ZC-3 8B15

PHYSICAL
nominal blend formulation
composition: R-32/152a
component mole fractions: 6.9 / 93.1 estimated % 8820
properties
molar mass: 65.1 estimated g/mol (0.143521 8820 lb/mol)

ENVIRONMENTAL
ODP (ozone depletion potential): 0.000 estimated mass average 9501 (model-derived relative to R 11)
0.000 estimated mass average 9501 (semi-empirical relative to R 11)
GWP (global warming potential): 230 estimated mass average relative to CO2 for 100 yr integration

SAFETY
classification
safety group (ASHRAE Standard 34): none (no application pending) 8601 (components are A2 and A2 8601
flammability
LFL-UFL (flammability limits in air): probably flammable

PRODUCTION
first commercial use as a refrigerant: circa 1995 in China 8B15
last year production allowed: unrestricted 8C01
R-32/227ea (35.0/65.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-32/227ea (35.0/65.0) see RDB#
zeotrope binary blend ----

COMMON USE(S)
under consideration as an alternative for refrigerant 22

The following information is preliminary and may be incomplete or incorrect. Data on this blend are available from Great Lakes Chemicals (Lafayette, IN, USA) and other refrigerant manufacturers.

IDENTIFIERS
common name(s): R-32/227ea (35.0/65.0)
R32/227ea (35.0/65.0)
R 32/227ea (35.0/65.0)
trade name(s): Great Lakes Chemical FM series

PHYSICAL
nominal blend formulation ---------
composition: R-32/227ea
component weight fractions: 35.0 / 65.0 %
component mole fractions: 62.935 / 37.065 % 8820

properties ------------------------
molar mass: 95.76166 g/mol (0.211118 lb/mol) 8820

normal boiling point ------------
bubble point temperature: -45.8 °C (-50.5 °F) 8401
dew point temperature: -33.9 °C (-28.9 °F) 8401
maximum temperature glide: 11.96 °C (21.5 °F) 8401
density, saturated liquid: 1432 kg/m³ (89.37 lb/cf) 8401
density, saturated vapor: 5.04 kg/m³ (0.314 lb/cf) 8401
specific volume, saturated liquid: 0.699 L/kg (0.0112 cf/lb) 8401
specific volume, saturated vapor: 198.6 L/kg (3.1809 cf/lb) 8401
heat of vaporization: 228.3 kJ/kg (98.1 Btu/lb) 8401
velocity of sound, saturated liquid: 727 m/s (2386 ft/s) 8401
velocity of sound, saturated vapor: 150 m/s (493 ft/s) 8401
viscosity, saturated liquid: 10.30 μPa⋅s (0.01030 cp) 8401
viscosity, saturated vapor: 377 μPa⋅s (0.377 cp) 8401
thermal conductivity, liquid: 0.1122 W/m⋅K (0.0648 Btu/hr⋅ft⋅°F) 8401
thermal conductivity, vapor: 0.0086 W/m⋅K (0.0050 Btu/hr⋅ft⋅°F) 8401

normal pressure, 20 °C (68 °F) ----
density, vapor: 4.014 kg/m³ (0.2506 lb/cf) 8401
density, liquid: 3.998 kg/m³ (0.2496 lb/cf) 8401

20 °C (68 °F) ---------------------
pressure, liquid (bubble point): 1090.3 kPa (158.13 psia) 8401
pressure, vapor (dew point): 643.4 kPa (122.33 psia) 8401
density, saturated liquid: 1185 kg/m³ (73.96 lb/cf) 8401
density, saturated vapor: 39.79 kg/m³ (2.484 lb/cf) 8401
specific volume, saturated liquid: 0.844 L/kg (0.0135 cf/lb) 8401
specific volume, saturated vapor: 25.1 L/kg (0.4026 cf/lb) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
velocity of sound, saturated liquid: 431 m/s (1415 ft/s) 8401
velocity of sound, saturated vapor: 147 m/s (483 ft/s) 8401
viscosity, saturated liquid: 156 \mu Pa \cdot s (0.156 cp) 8401
viscosity, saturated vapor: 12.9 \mu Pa \cdot s (0.0129 cp) 8401
thermal conductivity, saturated liquid: 0.0825 W/m\cdot K (0.0477 Btu/hr\cdot ft\cdot °F) 8401
thermal conductivity, saturated vapor: 0.01256 W/m\cdot K (0.00726 Btu/hr\cdot ft\cdot °F) 8401

- 60 °C (140 °F) ---------------
  pressure, liquid (bubble point): 2835 kPa (411.2 psia) 8401
  pressure, vapor (dew point): 2472 kPa (358.6 psia) 8401
  heat of vaporization: 109.9 kJ/kg for liquid and vapor both at nominal composition (47.2 Btu/lb) 8401
  96.6 kJ/kg coexisting liquid and vapor at bubble-point pressure (41.5 Btu/lb) 8401

- critical point ------------------
  temperature: 87.1 °C (188.7 °F) 8401
  pressure: 4720 kPa (684.6 psia) 8401
  density: 514 kg/m³ (32.1 lb/ft³) 8401
  specific volume: 1.95 L/kg (0.0312 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative to R 11) 8501
GWP (global warming potential): 2770 mass-weighted average relative to CO2 for 100 yr integration 9501
HGWP (halocarbon GWP): 0.50 mass-weighted average relative to R 11 for infinite integration period 8101

SAFETY

- classification -------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
### R-32/600 (95.0/5.0)

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<th>unassigned</th>
<th>R-32/600 (95.0/5.0)</th>
<th>see RDB#</th>
</tr>
</thead>
<tbody>
<tr>
<td>azeotrope</td>
<td>binary blend</td>
<td>--------</td>
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</tbody>
</table>

**COMMON USE(S)**

under consideration, especially in Japan, circa 1999 as an alternative for refrigerant 22 both in new equipment and as a service fluid

**IDENTIFIERS**

- **common name(s):** R-32/600 (95.0/5.0)
- **R-32/600 (95.0/5.0)**
- **R 32/600 (95.0/5.0)**
- **HFC-32/HC-600 (95.0/5.0)**
- **not HFC-32/600 (95.0/5.0)**
- **R-32/600 (95/5)**

**ARI container color / Pantone number:** none, use light green grey/413 6601 with red / 185 band

**PHYSICAL**

- **nominal blend formulation ---------**
  - **composition:** R-32/600
  - **component weight fractions:** 95.0 / 5.0 %
  - **component mole fractions:** 95.501 / 4.499 %
- **properties -------------------------**
  - **molar mass:** 52.29777 g/mol (0.115297 lb/mol)
  - **normal boiling point ---------------**
    - **bubble point temperature:** -51.4 °C (-60.6 °F)
    - **dew point temperature:** -51.3 °C (-60.3 °F)
    - **maximum temperature glide:** 0.17 °C (0.3 °F)
    - **density, saturated liquid:** 1155 kg/m³ (72.10 lb/cf)
    - **density, saturated vapor:** 3.00 kg/m³ (0.187 lb/cf)
    - **specific volume, saturated liquid:** 0.866 L/kg (0.0139 cf/lb)
    - **specific volume, saturated vapor:** 333.2 L/kg (5.3377 cf/lb)
    - **heat of vaporization:** 377.4 kJ/kg (162.3 Btu/lb)
    - **velocity of sound, saturated liquid:** 964 m/s (3164 ft/s)
    - **velocity of sound, saturated vapor:** 206 m/s (674 ft/s)
    - **viscosity, saturated liquid:** 274 µPa·s (0.274 cp)
    - **viscosity, saturated vapor:** 9.03 µPa·s (0.00903 cp)
    - **thermal conductivity, liquid:** 0.1816 W/m·K (0.1049 Btu/hr·ft·°F)
    - **thermal conductivity, vapor:** 0.0083 W/m·K (0.0048 Btu/hr·ft·°F)
  - **normal pressure, 20 °C (68 °F) ------**
    - **density, vapor:** 2.204 kg/m³ (0.1376 lb/cf)
    - **pressure, liquid (bubble point):** 1443.0 kPa (209.29 psia)
    - **pressure, vapor (dew point):** 1420.1 kPa (205.97 psia)
    - **density, saturated liquid:** 936 kg/m³ (58.40 lb/cf)
    - **density, saturated vapor:** 39.47 kg/m³ (2.464 lb/cf)
  - **normal pressure, 21.1 °C (70 °F) ---**
    - **density, vapor:** 2.195 kg/m³ (0.1371 lb/cf)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
specific volume, saturated liquid: 1.069 L/kg (0.0171 cf/lb) 8401
specific volume, saturated vapor: 25.3 L/kg (0.4058 cf/lb) 8401
velocity of sound, saturated liquid: 577 m/s (1893 ft/s) 8401
velocity of sound, saturated vapor: 203 m/s (667 ft/s) 8401
viscosity, saturated liquid: 122 µPa·s (0.0122 cp) 8401
viscosity, saturated vapor: 12.4 µPa·s (0.0124 cp) 8401
thermal conductivity, saturated liquid: 0.1321 W/m·K (0.0763 Btu/hr·ft°F) 8401
thermal conductivity, saturated vapor: 0.01460 W/m·K (0.00844 Btu/hr·ft°F) 8401

- 60 °C (140 °F) ----------------
piece of cake, liquid (bubble point): 3828 kPa (555.2 psia) 8401
pressure, vapor (dew point): 3783 kPa (548.7 psia) 8401
heat of vaporization: 173.7 kJ/kg for liquid and vapor both at nominal composition (74.7 Btu/lb) 8401
172.3 kJ/kg coexisting liquid and vapor at bubble-point pressure (74.1 Btu/lb) 8401

- critical point ----------------
temperature: 81.4 °C (178.6 °F) 8401
pressure: 5991 kPa (868.9 psia) 8401
density: 407 kg/m³ (25.4 lb/ft³) 8401
specific volume: 2.46 L/kg (0.0394 cf/lb) 8401

ENVIRONMENTAL
ODP (ozone depletion potential): 0.000 mass-weighted average (model-derived relative to R 11) 9501
GWP (global warming potential): 840 mass-weighted average relative to CO₂ for 100 yr integration 9501
HGWG (halocarbon GWP): 0.13 mass-weighted average DW relative to R 11 for infinite integration period 9501

SAFETY
- classification ----------------
safety group (ASHRAE Standard 34): none (no application pending) 8601
components are A2 and A3 8601

- long-term occupational limit -------
ACGIH TLV-TWA (time-weighted average): components: R-600 is 800 ppm v/v TWA for 8 hr/day and 40 hr/wk 9504
AIHA WEEL (workplace envl exp limit): components: R-32 is 1000 ppm v/v TWA for 8 hr/day and 40 hr/wk 5C14

- flammability ---------------------
LFL-UFL (flammability limits in air): flammable 9834
appearance: colorless, transparent

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized
last year production allowed: unrestricted 8C01
R-41/744

------------------------ REFRIGERANT DATA SUMMARY ------------------------

unassigned R-41/744 (various compositions) see RDB#
zeotrope binary blend ----

COMMON USE(S)
under consideration to replace refrigerants 13 and 503

IDENTIFIERS
common name(s): R-41/744 (??/??)
               HFC-41/C-744 (??/??)

ENVIRONMENTAL
ODP (ozone depletion potential): 0.000 mass-weighted average 5301
(model-derived relative to R 11)

SAFETY
classification -------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized
last year production allowed: unrestricted 8C01
R-123/141b/602/?polymers? (40.0/50.0/5.0/5.0)

--- REFRIGERANT DATA SUMMARY ---

Common Use(s)
not known to be used as a refrigerant; replacement for fluorochemical 11 as a blowing agent for rigid urethane, spray, froth, and pour foam systems

The following information is preliminary and may be incomplete or incorrect. Additional data on this blend may be available from InterCool Energy Corporation (ICE, Latham, NY, USA, a subsidiary of Intermagnetics General Corporation, IGC, Allentown, PA, USA) and other refrigerant manufacturers. This blend may be covered by pending patents. The fourth component is described as a proprietary polymer.

Identifiers
common name(s): R-123/141b/602/??? (40/50/5/?)
R123/141b/602/??? (40/50/5/?)
R 123/141b/602/??? (40/50/5/?)
HCFC-123/HCFC-141b/HC-602/??? not HCFC-123/141b/602/??? (40/50/5/?)
trade name(s): IGC/ICE FRIGC(R) FR-11(TM) MSDS
ARI container color / Pantone number: none, use light green grey/413 6601

Physical
normal boiling point temperature: IGC/ICE: >30 °C (>86 °F) MSDS

Environmental
ODP (ozone depletion potential): IGC/ICE: 0.07 (model-derived mfr relative to R 11)
GWP (global warming potential): IGC/ICE: 350 relative to CO2 mfr for 100 yr integration

Safety
classification safety group (ASHRAE Standard 34): none (no application pending) 8601
acute (short-term) toxicity anesthetic concentration: rat, deep anesthesia: 140,000 ppm v/v
flammability LFL-UFL (flammability limits in air): IGC/ICE: nonflammable MSDS
flash point: IGC/ICE: not applicable MSDS
detection appearance: clear liquid MSDS

Production
first commercial use as a refrigerant: 1997
promotion begun October 1996
last year production allowed: 2029 by refrigerant 123, 141b 8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
in developed countries under the Montreal Protocol
R-124/123

--------------- REFRIGERANT DATA SUMMARY ---------------
unassigned  R-124/123 formulations vary, typically (42.0/58.0) see
zeotrope  binary blend  RDB#

COMMON USE(S)
industrial use in applications with high condensing temperatures,
such as air conditioners for overhead crane cabs in steel mills, as a
service fluid for retrofit of systems designed for refrigerant 114

Note: The hoses commonly used in systems designed for refrigerant
114 are not compatible with the R-124/123 blend.

IDENTIFIERS
common name(s):  R-124/123 (??/??)
R124/123 (??/??)
R 124/123 (??/??)

alternative chemical names/formulae: incorrectly: R-123/124 (??/??)
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL
nominal blend formulation  ---------
composition:  R-124/123
component weight fractions:  formulation must be indicated

SAFETY
classification  ---------------------
safety group (ASHRAE Standard 34):  none (no application pending) 8601
components are A1 and B1 8601

PRODUCTION
first commercial use as a refrigerant: circa 1995
last year production allowed: 2029 by refrigerants 123, 124 8C01
in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-124/123 (42.0/58.0)

--REFRIGERANT DATA SUMMARY--

unassigned R-124/123 (42.0/58.0) see
zeotrope binary blend RDB#

COMMON USE(S)

industrial use in applications with high condensing temperatures,
such as air conditioners for overhead crane cabs in steel mills, as a
service fluid for retrofit of systems designed for refrigerant 114

Note: The hoses commonly used in systems designed for refrigerant
114 are not compatible with the R-124/123 blend.

IDENTIFIERS

common name(s): R-124/123 (42.0/58.0)
R124/123 (42.0/58.0)
R 124/123 (42.0/58.0)
incorrectly R-123/124 (58/42)
incorrectly R13/124 (58/42)
incorrectly R 13/124 (58/42)
HCFC-124/HCFC-123 (42/58) 2909
not: HCFC-124/123 (42/58) 2909

ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

nominal blend formulation --------

composition: R-124/123
component weight fractions: 42.0 / 58.0 %
component mole fractions: 44.795 / 55.205 % 8820

properties ---------------------
molar mass: 145.55918 g/mol (0.320903 lb/mol) 8820

normal boiling point ----------
bubble point temperature: 0.3 °C (32.6 °F) 8401
dew point temperature: 15.3 °C (59.5 °F) 8401
maximum temperature glide: 14.93 °C (26.9 °F) 8401
density, saturated liquid: 1484 kg/m3 (92.64 lb/cf) 8401
density, saturated vapor: 6.40 kg/m3 (0.400 lb/cf) 8401
specific volume, saturated liquid: 0.674 L/kg (0.0108 cf/lb) 8401
specific volume, saturated vapor: 156.2 L/kg (2.5022 cf/lb) 8401
heat of vaporization: 180.0 kJ/kg (77.4 Btu/lb) 8401
velocity of sound, saturated liquid: 712 m/s (2336 ft/s) 8401
velocity of sound, saturated vapor: 130 m/s (426 ft/s) 8401
viscosity, saturated liquid: 10.56 uPa·s (0.01056 cp) 8401
viscosity, saturated liquid: 428 uPa·s (0.428 cp) 8401
thermal conductivity, liquid: 0.0790 W/m·K (0.0457 Btu/hr·ft°F) 8401
thermal conductivity, vapor: 0.0097 W/m·K (0.0056 Btu/hr·ft°F) 8401

normal pressure, 20 °C (68 °F) ----
density, vapor: 6.283 kg/m3 (0.3922 lb/cf) 8401

normal pressure, 21.1 °C (70 °F) ---
density, vapor: 6.256 kg/m3 (0.3905 lb/cf) 8401

20 °C (68 °F) ----------------------
Pressure, liquid (bubble point): 203.1 kPa (29.46 psia) 8401
Pressure, vapor (dew point): 121.6 kPa (17.63 psia) 8401
Density, saturated liquid: 1429 kg/m³ (89.22 lb/ft³) 8401
Density, saturated vapor: 7.60 kg/m³ (0.474 lb/ft³) 8401
Specific volume, saturated liquid: 0.700 L/kg (0.0112 cf/lb) 8401
Specific volume, saturated vapor: 131.6 L/kg (2.1080 cf/lb) 8401
Velocity of sound, saturated liquid: 635 m/s (2082 ft/s) 8401
Velocity of sound, saturated vapor: 130 m/s (427 ft/s) 8401
Viscosity, saturated liquid: 337 µPa·s (0.337 cp) 8401
Viscosity, saturated vapor: 10.7 µPa·s (0.0107 cp) 8401
Thermal conductivity, saturated liquid: 0.0732 W/m·K (0.0423 Btu/hr·ft·°F) 8401
Thermal conductivity, saturated vapor: 0.00996 W/m·K (0.00576 Btu/hr·ft·°F) 8401

60 °C (140 °F) ---------------
Pressure, liquid (bubble point): 632 kPa (91.6 psia) 8401
Pressure, vapor (dew point): 447 kPa (64.9 psia) 8401
Heat of vaporization: 142.5 kJ/kg for liquid and vapor both at nominal composition (61.3 Btu/lb) 8401
124.4 kJ/kg coexisting liquid and vapor at bubble-point pressure (53.5 Btu/lb) 8401

Critical point ------------------
Temperature: 156.2 °C (313.2 °F) 8401
Pressure: 3835 kPa (556.2 psia) 8401
Density: 554 kg/m³ (34.6 lb/ft³) 8401
Specific volume: 1.80 L/kg (0.0289 cf/lb) 8401

Environmental
ODP (ozone depletion potential): 0.018 mass-weighted average (model-derived relative to R 11) 9501
GWP (global warming potential): 330 mass-weighted average relative to CO2 for 100 yr integration 9501
HGWP (halocarbon GWP): 0.05 mass-weighted average relative to R 11 for infinite integration period 9501

Safety
Classification ----------------------
Safety group (ASHRAE Standard 34): none (no application pending) 8601
Components are A1 and B1 8601
Flammability ---------------------
LFL-UFL (flammability limits in air): expected to be nonflammable 8601

Production
First commercial use as a refrigerant: circa 1995 8C01
Last year production allowed: 2029 by refrigerants 123, 124 in developed countries under the Montreal Protocol 8C01

See data limitations and notes on page 2
### Refrigerant Database

#### R-125/22 (70.0/30.0)

--- REFRIERANT DATA SUMMARY ---

<table>
<thead>
<tr>
<th>unassigned</th>
<th>R-125/22 (70.0/30.0)</th>
<th>see RDB#</th>
</tr>
</thead>
<tbody>
<tr>
<td>zeotrope</td>
<td>binary blend</td>
<td></td>
</tr>
</tbody>
</table>

**COMMON USE(S)**

Considered (circa 1992-1996) as an alternative for refrigerant 502

**IDENTIFIERS**

- **common name(s):** R-125/22 (70.0/30.0)
- **historical name(s):** Elf Atochem Porane(R) FX-20
- **ARI container color / Pantone number:** none, use light green grey/413 6601

**PHYSICAL**

- **nominal blend formulation **
  - **composition:** R-125/22
  - **component weight fractions:** 70.0 / 30.0 %
  - **component mole fractions:** 62.701 / 37.299 %
- **properties**
  - **molar mass:** 107.50629 g/mol (0.237011 lb/mol)
- **normal boiling point**
  - **bubble point temperature:** -47.4 °C (-53.4 °F)
  - **dew point temperature:** -47.1 °C (-52.7 °F)
  - **maximum temperature glide:** 0.20 °C (0.4 °F)
  - **density, saturated liquid:** 1483 kg/m³ (92.58 lb/cf)
  - **density, saturated vapor:** 6.04 kg/m³ (0.377 lb/cf)
  - **specific volume, saturated liquid:** 0.674 L/kg (0.0108 cf/lb)
  - **specific volume, saturated vapor:** 165.5 L/kg (2.6515 cf/lb)
  - **heat of vaporization:** 183.4 kJ/kg (78.8 Btu/lb)
  - **velocity of sound, saturated liquid:** 745 m/s (2446 ft/s)
  - **velocity of sound, saturated vapor:** 137 m/s (449 ft/s)
  - **viscosity, saturated liquid:** 385 μPa·s (0.385 cp)
  - **viscosity, saturated vapor:** 9.74 μPa·s (0.00974 cp)
  - **thermal conductivity, liquid:** 0.0985 W/m·K (0.0569 Btu/hr·ft°F)
  - **thermal conductivity, vapor:** 0.0079 W/m·K (0.0046 Btu/hr·ft°F)
- **normal pressure, 20 °C (68 °F) ****
  - **density, vapor:** 4.541 kg/m³ (0.2835 lb/cf)
- **normal pressure, 21.1 °C (70 °F) ***
  - **density, vapor:** 4.523 kg/m³ (0.2823 lb/cf)
- **20 °C (68 °F) **
  - **pressure, liquid (bubble point):** 1159.4 kPa (168.16 psia)
  - **pressure, vapor (dew point):** 1149.2 kPa (166.68 psia)
  - **specific volume, saturated liquid:** 0.624 L/kg (0.0132 cf/lb)
  - **specific volume, saturated vapor:** 15.5 L/kg (0.2480 cf/lb)
  - **velocity of sound, saturated liquid:** 409 m/s (1342 ft/s)
  - **velocity of sound, saturated vapor:** 132 m/s (432 ft/s)
  - **viscosity, saturated liquid:** 155 μPa·s (0.155 cp)
  - **viscosity, saturated vapor:** 13.0 μPa·s (0.0130 cp)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
thermal conductivity, saturated liquid: 0.0677 W/m·K (0.0391 Btu/hr·ft°F) 8401
thermal conductivity, saturated vapor: 0.01311 W/m·K (0.00757 Btu/hr·ft°F) 8401

- 60 °C (140 °F) ---------------------
  pressure, liquid (bubble point): 3027 kPa (439.1 psia) 8401
  pressure, vapor (dew point): 3013 kPa (436.9 psia) 8401
  heat of vaporization: 78.1 kJ/kg for liquid and 79.1 kJ/kg coexisting liquid 8401
  vapor both at nominal composition (33.6 Btu/lb) and vapor at bubble-point pressure (34.0 Btu/lb) 8401

- critical point ---------------------
  temperature: 73.7 °C (164.7 °F) 8401
  pressure: 4036 kPa (585.4 psia) 8401
  density: 563 kg/m3 (35.1 lb/cf) 8401
  specific volume: 1.78 L/kg (0.0285 cf/lb) 8401

ENVIRONMENTAL
  ODP (ozone depletion potential): 0.010 mass-weighted average 9501
  (model-derived relative to R 11)
  0.015 mass-weighted average 9501
  (semi-empirical relative to R 11)
  GWP (global warming potential): 3230 mass-weighted average 9501
  relative to CO2 for 100 yr integration
  HGWP (halocarbon GWP): 0.55 relative to R 11 for infinite integration period DW

SAFETY
  classification ---------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are both Al 8601
  flammability ---------------------
  LFL-UFL (flammability limits in air): none (nonflammable as tested) 2A06
  flash point: Elf Atochem: none MSDS
  autodecomposition temperature: Elf Atochem: >427 °C (>800 °F) MSDS

PRODUCTION
  first commercial use as a refrigerant: not known to be commercialized 8C01
  last year production allowed: 2029 based on refrigerant 22 8C01
  in developed countries under the Montreal Protocol
R-125/134a/600 (46.5/50.0/3.5)

--- REFRIGERANT DATA SUMMARY ---

unassigned  R-125/134a/600 (46.5/50.0/3.5)   see
zeotrope      ternary blend                    RDB#

COMMON USE(S)
alternative for refrigerant 22, for air conditioners, chillers, and refrigeration, and possibly also refrigerant 502, for low- and medium-temperature refrigeration, primarily for aftermarket use to retrofit existing equipment; developmental formulation for Rhodia Isceon 59 (subsequently reformulated)

The following information is preliminary and may be incomplete or incorrect. Data may be available from Rhodia Limited (Avonmouth, Bristol, UK) and other refrigerant manufacturers. Product literature indicates that compressor discharge temperatures and condensing pressures are lower than with refrigerant 22 and that the blend is suitable for use with existing lubricants.

IDENTIFIERS

common name(s): R-125/134a/600 (46.5/50.0/3.5) mfr
R125/134a/600 (46.5/50.0/3.5) mfr
R 125/134a/600 (46.5/50.0/3.5) mfr
historical name(s): Rhône-Poulenc RX3  6708

PHYSICAL

• nominal blend formulation ---------
  composition: R-125/134a/600 mfr
  component weight fractions: 46.5 / 50.0 / 3.5 % mfr
  component weight tolerances: ±1.0 / ±1.0 / ±0.0,-0.5 mfr
  component mole fractions: 41.317 / 52.261 / 6.422 % 8820

• properties ---------------------
  molar mass: 106.64430 g/mol (0.235110 lb/mol) 8820

• normal boiling point -----------
  bubble point temperature: -38.0 °C (-36.3 °F) 8414
  -41.8 °C (-43.2 °F) mfr
  dew point temperature: -32.8 °C (-27.1 °F) 8414
  -36.3 °C (-33.3 °F) mfr
  maximum temperature glide: 5.14 °C (9.2 °F) 8414
  density, saturated liquid: 1381 kg/m³ (86.21 lb/cf) 8414
  density, saturated vapor: 5.64 kg/m³ (0.352 lb/cf) 8414
  specific volume, saturated liquid: 0.724 L/kg (0.0116 cf/lb) 8414
  specific volume, saturated vapor: 177.2 L/kg (2.8380 cf/lb) 8414
  heat of vaporization: 201.9 kJ/kg (86.8 Btu/lb) 8414

• velocity of sound, saturated liquid: 741 m/s (2431 ft/s) 8814
• velocity of sound, saturated vapor: 140 m/s (460 ft/s) 8814
• viscosity, saturated liquid: 388 μPa·s (0.388 cp) 8414
• viscosity, saturated vapor: 9.63 μPa·s (0.00963 cp) 8414
• thermal conductivity, liquid: 0.1006 W/m·K (0.0581 Btu/hr·ft²·F) 8414
• thermal conductivity, vapor: 0.0093 W/m·K (0.0054 Btu/hr·ft²·F) 8414

• normal pressure, 20 °C (68 °F) ----
Density, vapor: 4.522 kg/m³ (0.2823 lb/cf) 8414

- Normal pressure, 21.1 °C (70 °F) ---
  Density, vapor: 4.504 kg/m³ (0.2812 lb/cf) 8414

- 20 °C (68 °F) ---------------------
  Pressure, liquid (bubble point): 822.3 kPa (119.27 psia) 8814
  Pressure, vapor (dew point): 731.1 kPa (106.03 psia) 8814
  Density, saturated liquid: 1180 kg/m³ (73.67 lb/cf) 8414
  Density, saturated vapor: 38.17 kg/m³ (2.383 lb/cf) 8414
  Specific volume, saturated liquid: 0.847 L/kg (0.0136 cf/lb) 8414
  Specific volume, saturated vapor: 26.2 L/kg (0.4197 cf/lb) 8414
  Velocity of sound, saturated liquid: 464 m/s (1524 ft/s) 8814
  Velocity of sound, saturated vapor: 138 m/s (453 ft/s) mfr 8814
  Viscosity, saturated liquid: 178 µPa·s (0.178 cp) 8414
  Viscosity, saturated vapor: 11.9 µPa·s (0.0119 cp) 8414
  Thermal conductivity, saturated liquid: 0.0747 W/m·K (0.0432 Btu/hr·ft·°F) 8414
  Thermal conductivity, saturated vapor: 0.0139 W/m·K (0.00804 Btu/hr·ft·°F) 8414

- 60 °C (140 °F) ---------------------
  Pressure, liquid (bubble point): 2225 kPa (322.7 psia) 8814
  Pressure, vapor (dew point): 2087 kPa (302.6 psia) 8814
  Heat of vaporization: 110.4 kJ/kg for liquid and vapor both at nominal composition (47.5 Btu/lb) 8414
  108.8 kJ/kg coexisting liquid and vapor at bubble-point pressure (46.8 Btu/lb) 8414

- Critical point ---------------------
  Temperature: 90.1 °C (194.1 °F) mfr 8414
  Pressure: 3860 kPa (559.8 psia) mfr 8814
  Density: 519 kg/m³ (32.4 lb/cf) 8414
  Specific volume: 1.93 L/kg (0.0306 cf/lb) 8414

Environmental
- ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
  Model-derived relative to R 11
- GWP (global warming potential): 2570 mass-weighted average 9501
  Relative to CO2 for 100 yr integration
- HGWP (halocarbon GWP): 0.44 mass-weighted average DW
  Relative to R 11 for infinite integration period

Safety
- Classification ---------------------
  Safety group (ASHRAE Standard 34): none (no application pending) 8601
- Flammability ---------------------
  LFL-UFL (flammability limits in air): nonflammable 6708

Production
- First commercial use as a refrigerant: June 1996 6708
- Last year production allowed: unrestricted 8C01
R-125/134a/600 (46.6/50.0/3.4)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-125/134a/600 (46.6/50.0/3.4) see RDB#
zeotrope ternary blend ----

COMMON USE(S)
alternative for refrigerant 22, for air conditioners, chillers, and refrigeration, and possibly also refrigerant 502, for low- and medium-temperature refrigeration, primarily for aftermarket use to retrofit existing equipment.

The following information is preliminary and may be incomplete or incorrect. Data may be available from Rhodia Limited (Avonmouth, Bristol, UK) and other refrigerant manufacturers. Product literature indicates that compressor discharge temperatures and condensing pressures are lower than with refrigerant 22 and that the blend is suitable for use with existing lubricants.

IDENTIFIERS

common name(s): R-125/134a/600 (46.6/50.0/3.4) mfr
R125/134a/600 (46.6/50.0/3.4) mfr
R 125/134a/600 (46.6/50.0/3.4) mfr
trade name(s): Rhodia Isceon 59
historical name(s): Rhône-Poulenc Isceon 59 mfr

PHYSICAL

· nominal blend formulation -------
  composition: R-125/134a/600 mfr
  component weight fractions: 46.6 / 50.0 / 3.4 % mfr
  component weight tolerances: ±1.1 / ±1.0 / +0.1,-0.4 mfr
  component mole fractions: 41.445 / 52.310 / 6.244 % 8820

· properties ------------------------
  molar mass: 106.74531 g/mol (0.235333 8820
  lb/mol)

  · normal boiling point ------------
    bubble point temperature: -38.0 °C (-36.4 °F) 8414
    dew point temperature: -32.9 °C (-27.2 °F) 8414
    maximum temperature glide: 5.14 °C (9.2 °F) 8414
    density, saturated liquid: 1383 kg/m³ (86.33 lb/cf) 8414
    density, saturated vapor: 5.65 kg/m³ (0.353 lb/cf) 8414
    specific volume, saturated liquid: 0.723 L/kg (0.0116 cf/lb) 8414
    specific volume, saturated vapor: 177.0 L/kg (2.8349 cf/lb) 8414
    heat of vaporization: 201.7 kJ/kg (86.7 Btu/lb) 8414
    velocity of sound, saturated liquid: 741 m/s (2430 ft/s) 8814
    velocity of sound, saturated vapor: 140 m/s (460 ft/s) 8814
    viscosity, saturated liquid: 3.89 µPa·s (0.389 cp) 8414
    viscosity, saturated vapor: 9.64 µPa·s (0.00964 cp) 8414
    thermal conductivity, liquid: 0.1006 W/m·K (0.0581 8414
    Btu/hr·ft·°F)
    thermal conductivity, vapor: 0.0093 W/m·K (0.0054 8414
    Btu/hr·ft·°F)

· normal pressure, 20 °C (68 °F) -----
  density, vapor: 4.526 kg/m³ (0.2826 lb/cf) 8414

· normal pressure, 21.1 °C (70 °F) ---

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
density, vapor: 4.508 kg/m³ (0.2814 lb/cf) 8414

- 20 °C (68 °F) ---------------
  pressure, liquid (bubble point): 823.4 kPa (119.43 psia) 8814
  pressure, vapor (dew point): 732.3 kPa (106.21 psia) 8814
  density, saturated liquid: 1182 kg/m³ (73.76 lb/cf) 8414
  density, saturated vapor: 38.27 kg/m³ (2.389 lb/cf) 8414
  specific volume, saturated liquid: 0.846 L/kg (0.0136 cf/lb) 8414
  specific volume, saturated vapor: 26.1 L/kg (0.4185 cf/lb) 8414
  velocity of sound, saturated liquid: 464 m/s (1522 ft/s) 8814
  velocity of sound, saturated vapor: 138 m/s (452 ft/s) 8814
  viscosity, saturated liquid: 178 μPa·s (0.178 cp) 8414
  viscosity, saturated vapor: 11.9 μPa·s (0.0119 cp) 8414
  thermal conductivity, saturated liquid: 0.0746 W/m·K (0.0431 Btu/hr·ft·°F) 8414
  thermal conductivity, saturated vapor: 0.01392 W/m·K (0.00804 Btu/hr·ft·°F) 8414

- 60 °C (140 °F) ---------------
  pressure, liquid (bubble point): 2228 kPa (323.1 psia) 8814
  pressure, vapor (dew point): 2090 kPa (303.1 psia) 8814
  heat of vaporization: 110.2 kJ/kg for liquid and vapor both at nominal composition (47.4 Btu/lb) 8414
  108.6 kJ/kg coexisting liquid and vapor at bubble-point pressure (46.7 Btu/lb) 8414

- critical point ---------------
  temperature: 89.9 °C (193.9 °F) 8414
  pressure: 3860 kPa (559.8 psia) mfr
  density: 520 kg/m³ (32.5 lb/cf) 8414
  specific volume: 1.92 L/kg (0.0308 cf/lb) 8414

ENVIRONMENTAL
  ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
    (model-derived relative to R 11)
    <0.00027 mass-weighted average 9501
    (semi-empirical relative to R 11)
  GWP (global warming potential): 2570 mass-weighted average 9501
    relative to CO2 for 100 yr integration
  HGWP (halocarbon GWP): 0.44 mass-weighted average DW
    relative to R 11 for infinite integration period

SAFETY
  classification -----------------------
    safety group (ASHRAE Standard 34): none (no application pending) 8601
  emergency exposure limit ------------
    Refrigerant Concentration Limit (RCL): 49,000 ppm v/v (preliminary value under review, based on draft ASHRAE 34aa)
  flammability -----------------------
    LFL-UFL (flammability limits in air): nonflammable 6708

PRODUCTION
  first commercial use as a refrigerant: June 1996 8601
  last year production allowed: unrestricted 8C01
R-125/143a (45.0/55.0)

--- REFRIGERANT DATA SUMMARY ---
unassigned: R-125/143a (45.0/55.0) see RDB#
azeotrope: binary blend

COMMON USE(S)
under consideration as a replacement for refrigerant 502 especially for low-temperature commercial refrigeration, such as supermarket display cases and ice machines; this blend may be covered by U.S.
patent 5,211,867 and was a developmental version of AlliedSignal Genetron(R) AZ-50 (subsequently reformulated)

IDENTIFIERS
common name(s): R-125/143a (45/55)
R125/143a (45/55)
R 125/143a (45/55)
candidate for R-507 series
HFC-125/HFC-143a (45/55)
not HFC-125/143a (45/55)

PHYSICAL
nominal blend formulation

composition: R-125/143a
component weight fractions: 45.0 / 55.0 %
component mole fractions: 36.423 / 63.577 %

properties
molar mass: 97.14584 g/mol (0.214170 lb/mol)

normal boiling point
bubble point temperature: -47.1 °C (-52.7 °F)
dew point temperature: -47.1 °C (-52.7 °F)
maximum temperature glide: 0.00 °C (0.0 °F)
density, saturated liquid: 1302 kg/m³ (81.28 lb/cf)
density, saturated vapor: 5.49 kg/m³ (0.343 lb/cf)
specific volume, saturated liquid: 0.768 L/kg (0.0123 cf/lb)
specific volume, saturated vapor: 182.2 L/kg (2.9178 cf/lb)
heat of vaporization: 199.2 kJ/kg (85.6 Btu/lb)
velocity of sound, saturated liquid: 745 m/s (2444 ft/s)
velocity of sound, saturated vapor: 143 m/s (470 ft/s)
viscosity, saturated liquid: 322 µPa·s (0.322 cp)
viscosity, saturated vapor: 9.04 µPa·s (0.00904 cp)
thermal conductivity, liquid: 0.0982 W/m·K (0.0567 Btu/hr·ft·°F)
thermal conductivity, vapor: 0.0090 W/m·K (0.0052 Btu/hr·ft·°F)

normal pressure, 20 °C (68 °F)
density, vapor: 4.110 kg/m³ (0.2566 lb/cf)

normal pressure, 21.1 °C (70 °F)
density, vapor: 4.094 kg/m³ (0.2556 lb/cf)

20 °C (68 °F)
pressure, liquid (bubble point): 1123.6 kPa (162.96 psia)
pressure, vapor (dew point): 1122.7 kPa (162.83 psia)
density, saturated liquid: 1060 kg/m³ (66.15 lb/cf)
density, saturated vapor: 58.36 kg/m³ (3.643 lb/cf)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific volume, saturated liquid</td>
<td>0.944 L/kg (0.0151 cf/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated vapor</td>
<td>17.1 L/kg (0.2745 cf/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Velocity of sound, saturated liquid</td>
<td>407 m/s (1335 ft/s)</td>
<td>8401</td>
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<tr>
<td>Velocity of sound, saturated vapor</td>
<td>136 m/s (445 ft/s)</td>
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<tr>
<td>Viscosity, saturated liquid</td>
<td>133 μPa·s (0.133 cp)</td>
<td>8401</td>
</tr>
<tr>
<td>Viscosity, saturated vapor</td>
<td>12.2 μPa·s (0.0122 cp)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated liquid</td>
<td>0.0689 W/m·K (0.0398 Btu/hr·ft²°F)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01548 W/m·K (0.00894 Btu/hr·ft²°F)</td>
<td>8401</td>
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</table>

- 60 °C (140 °F)--------------------------------

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure, liquid (bubble point)</td>
<td>2938 kPa (426.2 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure, vapor (dew point)</td>
<td>2937 kPa (425.9 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Heat of vaporization</td>
<td>79.0 kJ/kg for liquid and vapor both at nominal composition (34.0 Btu/lb)</td>
<td>8401</td>
</tr>
<tr>
<td></td>
<td>79.6 kJ/kg coexisting liquid and vapor at bubble-point pressure (34.2 Btu/lb)</td>
<td>8401</td>
</tr>
</tbody>
</table>

- Critical point-------------------

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>71.0 °C (159.9 °F)</td>
<td>8401</td>
</tr>
<tr>
<td></td>
<td>71.3 °C (160.3 °F)</td>
<td>3222</td>
</tr>
<tr>
<td>Pressure</td>
<td>3702 kPa (537.0 psia)</td>
<td>3512</td>
</tr>
<tr>
<td></td>
<td>3721 kPa (539.7 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Density</td>
<td>486 kg/m³ (30.3 lb/cf)</td>
<td>8401</td>
</tr>
<tr>
<td></td>
<td>490 kg/m³ (30.6 lb/cf)</td>
<td>3222</td>
</tr>
<tr>
<td>Specific volume</td>
<td>2.04 L/kg (0.0327 cf/lb)</td>
<td>8401</td>
</tr>
<tr>
<td></td>
<td>2.06 L/kg (0.0330 cf/lb)</td>
<td>8401</td>
</tr>
</tbody>
</table>

**Environmental**

- ODP (ozone depletion potential): <0.00002 mass-weighted average (model-derived relative to R 11)
- GWP (global warming potential): 4680 mass-weighted average relative to CO2 for 100 yr integration
- HGWP (halocarbon GWP): 0.83 mass-weighted average relative to R 11 for infinite integration period

**Safety**

- Classification: none (no application pending)
- Flammability: none (nonflammable as tested)

**Production**

- First commercial use as a refrigerant: not known to be commercialized
- Last year production allowed: unrestricted
R-125/143a/290/22 (42.0/6.0/2.0/50.0)

--- REFREGERANT DATA SUMMARY ---

| unassigned | R-125/143a/290/22 (42.0/6.0/2.0/50.0) | see RDB# |
| zetrop | tetry blend |

**COMMON USE(S)**

alternative for refrigerant 502, primarily for aftermarket use to service or retrofit existing low and medium temperature refrigeration equipment without a lubricant change.

**IDENTIFIERS**

| common name(s): | R-125/143a/290/22 (42/6/2/50) |
| R125/143a/290/22 (42/6/2/50) |
| R 125/143a/290/22 (42/6/2/50) |
| HFC-125/HFC-143a/HC-290/2909 |
| HCFC-22 (42/6/2/50) |
| not HCFC-125/143a/290/22 |
| "R-22/125/143a/2909" |
| "R22/R125/R143a/R290" |
| trade name(s): | Ausimont Meforex(R) DI-44 |
| ARI container color / Pantone number: | none, use light green grey/413 6601 |

**PHYSICAL**

- nominal blend formulation  
  composition: R-125/143a/290/22
  component weight fractions: 42.0 / 6.0 / 2.0 / 50.0 %
  component mole fractions: 33.489 / 6.832 / 4.341 / 55.338 % 8820

- properties  
  molar mass: 95.69968 g/mol (0.210982 lb/mol) 8820

- normal boiling point  
  bubble point temperature: -45.6 °C (-50.1 °F) 7203
  dew point temperature: -47.7 °C (-53.9 °F) 8401
  maximum temperature glide: 2.03 °C (3.6 °F) 8401
  density, saturated liquid: 1396 kg/m3 (87.12 lb/cf) 8401
  density, saturated vapor: 5.34 kg/m3 (0.333 lb/cf) 8401
  specific volume, saturated liquid: 0.717 L/kg (0.0115 cf/lb) 8401
  specific volume, saturated vapor: 187.4 L/kg (3.0015 cf/lb) 8401
  heat of vaporization: 206.7 kJ/kg (88.8 Btu/lb) 8401
  velocity of sound, saturated liquid: 796 m/s (2612 ft/s) 8401
  velocity of sound, saturated vapor: 147 m/s (483 ft/s) 8401
  viscosity, saturated liquid: 354 μPa·s (0.354 cp) 8401
  viscosity, saturated vapor: 9.61 μPa·s (0.00961 cp) 8401
  thermal conductivity, liquid: 0.1044 W/m·K (0.0603°F) 8401
  thermal conductivity, vapor: 0.0076 W/m·K (0.0044°F) 8401

- normal pressure, 20 °C (68 °F)  
  density, vapor: 4.041 kg/m3 (0.2523 lb/cf) 8401

- normal pressure, 21.1 °C (70 °F)  
  density, vapor: 4.025 kg/m3 (0.2513 lb/cf) 8401

- 20 °C (68 °F)  

---

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
pressure, liquid (bubble point): 1127.5 kPa (163.53 psia) 8401
pressure, vapor (dew point): 1091.0 kPa (158.24 psia) 8401
density, saturated liquid: 1152 kg/m³ (71.94 lb/ft³) 8401
density, saturated vapor: 53.50 kg/m³ (3.340 lb/ft³) 8401
specific volume, saturated liquid: 0.868 L/kg (0.0139 cf/lb) 8401
specific volume, saturated vapor: 18.7 L/kg (0.2994 cf/lb) 8401
velocity of sound, saturated liquid: 458 m/s (1502 ft/s) 8401
velocity of sound, saturated vapor: 144 m/s (472 ft/s) 8401
viscosity, saturated liquid: 152 μPa·s (0.152 cp) 8401
viscosity, saturated vapor: 12.7 μPa·s (0.0127 cp) 8401
thermal conductivity, saturated liquid: 0.0732 W/m·K (0.0423 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.0126 W/m·K (0.00728 Btu/hr·ft·°F) 8401

• 60 °C (140 °F) -----------------------
  pressure, liquid (bubble point): 2910 kPa (422.0 psia) 8401
  pressure, vapor (dew point): 2865 kPa (415.5 psia) 8401
  heat of vaporization: 99.1 kJ/kg for liquid and vapor both at nominal composition (42.6 Btu/lb) 8401
  99.5 kJ/kg coexisting liquid and vapor at bubble-point pressure (42.8 Btu/lb) 8401

• critical point -----------------------
temperature: 81.0 °C (177.7 °F) 8401
pressure: 4448 kPa (645.1 psia) 8401
density: 529 kg/m³ (33.0 lb/ft³) 8401
specific volume: 1.89 L/kg (0.0303 cf/lb) 8401

ENVIRONMENTAL
ODP (ozone depletion potential): 0.017 mass-weighted average (model-derived relative to R 11) 9501
0.025 mass-weighted average (semi-empirical relative to R 11) 9501
GWP (global warming potential): 2870 mass-weighted average relative to CO2 for 100 yr integration 9501
HGWP (halocarbon GWP): 0.49 mass-weighted average relative to R 11 for infinite integration period DW

SAFETY
• classification -----------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601
• long-term occupational limit -------
exposure limit consistent to OSHA PEL: Ausimont AEL: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk 7203
• flammability -----------------------
LFL-UFL (flammability limits in air): none (nonflammable as tested) 7203

PRODUCTION
first commercial use as a refrigerant: 1996
last year production allowed: 2029 by refrigerant 22 in developed countries under the Montreal Protocol 8C01
R-125/152a/227ea (40.0/5.0/55.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-125/152a/227ea (40.0/5.0/55.0) see
zeotrope ternary blend RDB# ---

COMMON USE(S)
alternative for refrigerant 134a for automobile air conditioners and
other mobile air-conditioning (MAC) systems to increase cooling
capacity, primarily for aftermarket use to service or retrofit
marginally performing existing equipment

The following information is preliminary and may be incomplete or
incorrect. Further data may be available from GHG Dev Labs (West
Lafayette, IN, USA) or refrigerant manufacturers. Product literature
indicates that thiszeotropic blend of hydrofluorocarbons (HFCs) is a
high performance refrigerant that will result in a 6 °C (10 °F)
colder duct temperature. The description indicates that the blend is
not miscible in mineral oils and requires a polyalkylene glycol (PAG)
or polyolester (POE) lubricant.

IDENTIFIERS

common name(s): R-125/152a/227ea
(40.0/5.0/55.0)
R125/152a/227ea
(40.0/5.0/55.0)
R 125/152a/227ea
(40.0/5.0/55.0)
HFC-125/HFC-152a/HFC-227ea
(40.0/5.0/55.0)
not HFC-125/152a/227ea

"R-227ea/152a/125 (55/5/40)" mfr
R-125/152a/227ea (40/5/55)

trade name(s): Autofrost GHG X7
MonroeAirTech Autofrost X7(TM)
Peoples Welding Supply GHG-X7

ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

- nominal blend formulation ---------
  composition: R-125/152a/227ea mfr
  component weight fractions: 40.0 / 5.0 / 55.0 % mfr
  component weight tolerances: not indicated
  component mole fractions: 45.501 / 10.335 / 44.163 % 8820

- properties ------------------------
  molar mass: 136.52832 g/mol (0.300993 8820
  lb/mol)

- normal boiling point -----------
  bubble point temperature: -34.4 °C (-29.9 °F) MSDS
  -38.6 °C (-37.4 °F) 8401
dew point temperature: -27.8 °C (-18.0 °F) 8401
  maximum temperature glide: 10.79 °C (19.4 °F) 8401
density, saturated liquid: 1509 kg/m3 (94.17 lb/cf) 8401
density, saturated vapor: 7.08 kg/m3 (0.442 lb/cf) 8401
  specific volume, saturated liquid: 0.663 L/kg (0.0106 cf/lb) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific volume, saturated vapor</td>
<td>141.2 L/kg (2.2613 cf/lb)</td>
<td>8401</td>
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<tr>
<td>Heat of vaporization</td>
<td>165.4 kJ/kg (71.1 Btu/lb)</td>
<td>8401</td>
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<tr>
<td>Velocity of sound, saturated liquid</td>
<td>646 m/s (2119 ft/s)</td>
<td>8401</td>
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<tr>
<td>Velocity of sound, saturated vapor</td>
<td>123 m/s (405 ft/s)</td>
<td>8401</td>
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<tr>
<td>Viscosity, saturated liquid</td>
<td>446 μPa·s (0.446 cp)</td>
<td>8401</td>
</tr>
<tr>
<td>Viscosity, saturated vapor</td>
<td>9.94 μPa·s (0.00994 cp)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, liquid</td>
<td>0.0801 W/m·K (0.0463 Btu/hr·ft·°F)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, vapor</td>
<td>0.0096 W/m·K (0.0055 Btu/hr·ft·°F)</td>
<td>8401</td>
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<tr>
<td>Normal pressure, 20 °C (68 °F)</td>
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<tr>
<td>Density, vapor</td>
<td>5.802 kg/m³ (0.3622 lb/cf)</td>
<td>8401</td>
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<tr>
<td>Normal pressure, 21.1 °C (70 °F)</td>
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<tr>
<td>Density, vapor</td>
<td>5.778 kg/m³ (0.3607 lb/cf)</td>
<td>8401</td>
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<tr>
<td>20 °C (68 °F)</td>
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<tr>
<td>Pressure, liquid (bubble point)</td>
<td>805.5 kPa (116.83 psia)</td>
<td>8401</td>
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<tr>
<td>Pressure, vapor (dew point)</td>
<td>636.1 kPa (92.25 psia)</td>
<td>8401</td>
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<tr>
<td>Density, saturated liquid</td>
<td>1282 kg/m³ (80.01 lb/cf)</td>
<td>8401</td>
</tr>
<tr>
<td>Density, saturated vapor</td>
<td>42.15 kg/m³ (2.631 lb/cf)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated liquid</td>
<td>0.780 L/kg (0.0125 cf/lb)</td>
<td>8401</td>
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<tr>
<td>Specific volume, saturated vapor</td>
<td>23.7 L/kg (0.3801 cf/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Velocity of sound, saturated liquid</td>
<td>394 m/s (1294 ft/s)</td>
<td>8401</td>
</tr>
<tr>
<td>Velocity of sound, saturated vapor</td>
<td>121 m/s (396 ft/s)</td>
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<td>Viscosity, saturated liquid</td>
<td>190 μPa·s (0.190 cp)</td>
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<tr>
<td>Viscosity, saturated vapor</td>
<td>12.1 μPa·s (0.0121 cp)</td>
<td>8401</td>
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<tr>
<td>Thermal conductivity, saturated liquid</td>
<td>0.0597 W/m·K (0.0345 Btu/hr·ft·°F)</td>
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<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01336 W/m·K (0.00772 Btu/hr·ft·°F)</td>
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<tr>
<td>60 °C (140 °F)</td>
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<tr>
<td>Pressure, liquid (bubble point)</td>
<td>2121 kPa (307.6 psia)</td>
<td>8401</td>
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<tr>
<td>Pressure, vapor (dew point)</td>
<td>1874 kPa (271.8 psia)</td>
<td>8401</td>
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<tr>
<td>Heat of vaporization</td>
<td>83.8 kJ/kg for liquid and vapor both at nominal composition (36.0 Btu/lb) and vapor at bubble-point pressure (33.8 Btu/lb)</td>
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<tr>
<td>Critical point</td>
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<tr>
<td>Temperature</td>
<td>87.2 °C (189.0 °F)</td>
<td>8401</td>
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<tr>
<td>Pressure</td>
<td>3577 kPa (518.8 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Density</td>
<td>560 kg/m³ (35.0 lb/cf)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume</td>
<td>1.78 L/kg (0.0286 cf/lb)</td>
<td>8401</td>
</tr>
</tbody>
</table>

**ENVIRONMENTAL**

ODP (ozone depletion potential): <0.00002 mass-weighted average 9501 (model-derived relative to R 11)

GWP (global warming potential): 3620 mass-weighted average 9501 relative to CO2 for 100 yr integration

HGWP (halocarbon GWP): 0.64 mass-weighted average DW relative to R 11 for infinite integration period

**SAFETY**

Classification: none (no application pending) 8601

Safety group (ASHRAE Standard 34): components are A1, A2, and 8601

See data limitations and notes on page 2
Refrigerant Database

- long-term occupational limit ------- unclassified 8601
  exposure limit consistent to OSHA PEL: GHG: 1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk MSDS
- flammability ------------------------ GHG: nonflammable MSDS
  LFL-UFL (flammability limits in air): GHG: none MSDS
  flash point: GHG: ~260°C (~500°F) MSDS
  autoignition temperature: GHG: ≥204 °C (≥400 °F) MSDS
  autodecomposition temperature: GHG: colorless liquified gas MSDS
- detection -------------------------- GHG: faint ethereal odor MSDS
  appearance: GHG: faint ethereal odor MSDS
  odor: GHG: faint ethereal odor MSDS

PRODUCTION
  first commercial use as a refrigerant: circa 1999 3C05
  last year production allowed: unrestricted
R-125/290/218

--- REFRIGERANT DATA SUMMARY ---

unassigned R-125/290/218 (formulation not disclosed) see RDB#
zeotrope blend

COMMON USE(S)
alternative for refrigerant 13B1 in both existing and new equipment for very low temperature refrigeration, including that for process use, thermal shock systems, environmental test chambers, and freeze drying

Note: The following information is preliminary and may be incomplete or incorrect. Data may be available from Rhodia Limited (Avonmouth, Bristol, UK), Star Refrigeration (Glasgow, Scotland, UK), and other refrigerant manufacturers. Preliminary data show the pressures of this blend to be similar, but slightly lower than for refrigerant 13B1 with a small increase in efficiency and small decrease in capacity under identical conditions.

IDENTIFIERS

common name(s): R-125/290/218 (?/?/?/??)
trade name(s): HFC-125/HC-290/FC-218 (?/??/??)
historical name(s): Rhône-Poulenc Isceon 89
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

- nominal blend formulation
  component weight fractions: formulation must be indicated

  normal boiling point
  bubble point temperature: -54.6 °C (-66.3 °F) mfr
  density, saturated vapor: 5.10 kg/m³ (0.318 lb/cf) mfr
  heat of vaporization: 176.1 kJ/kg (75.7 Btu/lb) mfr

  20 °C (68 °F) pressure, liquid (bubble point): 1328.8 kPa (192.73 psia) mfr
  pressure, vapor (dew point): 1244.0 kPa (180.43 psia) mfr
  density, saturated liquid: 1168 kg/m³ (72.93 lb/cf) mfr
  density, saturated vapor: 77.10 kg/m³ (4.813 lb/cf) 3209
  specific volume, saturated liquid: 0.883 L/kg (0.0141 cf/lb) mfr
  specific volume, saturated vapor: 13.0 L/kg (0.2078 cf/lb) mfr

  60 °C (140 °F) pressure, liquid (bubble point): 3284 kPa (476.2 psia) mfr
  pressure, vapor (dew point): 3135 kPa (454.7 psia) mfr

  critical point
  temperature: 70.1 °C (158.2 °F) mfr
  pressure: 3650 kPa (529.4 psia) mfr

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative to R 11)
HGWP (halocarbon GWP): 0.98 relative to R 11 for infinite integration period

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
**SAFETY**

- classification
  - safety group (ASHRAE Standard 34): none (no application pending) components are A1, A3, and A1

- flammability
  - LFL-UFL (flammability limits in air): nonflammable

- detection
  - appearance: Rhône-Poulenc: colorless
  - odor: Rhône-Poulenc: slightly ethereal

**PRODUCTION**

- first commercial use as a refrigerant: circa 1995
- last year production allowed: unrestricted
R-134a/124/600 (59.0/39.0/2.0)

REFRIGERANT DATA SUMMARY

unassigned R-134a/124/600 (59.0/39.0/2.0) see RDB#

ternary blend

COMMON USE(S)

considered as a replacement for refrigerant 12 for aftermarket use as a service fluid in mobile air conditioners, transport refrigeration equipment, and other applications

This refrigerant may be covered by U.S. patents 5,360,566 and 5,425,890.

IDENTIFIERS

common name(s): R-134a/124/600 (59/39/2)
RI34a/124/600 (59/39/2)
R 134a/124/600 (59/39/2)
candidate for R-416 series
HFC-134a/HCFC-124/HC-600 (59/39/2)
not HCFC-134a/124/600 (59/39/2)

trade name(s): Ausimont Meforex(R) DI-24

ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

nominal blend formulation -------

composition: R-134a/124/600

component weight fractions: 59.0 / 39.0 / 2.0 %

component mole fractions: 64.363 / 31.807 / 3.830 % 8820

properties -------------

molar mass: 111.30506 g/mol (0.245386 lb/mol) 8820

normal boiling point -------------

bubble point temperature: -23.4 °C (-10.1 °F) 8401
dew point temperature: -21.8 °C (-7.3 °F) 8401
maximum temperature glide: 1.56 °C (2.8 °F) 8401
density, saturated liquid: 1.378 kg/m³ (86.01 lb/cf) 8401
density, saturated vapor: 5.64 kg/m³ (0.352 lb/cf) 8401
specific volume, saturated liquid: 0.726 L/kg (0.0116 cf/lb) 8401
specific volume, saturated vapor: 177.3 L/kg (2.8406 cf/lb) 8401
heat of vaporization: 199.8 kJ/kg (85.9 Btu/lb) 8401
velocity of sound, saturated liquid: 721 m/s (2365 ft/s) 8401
velocity of sound, saturated vapor: 140 m/s (459 ft/s) 8401
viscosity, saturated liquid: 371 µPa·s (0.371 cp) 8401
viscosity, saturated vapor: 9.65 µPa·s (0.00965 cp) 8401
thermal conductivity, liquid: 0.0948 W/m·K (0.0548 Btu/hr·ft·°F) 8401
thermal conductivity, vapor: 0.0094 W/m·K (0.0055 Btu/hr·ft·°F) 8401

normal pressure, 20 °C (68 °F) -----
density, vapor: 4.739 kg/m³ (0.2958 lb/cf) 8401

density, vapor: 4.719 kg/m³ (0.2946 lb/cf) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2


• 20 °C (68 °F) ---------------
  pressure, liquid (bubble point): 505.0 kPa (73.24 psia) 8401
  pressure, vapor (dew point): 479.7 kPa (69.58 psia) 8401
  density, saturated liquid: 1240 kg/m³ (77.39 lb/ft³) 8401
  density, saturated vapor: 25.00 kg/m³ (1.561 lb/ft³) 8401
  specific volume, saturated liquid: 0.807 L/kg (0.0129 cf/lb) 8401
  specific volume, saturated vapor: 40.0 L/kg (0.6407 cf/lb) 8401
  velocity of sound, saturated liquid: 529 m/s (1735 ft/s) 8401
  velocity of sound, saturated vapor: 140 m/s (459 ft/s) 8401
  viscosity, saturated liquid: 213 µPa·s (0.213 cp) 8401
  viscosity, saturated vapor: 11.3 µPa·s (0.0113 cp) 8401
  thermal conductivity, saturated liquid: 0.0776 W/m·K (0.0448 Btu/hr·ft²·°F) 8401
  thermal conductivity, saturated vapor: 0.01277 W/m·K (0.00738 Btu/hr·ft²·°F) 8401

• 60 °C (140 °F) ---------------
  pressure, liquid (bubble point): 1478 kPa (214.4 psia) 8401
  pressure, vapor (dew point): 1425 kPa (206.6 psia) 8401
  heat of vaporization: 133.4 kJ/kg for liquid and vapor both at nominal composition (57.4 Btu/lb) 8401
  127.8 kJ/kg coexisting liquid and vapor at bubble-point pressure (54.9 Btu/lb) 8401

• critical point ---------------
  temperature: 108.6 °C (227.5 °F) 8401
  pressure: 4042 kPa (586.2 psia) 8401
  density: 513 kg/m³ (32.1 lb/ft³) 8401
  specific volume: 1.95 L/kg (0.0312 cf/lb) 8401

ENVIRONMENTAL

  ODP (ozone depletion potential): 0.010 mass-weighted average (model-derived relative to R 11) 9501
  0.010 mass-weighted average (semi-empirical relative to R 11) 9501

  GWP (global warming potential): 1190 mass-weighted average relative to CO₂ for 100 yr integration 9501

  HGWP (halocarbon GWP): 0.20 mass-weighted average relative to R 11 for infinite integration period 9501

SAFETY

• classification ------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A1, A1, and A3 8601
  NFFPA 704 degrees of hazard (H-F-R-S): IGC/ICE: 2-0-0 6006
  health-flammability-reactivity [-special]: 0=no, 4=severe 6006

• acute (short-term) toxicity --------
  cardiac sensitization threshold/LOEL: dog: 70,000 ppm v/v (lowest observed effect level in test animals) 4506

• flammability ---------------------
  LFL-UFL (flammability limits in air): none (nonflammable as tested) 6006
  flash point: IGC/ICE: none 6006

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
- detection -

<table>
<thead>
<tr>
<th>appearance</th>
<th>odor</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGC/ICE: clear, colorless gas</td>
<td>IGC/ICE: faint hydrocarbon</td>
</tr>
<tr>
<td>MSDS</td>
<td>MSDS</td>
</tr>
</tbody>
</table>

**PRODUCTION**

- first commercial use as a refrigerant: not known to be commercialized
- last year production allowed: 2029 based on refrigerant 124 8C01 in developed countries under the Montreal Protocol
R-134a/142b (80.0/20.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-134a/142b (80.0/20.0) see
zeotrope binary blend RDB#

COMMON USE(S)

service fluid to replace refrigerant 12, for aftermarket use to
retrofit existing automobile air conditioners and other mobile
air-conditioning (MAC) systems

The following information is preliminary and may be incomplete or
incorrect. Data may be available from Technical Chemical Company
(TCC, Dallas, TX, USA), and other refrigerant manufacturers.

Note: This refrigerant also is sold as a "ternary blend" containing
a small amount, up to 3%, of lubricant. Unconfirmed information
indicates that the lubricant component may be a polyolester.

IDENTIFIERS

common name(s): R-134a/142b (80/20)
R134a/142b (80/20)
R 134a/142b (80/20)
HFC-134a/HFC-142b (80/20)
not HCFC-134a/142b (80/20)
trade name(s): TCC Johnsen’s Freeze 12(TM) 8355
TCC Sercow Freeze 12(TM) 8355

PHYSICAL

nominal blend formulation --------
composition: R-134a/142b
component weight fractions: 80.0 / 20.0 %
component mole fractions: 79.756 / 20.244 % 8820

properties -----------------------
molar mass: 101.71191 g/mol (0.224236 lb/mol) 8820

normal boiling point ------------
bubble point temperature: -24.1 ºC (-11.4 ºF) 8401
dew point temperature: -22.7 ºC (-8.1 ºF) 8401
maximum temperature glide: 1.39 ºC (2.5 ºF) 8401
density, saturated liquid: 1336 kg/m³ (83.42 lb/cf) 8401
density, saturated vapor: 5.17 kg/m³ (0.323 lb/cf) 8401
specific volume, saturated liquid: 0.748 L/kg (0.0120 cf/lb) 8401
specific volume, saturated vapor: 193.4 L/kg (3.0983 cf/lb) 8401
heat of vaporization: 218.7 kJ/kg (94.0 Btu/lb) 8401
velocity of sound, saturated liquid: 748 m/s (2456 ft/s) 8401
velocity of sound, saturated vapor: 147 m/s (482 ft/s) 8401
viscosity, saturated liquid: 380 μPa·s (0.380 cp) 8401
viscosity, saturated vapor: 9.33 μPa·s (0.00933 cp) 8401
thermal conductivity, liquid: 0.1016 W/m·K (0.0587 Btu/hr·ft·ºF) 8401
thermal conductivity, vapor: 0.0093 W/m·K (0.0054 Btu/hr·ft·ºF) 8401

normal pressure, 20 ºC (68 ºF) ----
density, vapor: 4.328 kg/m³ (0.2702 lb/cf) 8401

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
normal pressure, 21.1 °C (70 °F) ---
density, vapor: 4.310 kg/m³ (0.2691 lb/cf) 8401

20 °C (68 °F) ---------------------
pressure, liquid (bubble point): 522.9 kPa (75.84 psia) 8401
pressure, vapor (dew point): 498.0 kPa (72.22 psia) 8401
density, saturated liquid: 1201 kg/m³ (74.96 lb/cf) 8401
density, saturated vapor: 23.75 kg/m³ (1.483 lb/cf) 8401
specific volume, saturated liquid: 0.833 L/kg (0.0133 cf/lb) 8401
specific volume, saturated vapor: 42.1 L/kg (0.6744 cf/lb) 8401
velocity of sound, saturated vapor: 550 m/s (1894 ft/s) 8401
velocity of sound, saturated liquid: 147 m/s (483 ft/s) 8401
viscosity, saturated liquid: 216 μPa·s (0.0216 cp) 8401
viscosity, saturated vapor: 11.0 μPa·s (0.00110 cp) 8401
thermal conductivity, saturated liquid: 0.0825 W/m·K (0.0477 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01286 W/m·K (0.00743 Btu/hr·ft·°F) 8401

60 °C (140 °F) ------------------
pressure, liquid (bubble point): 1535 kPa (222.7 psia) 8401
pressure, vapor (dew point): 1481 kPa (214.9 psia) 8401
heat of vaporization: 146.3 kJ/kg for liquid and vapor both at nominal composition (62.9 Btu/lb) 8401
144.9 kJ/kg for coexisting liquid and vapor at bubble-point pressure (62.3 Btu/lb) 8401

critical point ---------------------
temperature: 107.5 °C (225.5 °F) 8401
pressure: 4119 kPa (597.4 psia) 8401
density: 498 kg/m³ (31.1 lb/cf) 8401
specific volume: 2.01 L/kg (0.0322 cf/lb) 8401

ENVIRONMENTAL
ODP (ozone depletion potential): 0.010 mass-weighted average (model-derived relative to R 11) 5301
0.014 mass-weighted average (semi-empirical relative to R 11) 5301
GWP (global warming potential): 1400 mass-weighted average relative to CO2 for 100 yr integration 6695

HGWP (halocarbon GWP): 0.30 mass-weighted average relative to R 11 for infinite integration period DW

SAFETY
classification ---------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601 components are A1 and A2 8601

PRODUCTION
first commercial use as a refrigerant: 1996 8C01
last year production allowed: 2029 based on HCFC component in developed countries under the Montreal Protocol
R-134a/142b (80.0/20.0) plus lubricant additive

--- REFRIGERANT DATA SUMMARY ---

| unassigned | R-134a/142b (80.0/20.0) plus lubricant additive | see |
| zeotrope | binary blend | RDB# |

COMMON USE(S)

service fluid to replace refrigerant 12 for aftermarket use to retrofit existing automobile air conditioners, other mobile air-conditioning (MAC) systems, and stationary refrigeration systems

The following information is preliminary and may be incomplete or incorrect. Data may be available from Refrigerant Gases Incorporated (Bedford, TX) and other refrigerant manufacturers. This refrigerant was promoted and/or distributed by American National Corporation (Cocoa Beach, FL, USA), Cool EZ, Incorporated (New Orleans, LA, USA), Patriot Consumer Products (Metairie, LA, USA), and Technical Chemical Company (TCC, Dallas).

Notes: This refrigerant also is sold as a "ternary blend" containing a small amount of lubricant; the nominal formulation is "79/19/2," where the 2% implies the lubricant fraction. Unconfirmed information identifies the lubricant as an additized, naphthenic mineral oil (Royco 783). The trade name "RB-276" was derived from "Refrigerant Blend" and the sum of 134 and 142 from the component designations. The U.S. Air Force conducted tests of this refrigerant in two motor vehicles at Eglin AFB, FL.

IDENTIFIERS

common name(s): R-134a/142b (80/20)
R134a/142b (80/20)
R 134a/142b (80/20)
HFC-134a/HFC-142b (80/20)
not HCFC-134a/142b (80/20)

trade name(s): RGI Free Zone(TM) RB-276

historical name(s): American Natl FreeZone(TM)
Cool EZ RB-276
Patriot FreeZone(TM)
TCC Sercon FreeZone(TM)

name used in U.S. EPA SNAP Rule: HCFC Blend Delta

PHYSICAL

nominal blend formulation --------

composition: R-134a/142b
component weight fractions: 80.0 / 20.0 %
component mole fractions: 79.756 / 20.244 %

properties ------------------------
molar mass: 101.71991 g/mol (0.224254 lb/mol)

normal boiling point --------------

bubble point temperature: -24.1 °C (-11.4 °F)
dew point temperature: -22.7 °C (-8.9 °F)
maximum temperature glide: 1.39 °C (2.5 °F)
density, saturated liquid: 1336 kg/m3 (83.42 lb/cf)
density, saturated vapor: 5.17 kg/m3 (0.323 lb/cf)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific volume, saturated liquid</td>
<td>0.748 L/kg (0.0120 cf/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated vapor</td>
<td>193.4 L/kg (3.0983 cf/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Heat of vaporization</td>
<td>218.7 kJ/kg (94.0 Btu/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Velocity of sound, saturated liquid</td>
<td>748 m/s (2456 ft/s)</td>
<td>8401</td>
</tr>
<tr>
<td>Velocity of sound, saturated vapor</td>
<td>147 m/s (482 ft/s)</td>
<td>8401</td>
</tr>
<tr>
<td>Viscosity, saturated liquid</td>
<td>380 μPa·s (0.380 cp)</td>
<td>8401</td>
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<tr>
<td>Viscosity, saturated vapor</td>
<td>9.33 μPa·s (0.00933 cp)</td>
<td>8401</td>
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<tr>
<td>Thermal conductivity, liquid</td>
<td>0.1016 W/m·K (0.0587 Btu/hr·ft°F)</td>
<td>8401</td>
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<tr>
<td>Thermal conductivity, vapor</td>
<td>0.0093 W/m·K (0.0054 Btu/hr·ft°F)</td>
<td>8401</td>
</tr>
<tr>
<td>Normal pressure, 20 °C (68 °F)</td>
<td>4.328 kg/m³ (0.2702 lb/cf)</td>
<td>8401</td>
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<tr>
<td>Normal pressure, 21.1 °C (70 °F)</td>
<td>4.310 kg/m³ (0.2691 lb/cf)</td>
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<tr>
<td>20 °C (68 °F)</td>
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<tr>
<td>Pressure, liquid (bubble point)</td>
<td>522.9 kPa (75.84 psia)</td>
<td>8401</td>
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<tr>
<td>Pressure, vapor (dew point)</td>
<td>498.0 kPa (72.22 psia)</td>
<td>8401</td>
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<td>Density, saturated liquid</td>
<td>1201 kg/m³ (74.96 lb/cf)</td>
<td>8401</td>
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<td>Density, saturated vapor</td>
<td>23.75 kg/m³ (1.483 lb/cf)</td>
<td>8401</td>
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<tr>
<td>Specific volume, saturated liquid</td>
<td>0.833 L/kg (0.0133 cf/lb)</td>
<td>8401</td>
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<tr>
<td>Specific volume, saturated vapor</td>
<td>42.1 L/kg (0.6744 cf/lb)</td>
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<td>Velocity of sound, saturated liquid</td>
<td>550 m/s (1804 ft/s)</td>
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<td>Velocity of sound, saturated vapor</td>
<td>147 m/s (483 ft/s)</td>
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<tr>
<td>Viscosity, saturated liquid</td>
<td>216 μPa·s (0.216 cp)</td>
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<tr>
<td>Viscosity, saturated vapor</td>
<td>11.0 μPa·s (0.0110 cp)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated liquid</td>
<td>0.0825 W/m·K (0.0477 Btu/hr·ft°F)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated vapor</td>
<td>0.01286 W/m·K (0.00743 Btu/hr·ft°F)</td>
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<td>60 °C (140 °F)</td>
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<tr>
<td>Pressure, liquid (bubble point)</td>
<td>1535 kPa (222.7 psia)</td>
<td>8401</td>
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<tr>
<td>Pressure, saturated vapor</td>
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<td>4101</td>
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<tr>
<td>Pressure, vapor (dew point)</td>
<td>1481 kPa (214.9 psia)</td>
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</tr>
<tr>
<td>Heat of vaporization</td>
<td>146.3 kJ/kg for liquid and vapor both at nominal composition (62.9 Btu/lb)</td>
<td>8401</td>
</tr>
<tr>
<td></td>
<td>144.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (62.3 Btu/lb)</td>
<td>8401</td>
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<tr>
<td>Critical point</td>
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<tr>
<td>Temperature</td>
<td>107.5 °C (225.5 °F)</td>
<td>8401</td>
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<tr>
<td>Pressure, saturated vapor</td>
<td>4119 kPa (597.4 psia)</td>
<td>8401</td>
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<tr>
<td>Density</td>
<td>498 kg/m³ (31.1 lb/cf)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume</td>
<td>2.01 L/kg (0.0322 cf/lb)</td>
<td>8401</td>
</tr>
</tbody>
</table>

**Environmental**

ODP (ozone depletion potential): 0.009 mass-weighted average (model-derived relative to R 11) 5301

GWP (global warming potential): 1740 mass-weighted average relative to CO2 for 100 yr integration 9501

HGWP (halocarbon GWP): 0.30 mass-weighted average relative to R 11 for infinite integration period

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
SAFETY

classification -------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601
components are A1 and A2 8601

PRODUCTION

first commercial use as a refrigerant: 1996
last year production allowed: 2029 based on HCFC component in developed countries under the Montreal Protocol 8C01
### R-134a/152a (20.0/80.0)

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**IDENTIFIERS**

- **common name(s):** R-134a/152a (20.0/80.0) 2909
- **common name(s):** R134a/152a (20.0/80.0) 2909
- **common name(s):** R 134a/152a (20.0/80.0) 2909
- **ARI container color / Pantone number:** none, use light green grey/413 6601

**PHYSICAL**

- **nominal blend formulation**
  - **composition:** R-134a/152a
  - **component weight fractions:** 20.0 / 80.0 %
  - **component mole fractions:** 13.929 / 86.071 % 8820
- **properties**
  - **molar mass:** 71.06193 g/mol (0.156665 lb/mol) 8820
- **normal boiling point**
  - **bubble point temperature:** -24.1 °C (-11.4 °F) 8401
  - **dew point temperature:** -24.1 °C (-11.4 °F) 8401
  - **maximum temperature glide:** 0.01 °C (0.0 °F) 8401
  - **density, saturated liquid:** 1065 kg/m³ (66.49 lb/cf) 8401
  - **density, saturated vapor:** 3.63 kg/m³ (0.227 lb/cf) 8401
  - **specific volume, saturated liquid:** 0.939 L/kg (0.0150 cf/lb) 8401
  - **specific volume, saturated vapor:** 275.2 L/kg (4.4075 cf/lb) 8401
  - **heat of vaporization:** 307.5 kJ/kg (132.2 Btu/lb) 8401
  - **velocity of sound, saturated liquid:** 862 m/s (2829 ft/s) 8401
  - **velocity of sound, saturated vapor:** 178 m/s (584 ft/s) 8401
  - **viscosity, saturated liquid:** 308 μPa·s (0.308 cp) 8401
  - **viscosity, saturated vapor:** 8.64 μPa·s (0.00864 cp) 8401
  - **thermal conductivity, liquid:** 0.1179 W/m·K (0.0681 Btu/hr·ft·°F) 8401
  - **thermal conductivity, vapor:** 0.0094 W/m·K (0.0054 Btu/hr·ft·°F) 8401
- **normal pressure, 20 °C (68 °F)**
  - **density, vapor:** 2.983 kg/m³ (0.1862 lb/cf) 8401
- **normal pressure, 21.1 °C (70 °F)**
  - **density, vapor:** 2.971 kg/m³ (0.1855 lb/cf) 8401
- **20 °C (68 °F)**
  - **pressure, liquid (bubble point):** 517.7 kPa (75.08 psia) 8401
  - **pressure, vapor (dew point):** 517.4 kPa (75.04 psia) 8401
  - **density, saturated liquid:** 959 kg/m³ (59.88 lb/cf) 8401
  - **density, saturated vapor:** 17.30 kg/m³ (1.080 lb/cf) 8401
  - **specific volume, saturated liquid:** 1.043 L/kg (0.0167 cf/lb) 8401

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SEE DATA LIMITATIONS AND NOTES ON PAGE 2

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**COMMON USE(S)**

- Considered (circa 1990-1995) as a replacement for refrigerant 12 as a quasi-azeotropic blend — one that maintains uniform composition of the liquid and vapor phases coexisting in equilibrium within the entire concentration interval for the range -43 to 87 °C (-46 to 188 °F) (see RDB 7732)
specific volume, saturated vapor: 57.8 L/kg (0.9259 cf/lb) 8401
velocity of sound, saturated liquid: 648 m/s (2125 ft/s) 8401
velocity of sound, saturated vapor: 179 m/s (587 ft/s) 8401
viscosity, saturated liquid: 176 μPa·s (0.176 cp) 8401
viscosity, saturated vapor: 10.3 μPa·s (0.0103 cp) 8401
thermal conductivity, saturated liquid: 0.0977 W/m·K (0.0564 Btu/hr·ft²°F) 8401
thermal conductivity, saturated vapor: 0.01410 W/m·K (0.00815 Btu/hr·ft²°F) 8401

• 60 °C (140 °F) ---------------------
  pressure, liquid (bubble point): 1518 kPa (220.1 psia) 8401
  pressure, vapor (dew point): 1517 kPa (220.0 psia) 8401
  heat of vaporization: 211.6 kJ/kg for liquid and vapor both at nominal composition (91.0 Btu/lb) 8401
  211.8 kJ/kg coexisting liquid and vapor at bubble-point pressure (91.0 Btu/lb) 8401

• critical point ---------------------
temperature: 384.2 °C (723.6 °F) 8401
pressure: 4395 kPa (637.4 psia) 8401
density: 375 kg/m³ (23.4 lb/cf) 8401
specific volume: 2.67 L/kg (0.0427 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): <0.00001 mass-weighted average 9501 (model-derived relative to R11) 8401
<0.00001 mass-weighted average 9501 (semi-empirical relative to R11) 8401

GWP (global warming potential): 470 mass-weighted average relative to CO2 for 100 yr integration 9501
HGWP (halocarbon GWP): 0.07 mass-weighted average DW relative to R 11 for infinite integration period 8401

SAFETY

• classification ---------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A1 and A2 8601

• flammability ----------------------
LFL-UFL (flammability limits in air): probably flammable

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
last year production allowed: unrestricted 8C01
R-134a/152a (85.0/15.0)

unassigned  R-134a/152a (85.0/15.0)  see  RDB#
azeotrope   binary blend

COMMON USE(S)
considered (circa 1990-1995) as an alternative for refrigerant 12; the following information is preliminary and may be incomplete or incorrect; data on this blend are available from chemical manufacturers

IDENTIFIERS
common name(s):  R-134a/152a (85.0/15.0)
R13a/152a (85.0/15.0)
R 134a/152a (85.0/15.0)
HFC-134a/HFC-152a (85/15)
not HFC-134a/152a (85/15)

PHYSICAL
- nominal blend formulation ---------
  composition:  R-134a/152a
  component weight fractions:  85.0 / 15.0 %
  component mole fractions:  78.579 / 21.421 %  8820
- properties --------------------------
  molar mass:  94.32344 g/mol (0.207948 lb/mol)  8820
- normal boiling point ---------------
  bubble point temperature:  -25.4 °C (-13.8 °F)  8401
  dew point temperature:  -25.4 °C (-13.7 °F)  8401
  maximum temperature glide:  0.06 °C (0.1 °F)  8401
  density, saturated liquid:  1301 kg/m³ (81.23 lb/cf)  8401
  density, saturated vapor:  4.85 kg/m³ (0.303 lb/cf)  8401
  specific volume, saturated liquid:  0.769 L/kg (0.0123 cf/lb)  8401
  specific volume, saturated vapor:  206.2 L/kg (3.3035 cf/lb)  8401
  heat of vaporization:  234.2 kJ/kg (100.7 Btu/lb)  8401
  velocity of sound, saturated liquid:  767 m/s (2515 ft/s)  8401
  velocity of sound, saturated vapor:  152 m/s (499 ft/s)  8401
  viscosity, saturated liquid:  361 µPa·s (0.361 cp)  8401
  viscosity, saturated vapor:  9.39 µPa·s (0.00939 cp)  8401
  thermal conductivity, liquid:  0.1073 W/m·K (0.0620 Btu/hr·ft²F)  8401
  thermal conductivity, vapor:  0.0093 W/m·K (0.0054 Btu/hr·ft²F)  8401
- normal pressure, 20 °C (68 °F) -----
  density, vapor:  4.011 kg/m³ (0.2504 lb/cf)  8401
- normal pressure, 21.1 °C (70 °F) ---
  density, vapor:  3.994 kg/m³ (0.2493 lb/cf)  8401
- 20 °C (68 °F) ----------------------
  pressure, liquid (bubble point):  555.1 kPa (80.50 psia)  8401
  pressure, vapor (dew point):  553.6 kPa (80.30 psia)  8401
  density, saturated liquid:  1162 kg/m³ (72.55 lb/cf)  8401
  density, saturated vapor:  24.79 kg/m³ (1.548 lb/cf)  8401
  specific volume, saturated liquid:  0.861 L/kg (0.0138 cf/lb)  8401
  specific volume, saturated vapor:  40.3 L/kg (0.6461 cf/lb)  8401
velocity of sound, saturated liquid: 554 m/s (1818 ft/s) 8401
velocity of sound, saturated vapor: 152 m/s (499 ft/s) 8401
viscosity, saturated liquid: 201 µPa·s (0.2012 cp) 8401
viscosity, saturated vapor: 11.2 µPa·s (0.0112 cp) 8401
thermal conductivity, saturated liquid: 0.0869 W/m·K (0.0502 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01350 W/m·K (0.00780 Btu/hr·ft·°F) 8401

- 60 °C (140 °F) -------------------
  pressure, liquid (bubble point): 1633 kPa (236.8 psia) 8401
  pressure, vapor (dew point): 1630 kPa (236.4 psia) 8401
  heat of vaporization: 153.0 kJ/kg for liquid and vapor both at nominal composition (65.8 Btu/lb) 8401
  153.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (65.9 Btu/lb) 8401

- critical point -------------------
  temperature: 102.9 °C (217.2 °F) 8401
  pressure: 4082 kPa (592.0 psia) 8401
  density: 474 kg/m³ (29.6 lb/ft³) 8401
  specific volume: 2.11 L/kg (0.0338 ft³/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
(model-derived relative to R 11) 8401
<0.0005 mass-weighted average 9501
(semi-empirical relative to R 11) 8401

GWP (global warming potential): 1390 mass-weighted average 9501
relative to CO2 for 100 yr integration

HGWP (halocarbon GWP): 0.24 mass-weighted average 9501
relative to R 11 for infinite integration period

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized 8C01
last year production allowed: unrestricted 8C01
R-134a/152a/1311 (26.4/22.8/50.8)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-134a/152a/1311 (26.4/22.8/50.8) see RDB#

zeotrope ternary blend

COMMON USE(S)
developmental blend, examined circa 1994, as an alternative for refrigerant 12

The designations "Ikon-12D" and "R-12D" were trade names and not refrigerant numbers conforming to ASHRAE Standard 34.

IDENTIFIERS

| common name(s) | R-134a/152a/1311 | 4831 |
| R134a/152a/1311 | 4831 |
| R 134a/152a/1311 | 4831 |
| (26.4/22.8/50.8) | |

| historical name(s) | Ikon(R) 12D | 4831 |

PHYSICAL

nominal blend formulation --------

| component weight fractions | 26.4 / 22.8 / 50.8 % | 4831 |
| component mole fractions  | 29.974 / 39.988 / 30.038 % | 8820 |

properties ------------------------

| molar mass | 115.84256 g/mol (0.255389 lb/mol) | 8820 |

ENVIRONMENTAL

ODP (ozone depletion potential): 0.0042 mass-weighted average (model-derived relative to R 11) 9501
0.0042 mass-weighted average (semi-empirical relative to R 11) 9501

GWP (global warming potential): 470 mass-weighted average relative to CO2 for 100 yr integration 9501

SAFETY

flammmability ---------------------

| LFL-UFL (flammability limits in air) | Ikon: nonflammable | 4831 |

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
R-134a/152a/1311

------------------------ REFRIGERANT DATA SUMMARY ------------------------

unassigned R-134a/152a/1311 (formulation not disclosed) see
zeotrope ternary blend RDB# ----

COMMON USE(S)
under consideration as a replacement for refrigerants 12 and 134a in
medium-temperature, commercial refrigeration systems and other
applications

The following information is preliminary and may be incomplete or
incorrect. Data may be available from ETEC (Albuquerque, NM, USA),
Ikon Corporation (c/o Dole Foods, Boynton Beach, FL, USA), and
refrigerant manufacturers.

IDENTIFIERS

common name(s): R-134a/152a/1311 (??/??/??) mfr
R134a/152a/1311 (??/??/??) mfr
R 134a/152a/1311 (??/??/??) mfr
trade name(s): Ikon(R) B
name used in U.S. EPA SNAP Rule: "Ikon(R) 12"
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

nominal blend formulation --------

composition: R-134a/152a/1311 mfr
component weight tolerances: not disclosed mfr

properties ------------------------
normal freezing/melting/triple point:
boiling point ----------------------
temperature: -25.0 °C (-13.0 °F) MSDS

SAFETY

classification ---------------------
safety group (ASHRAE Standard 34):
none (no application pending) 8601
NFPA 704 degrees of hazard (H-F-R-S):
components A1/A2/unclassified 8601
ETEC: 2-0-1 MSDS
health-flammability-reactivity
[-special]: 0=no, 4=severe

short-term occupational limit ------
exposure limit consistent OSHA STEL:
ETEC tentative: 2,000 ppm v/v
TWA for 15 min MSDS

long-term occupational limit ------
exposure limit consistent to OSHA PEL:
ETEC tentative AEL: 170 ppm
v/v TWA for 8 hr/day and 40
hr/wk MSDS

flammability ---------------------
flash point:
ETEC: nonflammable MSDS

appearance: ETEC: colorless gas MSDS
odor: ETEC: slight ethereal MSDS

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
last year production allowed: unrestricted 8C01
R-134a/152a/13I1

------------------------- REFRIGERANT DATA SUMMARY -------------------------

unassigned  R-134a/152a/13I1 (formulation not disclosed)  see
zeotrope  ternary blend  RDB#

COMMON USE(S)
developmental blend, examined circa 1994, as an alternative for
refrigerant 22

The designations "Ikon-22C" and "R-22A" were trade names and not
refrigerant numbers conforming to ASHRAE Standard 34.

IDENTIFIERS

historical name(s):  Ikon(R) 22A  4831

SAFETY

·  flammability  ----------------------
  LFL-UFL (flammability limits in air):  Ikon: nonflammable  4831

PRODUCTION

first commercial use as a refrigerant:  not known to be commercialized

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
### R-134a/600a (80.0/20.0)

--- REFRIGERANT DATA SUMMARY ---

<table>
<thead>
<tr>
<th>unassigned</th>
<th>R-134a/600a (80.0/20.0)</th>
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<tr>
<td>azeotrope</td>
<td>binary blend</td>
</tr>
<tr>
<td></td>
<td>see RDB# (80.0/20.0)</td>
</tr>
</tbody>
</table>

**COMMON USE(S)**

- under consideration as an alternative for refrigerants 12 and 134a in domestic refrigerators as well as refrigerant 22 in air conditioners and heat pumps

Note: The following information is preliminary and may be incomplete or incorrect. Further data may be available from Electrolux Compressors and refrigerant manufacturers.

**IDENTIFIERS**

- **common name(s):** R-134a/600a (80.0/20.0), R134a/600a (80.0/20.0), R 134a/600a (80.0/20.0), HFC-134a/HC-600a (80/20), not HFC-134a/600a (80/20)
- **trade name(s):** Electrolux Compressors RC
- **ARI container color / Pantone number:** none, use light green grey/413 6601 with red / 185 band

**PHYSICAL**

- **nominal blend formulation ---**
  - **composition:** R-134a/600a
  - **component weight fractions:** 80.0 / 20.0 %
  - **component mole fractions:** 69.499 / 30.501 %
  - **molar mass:** 88.63843 g/mol (0.195414 lb/mol)

- **normal boiling point ---**
  - **bubble point temperature:** -29.5 °C (-21.0 °F)
  - **dew point temperature:** -29.4 °C (-21.0 °F)
  - **maximum temperature glide:** 0.00 °C (0.0 °F)
  - **density, saturated liquid:** 1088 kg/m³ (67.90 lb/cf)
  - **density, saturated vapor:** 4.64 kg/m³ (0.290 lb/cf)
  - **specific volume, saturated liquid:** 0.919 L/kg (0.0147 cf/lb)
  - **specific volume, saturated vapor:** 215.6 L/kg (3.4534 cf/lb)
  - **heat of vaporization:** 237.8 kJ/kg (102.2 Btu/lb)
  - **velocity of sound, saturated liquid:** 782 m/s (2567 ft/s)
  - **velocity of sound, saturated vapor:** 155 m/s (508 ft/s)
  - **viscosity, saturated liquid:** 316 µPa·s (0.316 cp)
  - **viscosity, saturated vapor:** 8.61 µPa·s (0.00861 cp)
  - **thermal conductivity, liquid:** 0.1028 W/m·K (0.0594 Btu/hr·ft·°F)
  - **thermal conductivity, vapor:** 0.0096 W/m·K (0.0055 Btu/hr·ft·°F)

- **normal pressure, 20 °C (68 °F) ---**
  - **density, vapor:** 3.676 kg/m³ (0.2295 lb/cf)

- **normal pressure, 21.1 °C (70 °F) ---**
  - **density, vapor:** 3.752 kg/m³ (0.2342 lb/cf)

- **20 °C (68 °F) ---**

See data limitations and notes on page 2.
pressure, liquid (bubble point): 612.6 kPa (88.84 psia) 8401
pressure, vapor (dew point): 606.7 kPa (87.99 psia) 8401
density, saturated liquid: 959 kg/m³ (59.86 lb/cf) 8401
density, saturated vapor: 25.91 kg/m³ (1.618 lb/cf) 8401
specific volume, saturated liquid: 1.043 L/kg (0.0167 cf/lb) 8401
specific volume, saturated vapor: 38.6 L/kg (0.6181 cf/lb) 8401
velocity of sound, saturated liquid: 544 m/s (1785 ft/s) 8401
velocity of sound, saturated vapor: 153 m/s (503 ft/s) 8401
viscosity, saturated liquid: 168 μPa·s (0.168 cp) 8401
viscosity, saturated vapor: 10.5 μPa·s (0.0105 cp) 8401
thermal conductivity, saturated liquid: 0.0803 W/m·K (0.0464 Btu/hr·ft·°F) 8401
thermal conductivity, saturated vapor: 0.01418 W/m·K (0.00819 Btu/hr·ft·°F) 8401

• 60 °C (140 °F) ------------------
  pressure, liquid (bubble point): 1725 kPa (250.1 psia) 8401
  pressure, vapor (dew point): 1702 kPa (246.8 psia) 8401
  heat of vaporization: 148.2 kJ/kg for liquid and vapor both at nominal composition (63.7 Btu/lb) 8401
  heat of vaporization: 148.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (63.7 Btu/lb) 8401

• critical point -----------------
temperature: 111.3 °C (232.3 °F) 8401
pressure: 4806 kPa (697.1 psia) 8401
density: 408 kg/m³ (25.4 lb/cf) 8401
specific volume: 2.45 L/kg (0.0393 cf/lb) 8401

ENVIRONMENTAL
  ODP (ozone depletion potential): <0.00002 mass-weighted average 9501
  (model-derived relative to R 11)
  GWP (global warming potential): 1280 mass-weighted average 9501
  relative to CO₂ for 100 yr integration
  HGWP (halocarbon GWP): 0.22 mass-weighted average 6739
  relative to R 11 for infinite integration period

SAFETY
  • classification ------------------
    safety group (ASHRAE Standard 34): none (no application pending) 8601
    components are A1 and A3 8601
  • flammability ------------------
    LFL-UFL (flammability limits in air): 3.9−13.3 % v/v 6432

PRODUCTION
  first commercial use as a refrigerant: not known to be commercialized 8C01
  last year production allowed: unrestricted 8C01
R-134a with alcohol, hydrocarbon, and weak alkaline

---------------------------- REFRIGERANT DATA SUMMARY ----------------------------

unassigned R 134a (98%), alcohol, hydrocarbon, weak alkaline see RDB#
zeotrope tetrary blend

COMMON USE(S)

Additized version of refrigerant 134a to provide miscibility with mineral oils and other lubricants for use as a replacement for refrigerant 12 in domestic and commercial refrigeration, automobile air conditioners, and transport refrigeration.

The following information is preliminary and may be incomplete or incorrect. Further information may be available from Kanao Metal Manufacturing Company (Japan) or Solpower Australia Pty Limited (Chattenham, Australia). The blend is described as 98% refrigerant 134a with 2% unspecified alcohol, hydrocarbon, and weak alkaline. A description claims the same performance and characteristics as refrigerant 134a plus compatibility with mineral oil, polyalkylene glycol (PAG), and polyolester (POE) lubricants.

IDENTIFIERS

trade name(s): Kanao Metal 134a-E

SAFETY

classification ----------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601

PRODUCTION

First commercial use as a refrigerant: circa 1997
R-143a/22 (55.0/45.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned  R-143a/22 (55.0/45.0) see RDB#
zeotrope  binary blend ---

COMMON USE(S)
under consideration as an alternative for refrigerant 502 and possibly also as a blowing agent and aerosol propellant; developmental and initial formulation for Atochem FX10 (subsequently reformulated)

IDENTIFIERS

common name(s):  R-143a/22 (55.0/45.0)
R143a/22 (55.0/45.0)
R 143a/22 (55.0/45.0)
HFC-143a/HCFC-22 (55/45)
not HCFC-143a/22 (55/45)

historical name(s):  Elf Atochem Forane(R) FX-10 4136
until 8 May 1994 4B16

PHYSICAL

• nominal blend formulation -------
  composition:  R-143a/22
  component weight fractions:
    55.0 / 45.0 %
  component mole fractions:
    59.375 / 40.625 % 8820

• properties -----------------------
  molar mass:  90.72503 g/mol (0.200014 lb/mol) 8820

• normal boiling point -----------
  bubble point temperature:  -44.5 °C (-48.1 °F) 2A06
  dew point temperature:  -44.0 °C (-47.2 °F) 4136
  maximum temperature glide:  0.50 °C (0.9 °F) 2A06
  density, saturated vapor:  4.67 kg/m³ (0.292 lb/cf) 4136
  heat of vaporization:  235.0 kJ/kg (101.0 Btu/lb) 4136

• 25 °C (77 °F) ---------------------
  pressure, saturated vapor:  1180.0 kPa (171.14 psia) 4136
  density, saturated liquid:  1040 kg/m³ (64.93 lb/cf) 4136

• critical point -------------------
  temperature:  83.0 °C (181.4 °F) 4136
  pressure:  4300 kPa (623.7 psia) 4136

ENVIRONMENTAL

ODP (ozone depletion potential):  0.019 mass-weighted average (model-derived relative to R 11)
  0.030 mass-weighted average (semi-empirical relative to R 11) 9501

GWP (global warming potential):  4010 mass-weighted average relative to CO2 for 100 yr integration 9501

HGWP (halocarbon GWP):  0.72 mass-weighted average relative to R 11 for infinite integration period DW

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
SAFETY

- classification ---------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A2 and A1 8601

- flammability ---------------------
  LFL-UFL (flammability limits in air): none (nonflammable as tested) 3A40

PRODUCTION

  last year production allowed: 2029 based on refrigerant 22 8C01
  in developed countries under the Montreal Protocol
R-152a/13I1 (25.0/75.0)

---------- REFRIGERANT DATA SUMMARY ----------
unassigned  R-152a/13I1 (25.0/75.0)  see
zeotrope    binary blend           RDB#

COMMUNITY USE(S)
developmental blend, examined circa 1994, as an alternative for
refrigerant 12

The designations "Ikon-12C" and "R-12C" were trade names and not
refrigerant numbers conforming to ASHRAE Standard 34.

IDENTIFIERS
common name(s):  R-152a/13I1 (75/25)  4831
                 R152a/13I1 (75/25)  4831
                 R 152a/13I1 (75/25)  4831
historical name(s):  Ikon(R) 12C  4831
name used in U.S. EPA SNAP Rule: Blend Zeta (possibly a revised
formulation)
                        "HCFC" Blend Zeta (incorrect)

PHYSICAL
nominal blend formulation ------
composition:  R-152a/13I1  4831
component weight fractions:  75.0 / 25.0 %
                             4831
component mole fractions:    49.716 / 50.284 %
                             4831
                             52 / 48 %
                             8820
                             4831
properties -------------------------
molar mass:  131.34918 g/mol (0.289575 lb/mol)
                             8820
                             4831

ENVIRONMENTAL
ODP (ozone depletion potential):  0.006 (model-derived relative 9501
to R 11)
0.006 (semi-empirical relative 9501
to R 11)
GWP (global warming potential):  50 mass-weighted average 9501
relative to CO2 for 100 yr
integration

SAFETY
flammability -----------------------
LFL-UFL (flammability limits in air):  Ikon: nonflammable 4831

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized
R-152a/13I1

------------------------ REFRIGERANT DATA SUMMARY ------------------------

unassigned  R-152a/13I1 (formulation not disclosed)  see
zeotrope  binary blend  RDB#

COMMON USE(S)
under consideration as an alternative for refrigerant 12

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from ETEC (Albuquerque, NM, USA), Ikon Corporation (c/o Dole Foods, Boynton Beach, FL, USA), and refrigerant manufacturers.

The historical designation "Ikon 12" was a trade name and not a refrigerant number conforming to ASHRAE Standard 34.

IDENTIFIERS

common name(s):  R-152a/13I1 (??/??)  mfr
R152a/13I1 (??/??)  mfr
R 152a/13I1 (??/??)  mfr
trade name(s):  Ikon(R) A  mfr
historical name(s):  "Ikon 12"  mfr
ARI container color / Pantone number:  none, use light green grey/413 6601

PHYSICAL

- nominal blend formulation --------
composition:  R-152a/13I1  mfr
component weight tolerances:  not disclosed  mfr
normal boiling point ----------
temperature:  -22.5 °C (-8.5 °F)  MSDS

SAFETY

- classification -----------------------
safety group (ASHRAE Standard 34):  none (no application pending)  8601
components A2/unclassified  8601
NFPA 704 degrees of hazard (H-F-R-S):
ETEC:  2-0-1  MSDS
health-flammability-reactivity
[-special]:  0=no, 4=severe
long-term occupational limit -------
exposure limit consistent to OSHA PEL:  ETEC tentative AEL: 170 ppm  MSDS
v/v TWA for 8 hr/day and 40 hr/wk
acute (short-term) toxicity -------
LC50 (lethal concentration, 50%):  rat, 15 min, ETEC: 274,000 ppm MSDS
(fatal concentration by inhalation for half of test animals)
cardiac sensitization threshold/LOEL:
dog, ETEC: 4,000 ppm v/v  MSDS
(lowest observed effect level in test animals)
cardiac sensitization (CS) NOEL:
dog, ETEC: 2,000 ppm v/v (no MSDS
observed effect level in test animals)

- flammability ------------------------

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
flash point: ETEC: nonflammable MSDS

appearance: ETEC: colorless gas MSDS

detection -----------------
odor: ETEC: slight ethereal MSDS

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized 8C01

last year production allowed: unrestricted MSDS

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-152a/227ea (25.0/75.0)

Refrigerant Database

Common USE(S)
under consideration as an alternative for refrigerant 12 for retrofit of refrigerators and freezers

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from Great Lakes Chemicals (Lafayette, IN, USA) and other refrigerant manufacturers.

IDENTIFIERS
common name(s): R-152a/227ea (75.0/25.0)
R152a/227ea (75.0/25.0)
R 152a/227ea (75.0/25.0)
trade name(s): Great Lakes Chemical FM series

Physical
- nominal blend formulation ---------
  composition: R-152a/227ea
  component weight fractions: 25.0 / 75.0 %
  component mole fractions: 46.181 / 53.819 %
  molar mass: 122.01030 g/mol (0.268987 lb/mol)
- normal boiling point -------------
  bubble point temperature: -20.7 °C (-45.2 °F)
- critical point ------------------
  temperature: 107.8 °C (226.0 °F)
  pressure: 2834 kPa (411.0 psia)
  density: 485 kg/m3 (30.3 lb/cuft)
  specific volume: 2.06 L/kg (0.0330 cf/lb)

Environmental
ODP (ozone depletion potential): 0.000 (model-derived relative to R 11)
GWP (global warming potential): 2210 mass-weighted average relative to CO2 for 100 yr integration
HGWP (halocarbon GWP): 0.52 relative to R 11 for infinite integration period

Safety
- classification ---------------------
  safety group (ASHRAE Standard 34): none (no application pending)

Production
first commercial use as a refrigerant: not known to be commercialized
last year production allowed: unrestricted

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
### R-152a/227ea (80.0/20.0)

---

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<tr>
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<th>see RDB#</th>
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<tbody>
<tr>
<td>zeotrope: binary blend</td>
<td></td>
</tr>
</tbody>
</table>

**COMMON USE(S)**
- Under consideration as an alternative for refrigerant 12

The following information is preliminary and may be incomplete or incorrect. Data on this blend are available from Great Lakes Chemicals and other refrigerant manufacturers.

**IDENTIFIERS**
- **common name(s):** R-152a/227ea (80.0/20.0)
  - R152a/227ea (80.0/20.0)
  - R 152a/227ea (80.0/20.0)
- **trade name(s):** Great Lakes Chemical FM series

**PHYSICAL**
- **nominal blend formulation**
  - **composition:** R-152a/227ea
  - **component weight fractions:** 80.0 / 20.0 %
  - **component mole fractions:** 91.148 / 8.852 %

**ENVIRONMENTAL**
- **ODP (ozone depletion potential):** 0.000 (model-derived relative to R 11)
- **GWP (global warming potential):** 910 mass-weighted average relative to CO2 for 100 yr integration
- **HGWP (halocarbon GWP):** 0.15 relative to R 11 for infinite integration period

**SAFETY**
- **classification**
  - **safety group [ASHRAE Standard 34]:** none (no application pending)

**PRODUCTION**
- **first commercial use as a refrigerant:** not known to be commercialized
- **last year production allowed:** unrestricted

---

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-152a/600a (70.0/30.0)

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
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<tbody>
<tr>
<td>Molar mass</td>
<td>63.45348 g/mol (0.139891 lb/mol)</td>
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<tr>
<td>Normal boiling point</td>
<td></td>
</tr>
<tr>
<td>Bubble point temperature</td>
<td>-26.5 °C (-15.7 °F)</td>
</tr>
<tr>
<td>Dew point temperature</td>
<td>-26.4 °C (-15.6 °F)</td>
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<tr>
<td>Maximum temperature glide</td>
<td>0.07 °C (0.1 °F)</td>
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<tr>
<td>Density, saturated liquid</td>
<td>834 kg/m³ (52.06 lb/cf)</td>
</tr>
<tr>
<td>Density, saturated vapor</td>
<td>3.28 kg/m³ (0.205 lb/cf)</td>
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<tr>
<td>Specific volume, saturated liquid</td>
<td>1.199 L/kg (0.0192 cf/lb)</td>
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<tr>
<td>Specific volume, saturated vapor</td>
<td>304.8 L/kg (4.8829 cf/lb)</td>
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<tr>
<td>Heat of vaporization</td>
<td>329.7 kJ/kg (141.8 Btu/lb)</td>
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<td>Velocity of sound, saturated liquid</td>
<td>910 m/s (2984 ft/s)</td>
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<tr>
<td>Velocity of sound, saturated vapor</td>
<td>186 m/s (610 ft/s)</td>
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<tr>
<td>Viscosity, saturated liquid</td>
<td>265 μPa·s (0.265 cp)</td>
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<tr>
<td>Viscosity, saturated vapor</td>
<td>7.46 μPa·s (0.00746 cp)</td>
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<tr>
<td>Thermal conductivity, liquid</td>
<td>0.1138 W/m·K (0.0658 Btu/hr·ft°F)</td>
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<tr>
<td>Thermal conductivity, vapor</td>
<td>0.0098 W/m·K (0.0056 Btu/hr·ft°F)</td>
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</table>

Common Use(s)
under consideration in the Russian Federation (since 1996) as an alternative for refrigerant 12, in both existing and new equipment, for domestic refrigerators.

Identifiers
- Common name(s): R-152a/600 (70.0/30.0)
  R152a/600 (70.0/30.0)
  R152a/600 (70.0/30.0)
  HFC-152a/HC-600a (70/30)
  not HFC-152a/600a (70/30)
  (Russia) "C1"
- ARI container color / Pantone number: none, use light green grey/413 6601 with red / 185 band

Physical
- Nominal blend formulation
  Composition: R-152a/600
  Component weight fractions: 70.0 / 30.0 %
  Component mole fractions: 67.248 / 32.752 %

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
specific volume, saturated liquid: 1.339 L/kg (0.0214 cf/lb) 8401
specific volume, saturated vapor: 62.6 L/kg (1.0026 cf/lb) 8401
velocity of sound, saturated liquid: 670 m/s (2197 ft/s) 8401
velocity of sound, saturated vapor: 186 m/s (610 ft/s) 8401
viscosity, saturated liquid: 151 μPa·s (0.151 cp) 8401
viscosity, saturated vapor: 9.0 μPa·s (0.0090 cp) 8401
thermal conductivity, saturated liquid: 0.0926 W/m·K (0.0535 Btu/hr·ft°F) 8401
thermal conductivity, saturated vapor: 0.01481 W/m·K (0.00856 Btu/hr·ft°F) 8401

- 60 °C (140 °F) ---------------
  pressure, liquid (bubble point): 1512 kPa (219.3 psia) 8401
  pressure, vapor (dew point): 1492 kPa (216.3 psia) 8401
  heat of vaporization: 223.2 kJ/kg for liquid and vapor both at nominal composition (96.0 Btu/lb)
  222.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (95.5 Btu/lb)

- critical point ---------------
  temperature: 120.3 °C (248.5 °F) 8401
  pressure: 4933 kPa (715.5 psia) 8401
  density: 309 kg/m3 (19.3 lb/cf) 8401
  specific volume: 3.24 L/kg (0.0519 cf/lb) 8401

ENVIRONMENTAL
ODP (ozone depletion potential): 0.000 (model-derived relative to R 11) 3B12
GWP (global warming potential): 140 mass-weighted average relative to CO2 for 100 yr integration 9501
HGWP (halocarbon GWP): 0.011 relative to R 11 for infinite integration period 5964

SAFETY
- classification ---------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A2 and A3 8601

- flammability ---------------
  LFL-UFL (flammability limits in air): probably highly flammable

PRODUCTION
first commercial use as a refrigerant: 1998
last year production allowed: unrestricted 8C01
R-170/22/115

REFRIGERANT DATA SUMMARY

unassigned    R-170/22/115 (formulation must be indicated)  see  RDB#
zeotrope      ternary blend

COMMON USE(S)
field mixture to improve oil return in ultra-low temperature systems,
especially for blood refrigeration in hospitals with evaporator
temperatures of approximately -60 °C (-76 °F)

IDENTIFIERS
common name(s): R-170/22/115; R170/22/115;
R 170/22/115 (??/??/??)
HC-170/HCFC-22/CFC-115
not CFC-170/22/115
"R-170/502"
R-502 with ethane

PHYSICAL
  nominal blend formulation -------
  composition: R-170/22/115

SAFETY
  classification ---------------------
  safety group (ASHRAE Standard 34):
  none (no application pending) 8601
  components are A3, A1, and A1 8601
  long-term occupational limit -------
  exposure limit consistent to OSHA PEL:
  none, all components are 1,000
  ppm v/v TWA for 8 hr/day and
  40 hr/wk

PRODUCTION
last year production allowed: 1995 based on refrigerant 115 8C01
in developed countries under
the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-170/290 (6.0/94.0)

--- REFRIGERANT DATA SUMMARY ---

| unassigned | R-170/290 (6.0/94.0) | see |
| zeotrope | binary blend | RDB# |

**COMMON USE(S)**

candidate replacement for refrigerants 22 and 502, primarily as a service fluid in aftermarket use for retrofits, in commercial, industrial, and transport refrigeration

The following information is preliminary and may be incomplete or incorrect. Data may be available from Esanty Refrigerants / Boral Energy (Victoria, Australia) and other refrigerant manufacturers.

**IDENTIFIERS**

- **common name(s):** R-170/290 (6.0/94.0)
- **trade name(s):** Boral Energy (Australia) ER22 mfr
- **ARI container color / Pantone number:** none, use light green grey/413 6601 with red / 185 band

**PHYSICAL**

- **nominal blend formulation -------**
  - **composition:** R-170/290
  - **component weight fractions:** 6.0 / 94.0 %
  - **component mole fractions:** 8.559 / 91.441 %
- **properties ------------------------**
  - **molar mass:** 42,89504 g/mol (0.094567 lb/mol)
  - **normal boiling point -----------**
    - **temperature:** -50 to 0 ºC (-58 to 32 ºF)
    - **bubble point temperature:** -52.8 ºC (-63.0 ºF)
    - **dew point temperature:** -43.9 ºC (-47.0 ºF)
    - **maximum temperature glide:** 8.88 ºC (16.0 ºF)
    - **density, saturated liquid:** 588 kg/m³ (36.72 lb/cf)
    - **density, saturated vapor:** 2.37 kg/m³ (0.148 lb/cf)
    - **specific volume, saturated liquid:** 1.699 L/kg (0.0272 cf/lb)
    - **specific volume, saturated vapor:** 422.5 L/kg (6.7673 cf/lb)
    - **heat of vaporization:** 447.3 kJ/kg (192.3 Btu/lb)
    - **velocity of sound, saturated liquid:** 1212 m/s (3978 ft/s)
    - **velocity of sound, saturated vapor:** 221 m/s (726 ft/s)
    - **viscosity, saturated liquid:** 211 μPa·s (0.211 cp)
    - **viscosity, saturated vapor:** 6.24 μPa·s (0.00624 cp)
    - **thermal conductivity, liquid:** 0.1372 W/m·K (0.0793 Btu/hr·ft·ºF)
    - **thermal conductivity, vapor:** 0.0115 W/m·K (0.0066 Btu/hr·ft·ºF)
  - **normal pressure, 20 ºC (68 ºF) -------**
    - **density, vapor:** 1.812 kg/m³ (0.1131 lb/cf)
  - **normal pressure, 21.1 ºC (70 ºF) ---**

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
density, vapor: 1.805 kg/m³ (0.1127 lb/cf) 8401

- 20 °C (68 °F) ---------------------
  pressure, liquid (bubble point): 1050.6 kPa (152.38 psia) 8401
  pressure, vapor (dew point): 903.8 kPa (131.08 psia) 8401
  density, saturated liquid: 493 kg/m³ (30.75 lb/cf) 8401
  density, saturated vapor: 19.10 kg/m³ (1.192 lb/cf) 8401
  specific volume, saturated liquid: 2.030 L/kg (0.0325 cf/lb) 8401
  specific volume, saturated vapor: 52.4 L/kg (0.8389 cf/lb) 8401
  velocity of sound, saturated liquid: 734 m/s (2407 ft/s) 8401
  velocity of sound, saturated vapor: 220 m/s (721 ft/s) 8401
  viscosity, saturated liquid: 97 μPa·s (0.097 cp) 8401
  viscosity, saturated vapor: 8.0 μPa·s (0.0080 cp) 8401
  thermal conductivity, saturated liquid: 0.0954 W/m·K (0.0551 Btu/hr·ft·°F) 8401
  thermal conductivity, saturated vapor: 0.01876 W/m·K (0.01084 Btu/hr·ft·°F) 8401

- 60 °C (140 °F) ---------------------
  pressure, liquid (bubble point): 2490 kPa (361.1 psia) 8401
  pressure, vapor (dew point): 2295 kPa (332.8 psia) 8401
  heat of vaporization: 250.8 kJ/kg for liquid and 8401
  vapor both at nominal 8401
  composition (107.8 Btu/lb) 8401
  232.3 kJ/kg coexisting liquid 8401
  and vapor at bubble-point 8401
  pressure (99.9 Btu/lb) 8401

- critical point ---------------------
  temperature: 91.2 °C (196.1 °F) 8401
  pressure: 4286 kPa (621.6 psia) 8401
  density: 220 kg/m³ (13.7 lb/cf) 8401
  specific volume: 4.55 L/kg (0.0729 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 mass-weighted average 5301
(model-derived relative to R 11)

GWP (global warming potential): unknown, but very low: ~21 8401
relative to CO2 for 100 yr 8401
integration

HGWP (halocarbon GWP): <0.01 mass-weighted average 8401
relative to R 11 for infinite 8401
integration period

SAFETY

- classification ----------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are both A3 8601

- flammability ----------------------
  LFL-UFL (flammability limits in air): Esanty: 1.9-9.5 % v/v 8601
  flash point: -104 to 60 °C (-155 to 140 °F) mfr 8601
  autoignition temperature: Esanty: 550 °C (1022 °F) 8601

- detection ----------------------
  odor: rotten cabbage-like odor mfr

PRODUCTION

first commercial use as a refrigerant: circa 1998
last year production allowed: unrestricted 8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-170/290

------------------ REFRIGERANT DATA SUMMARY ------------------

unassigned R-170/290 (formulation not disclosed) see RDB#
zeotrope binary blend

COMMON USE(S)

service fluid for refrigerant 502 in commercial, industrial, and transport refrigeration

While the manufacturer indicates this blend is R-170/290, it has not disclosed the formulation. One study addressing it (see RDB9822) determined the formulation by gas chromatography as R-170/1270/290 (3.95/1.0/95.0), so the nominal formulation may be approximately R-170/290 (5/95). The following information is preliminary and may be incomplete or incorrect. Further data may be available from Calor Gas Refrigeration (Slough, UK) and other refrigerant manufacturers.

IDENTIFIERS

common name(s): R-170/290 (??/??)
R170/290 (??/??)
R-170/1270/290 (4.0/1.0/95.0) 9822
HC-170/HC-290 (??/??)
not HC-170/290 (??/??)
trade name(s): Calor Gas (UK) CARE 50 5B12
Calor Gas (UK) CARE R290/R170 5B12
Ecozone BV (NL) Ecool-PET

ARI container color / Pantone number: none, use light green grey/413 6601
with red / 185 band

PHYSICAL

- nominal blend formulation --------
  composition: R-170/290
  component weight fractions: formulation must be indicated
  %
- normal boiling point ---------------
  temperature: -49.0 °C (-56.2 °F) 5B12

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative to R 11)
GWP (global warming potential): unknown, but very low: ~20
relative to CO2 for 100 yr integration

SAFETY

- classification -------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are both A3 8601
- flammability ---------------------
  LFL-UFL (flammability limits in air): 2.2-10.2 % v/v 5B12

PRODUCTION

first commercial use as a refrigerant: November 1994
last year production allowed: unrestricted 8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-170/1270

--- REFRIGERANT DATA SUMMARY ---

unassigned  R-170/1270 (formulation must be indicated)  see RDB#
zeotrope  binary blend

COMMON USE(S)
under consideration as a replacement for refrigerant 13B1 both in new
equipment and as a service fluid; use is constrained by high
flammability

IDENTIFIERS

common name(s):  R-170/1270 (??/??)
                 R170/1270 (??/??)
                 R 170/1270 (??/??)
formulation must be indicated
HC-170/HC-1270 (??/??)
not HC-170/1270

ARI container color / Pantone number:  none, use light green grey/413 6601
                                         with red / 185 band

PHYSICAL

nominal blend formulation ----------
composition:  R-170/1270
component weight fractions:  formulation must be indicated

SAFETY

classification ----------------------
safety group (ASHRAE Standard 34):  none (no application pending)  8601
components are both A3  8601

long-term occupational limit --------
exposure limit consistent to OSHA PEL:
none, all components are 1,000
ppm v/v TWA for 8 hr/day and
40 hr/wk

PRODUCTION

first commercial use as a refrigerant:  circa 1996
last year production allowed:  unrestricted  8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
### R-218/134/600 (32.7/62.8/4.5)

**REFRIGERANT DATA SUMMARY**

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<tr>
<th>unassigned</th>
<th>R-218/134/600 (32.7/62.8/4.5)</th>
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<tbody>
<tr>
<td>azeotrope</td>
<td>ternary blend</td>
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</tbody>
</table>

**COMMON USE(S)**

Under consideration (since 1996) in the Russian Federation as an alternative for refrigerant 12, in both existing and new equipment, for domestic refrigerators.

There is uncertainty whether the CMI blend in Russia is R-218/134/600 (32.7/62.8/4.5) or R-218/134a/600 (32.7/62.8/4.5).

**IDENTIFIERS**

<table>
<thead>
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<th>R-218/134/600 (32.7/62.8/4.5)</th>
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<td>R219/134/600 (32.7/62.8/4.5)</td>
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<tr>
<td></td>
<td>R 218/134/600 (32.7/62.8/4.5)</td>
</tr>
<tr>
<td></td>
<td>(Russia) &quot;CMI&quot;</td>
</tr>
<tr>
<td></td>
<td>(Russia) &quot;SML&quot;</td>
</tr>
</tbody>
</table>

| ARI container color / Pantone number: | none, use light green grey/413 6601 |

**PHYSICAL**

- **nominal blend formulation**
  - composition: R-218/134/600
  - component weight fractions: 32.7 / 62.8 / 4.5 %
  - component mole fractions: 20.063 / 71.005 / 8.932 %

<table>
<thead>
<tr>
<th>properties</th>
<th>molar mass: 115.36138 g/mol (0.254328 lb/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8820</td>
</tr>
</tbody>
</table>

**ENVIRONMENTAL**

- **ODP (ozone depletion potential):** 0.000 mass-weighted average (model-derived relative to R 11)
- **GWP (global warming potential):** 3570 mass-weighted average relative to CO2 for 100 yr integration
- **HGWP (halocarbon GWP):** 13 relative to R 11 for infinite integration period

**SAFETY**

- **classification**
  - safety group (ASHRAE Standard 34): none (no application pending)

**PRODUCTION**

- **first commercial use as a refrigerant:** not known to be commercialized
- **last year production allowed:** unrestricted
R-218/134a/600 (32.7/62.8/4.5)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-218/134a/600 (32.7/62.8/4.5) see RDB#
azeotrope ternary blend ----

COMMON USE(S)
under consideration (since 1996) in the Russian Federation as an alternative for refrigerant 12, in both existing and new equipment, for domestic refrigerators

There is uncertainty whether the CM1 blend in Russia is R-218/134/600 (32.7/62.8/4.5) or R-218/134a/600 (32.7/62.8/4.5).

IDENTIFIERS
common name(s): R-218/134a/600 (32.7/62.8/4.5) R218/134a/600 (32.7/62.8/4.5) R 218/134a/600 (32.7/62.8/4.5) (Russia) "CM1" (Russia) "SML"

PHYSICAL
• nominal blend formulation -------
  composition: R-218/134a/600
  component weight fractions: 32.7 / 62.8 / 4.5 %
  component mole fractions: 20.063 / 71.005 / 8.932 % 8820
• properties ------------------------
  molar mass: 115.36138 g/mol (0.254328 lb/mol) 8820
• normal boiling point ------------
  bubble point temperature: -31.4 °C (-24.6 °F) 8814
dew point temperature: -29.0 °C (-20.2 °F) 8814
  maximum temperature glide: 2.44 °C (4.4 °F) 8814
density, saturated liquid: 1367 kg/m3 (85.31 lb/cf) 8814
density, saturated vapor: 6.03 kg/m3 (0.376 lb/cf) 8814
  specific volume, saturated liquid: 0.732 L/kg (0.0117 cf/lb) 8814
  specific volume, saturated vapor: 186.7 L/kg (2.9913 cf/lb) 8814
  heat of vaporization: 186.7 kJ/kg (80.3 Btu/lb) 8814
  velocity of sound, saturated liquid: 696 m/s (2284 ft/s) 8814
  velocity of sound, saturated vapor: 135 m/s (442 ft/s) 8814
  viscosity, saturated liquid: 346 μPa·s (0.346 cp) 8814
  viscosity, saturated vapor: 9.65 μPa·s (0.00965 cp) 8814
  thermal conductivity, liquid: 0.0898 W/m·K (0.0519 Btu/hr·ft°F) 8814
  thermal conductivity, vapor: 0.0093 W/m·K (0.0054 Btu/hr·ft°F) 8814
• normal pressure, 20 °C (68 °F) ----
  density, vapor: 4.904 kg/m3 (0.3061 lb/cf) 8814
density, saturated liquid: 4.884 kg/m3 (0.3049 lb/cf) 8814
• 20 °C (68 °F) ---------------------
  pressure, liquid (bubble point): 654.7 kPa (94.96 psia) 8814
  pressure, vapor (dew point): 620.8 kPa (90.04 psia) 8814
  density, saturated liquid: 1194 kg/m3 (74.51 lb/cf) 8814
density, saturated vapor: 34.71 kg/m3 (2.167 lb/cf) 8814

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
specific volume, saturated liquid: \(0.838 \text{ L/kg (0.0134 cf/lb)}\) 8814

specific volume, saturated vapor: \(28.8 \text{ L/kg (0.4615 cf/lb)}\) 8814

velocity of sound, saturated liquid: \(464 \text{ m/s (1523 ft/s)}\) 8814

velocity of sound, saturated vapor: \(133 \text{ m/s (435 ft/s)}\) 8814

viscosity, saturated liquid: \(177 \text{ µPa·s (0.177 cp)}\) 8814

viscosity, saturated vapor: \(11.8 \text{ µPa·s (0.0118 cp)}\) 8814

thermal conductivity, saturated liquid: \(0.0702 \text{ W/m·K (0.0406 Btu/hr·ft°F)}\) 8814

thermal conductivity, saturated vapor: \(0.01364 \text{ W/m·K (0.00788 Btu/hr·ft°F)}\) 8814

\(\cdot\) 60 °C (140 °F) -------------------------------

pressure, liquid (bubble point): \(1828 \text{ kPa (265.2 psia)}\) 8814

pressure, vapor (dew point): \(1766 \text{ kPa (256.2 psia)}\) 8814

heat of vaporization: \(109.8 \text{ kJ/kg for liquid and vapor both at nominal composition (47.2 Btu/lb)}\) 8814

110.5 \text{ kJ/kg coexisting liquid and vapor at bubble-point pressure (47.5 Btu/lb)} 8814

\(\cdot\) critical point -----------------------------

temperature: \(99.8 °C (211.6 °F)}\) 8814

pressure: \(4145 \text{ kPa (601.2 psia)}\) 8814

density: \(514 \text{ kg/m}^3 (32.1 \text{ lb/ft}^3)\) 8814

specific volume: \(1.95 \text{ L/kg (0.0312 cf/lb)}\) 8814

ENVIRONMENTAL

ODP (ozone depletion potential): <0.00001 mass-weighted average 5301 (model-derived relative to R 11)
<0.00032 mass-weighted average 5301 (semi-empirical relative to R 11)

GWP (global warming potential): 3110 relative to CO2 for 100 yr integration 6694
HGWP (halocarbon GWP): 13 relative to R 11 for infinite integration period 6739

SAFETY

\(\cdot\) classification ---------------

safety group (ASHRAE Standard 34): none (no application pending) 8601

components are A1, A1, and A3 8601

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized 801

last year production allowed: unrestricted 801
R-218/134a/600 (33.0/62.0/5.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-218/134a/600 (33.0/62.0/5.0) see RDB#
azeotrope ternary blend

COMMON USE(S)
under consideration (since 1996) in the Russian Federation as an alternative for refrigerant 12, in both existing and new equipment, for domestic refrigerators
developmental formulation of the CM1 blend in Russia

IDENTIFIERS
common name(s):
R-218/134a/600 (33.0/62.0/5.0)
R218/134a/600 (33.0/62.0/5.0)
R 218/134a/600 (33.0/62.0/5.0)

PHYSICAL
- nominal blend formulation --------
  composition: R-218/134a/600
  component weight fractions: 33.0 / 62.0 / 5.0 %
  component mole fractions: 20.193 / 69.910 / 9.897 % 8820
- properties ----------------------
  molar mass: 115.04850 g/mol (0.253639 lb/mol)
- normal boiling point -----------
  bubble point temperature: -31.4 °C (-24.5 °F) 8814
dew point temperature: -28.9 °C (-20.0 °F) 8814
maximum temperature glide: 2.46 °C (4.4 °F) 8814
density, saturated liquid: 1358 kg/m³ (84.80 lb/cf) 8814
density, saturated vapor: 6.01 kg/m³ (0.375 lb/cf) 8814
specific volume, saturated liquid: 0.736 L/kg (0.0118 cf/lb) 8814
specific volume, saturated vapor: 166.4 L/kg (2.6660 cf/lb) 8814
heat of vaporization: 187.1 kJ/kg (80.5 Btu/lb) 8814
velocity of sound, saturated liquid: 697 m/s (2287 ft/s) 8814
velocity of sound, saturated vapor: 135 m/s (442 ft/s) 8814
viscosity, saturated liquid: 344 μPa·s (0.344 cp) 8814
viscosity, saturated vapor: 9.63 μPa·s (0.00963 cp) 8814
thermal conductivity, liquid: 0.0898 W/m·K (0.0519 Btu/hr·ft·°F) 8814
thermal conductivity, vapor: 0.0094 W/m·K (0.0054 Btu/hr·ft·°F) 8814
- normal pressure, 20 °C (68 °F) ----
  density, vapor: 4.891 kg/m³ (0.3053 lb/cf) 8814
- normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 4.871 kg/m³ (0.3041 lb/cf) 8814
- 20 °C (68 °F) ----------------------
  pressure, liquid (bubble point): 652.7 kPa (94.67 psia) 8814
  pressure, vapor (dew point): 617.4 kPa (89.54 psia) 8814
density, saturated liquid: 1187 kg/m³ (74.09 lb/cf) 8814
density, saturated vapor: 34.40 kg/m³ (2.147 lb/cf) 8814
specific volume, saturated liquid: 0.843 L/kg (0.0135 cf/lb) 8814
specific volume, saturated vapor: 29.1 L/kg (0.4657 cf/lb) 8814
velocity of sound, saturated liquid: 465 m/s (1527 ft/s) 8814

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
### Refrigerant Database

- **velocity of sound, saturated vapor**: 133 m/s (436 ft/s)
- **viscosity, saturated liquid**: 176 μPa·s (0.176 cp)
- **viscosity, saturated vapor**: 11.7 μPa·s (0.0117 cp)
- **thermal conductivity, saturated liquid**: 0.0702 W/m·K (0.0406 Btu/hr·ft°F)
- **thermal conductivity, saturated vapor**: 0.01367 W/m·K (0.00790 Btu/hr·ft°F)

- **60 °C (140 °F)**
  - **pressure, liquid (bubble point)**: 1822 kPa (264.2 psia)
  - **pressure, vapor (dew point)**: 1766 kPa (256.2 psia)
  - **heat of vaporization**: 110.2 kJ/kg for liquid and vapor both at nominal composition (47.4 Btu/lb)
  - **111.0 kJ/kg coexisting liquid and vapor at bubble-point pressure (47.7 Btu/lb)**

- **critical point**
  - **temperature**: 100.2 °C (212.4 °F)
  - **pressure**: 4159 kPa (603.2 psia)
  - **density**: 511 kg/m³ (31.9 lb/cf)
  - **specific volume**: 1.96 L/kg (0.0313 cf/lb)

### ENVIRONMENTAL

- **ODP (ozone depletion potential)**: <0.00001 mass-weighted average (model-derived relative to R 11)
- **GWP (global warming potential)**: 3830 mass-weighted average relative to CO₂ for 100 yr integration
- **HGWP (halocarbon GWP)**: 14 mass-weighted average relative to R 11 for infinite integration period

### SAFETY

- **classification**
  - **safety group (ASHRAE Standard 34)**: none (no application pending)

### PRODUCTION

- **first commercial use as a refrigerant**: not known to be commercialized
- **last year production allowed**: unrestricted

---

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-218/152a (83.5/16.5)

--- REFRIGERANT DATA SUMMARY ---
unassigned R-218/152a (83.5/16.5) see RDB#
azeotrope binary blend

COMMON USE(S)
under consideration as an alternative for refrigerants 12, 22, and 502 in commercial and transport refrigeration and in domestic refrigerators and freezers; may be covered by USSR patent 1362739; consideration constrained by high global warming potential of component refrigerant 218

IDENTIFIERS
common name(s): R-218/152a (83.5/16.5)
R218/152a (83.5/16.5)
R 218/152a (83.5/16.5)
FC-218/HFC-152a (83.5/16.5)
not HFC-218/152a (83.5/16.5)
"R507" (not by Standard 34) 4A07

PHYSICAL
- nominal blend formulation -------
  composition: R-218/152a
  component weight fractions: 83.5 / 16.5 %
  component mole fractions: 64.000 / 36.000 % 8820
- properties -----------------------
  molar mass: 144.11004 g/mol (0.317708 lb/mol) 8820
- normal boiling point ------------
  bubble point temperature: -34.8 °C (-30.7 °F) 8814
dew point temperature: -33.7 °C (-28.6 °F) 8814
maximum temperature glide: 1.17 °C (2.1 °F) 8814
density, saturated liquid: 1471 kg/m³ (91.84 lb/cf) 8814
density, saturated vapor: 1.71 kg/m³ (0.107 lb/cf) 8814
specific volume, saturated liquid: 0.680 L/kg (0.0109 cf/lb) 8814
specific volume, saturated vapor: 129.8 L/kg (2.0784 cf/lb) 8814
heat of vaporization: 142.2 kJ/kg (61.1 Btu/lb) 8814
velocity of sound, saturated liquid: 615 m/s (2018 ft/s) 8814
velocity of sound, saturated vapor: 118 m/s (386 ft/s) 8814
viscosity, saturated vapor: 10.00 μPa·s (0.01000 cp) 8814
viscosity, saturated liquid: 308 μPa·s (0.308 cp) 8814
thermal conductivity, liquid: 0.0697 W/m·K (0.0403 Btu/hr·ft°F) 8814
thermal conductivity, vapor: 0.0089 W/m·K (0.0052 Btu/hr·ft°F) 8814
- normal pressure, 20 °C (68 °F) -----
density, vapor: 6.129 kg/m³ (0.3826 lb/cf) 8814
- normal pressure, 21.1 °C (70 °F) ----
density, vapor: 6.104 kg/m³ (0.3811 lb/cf) 8814
- 20 °C (68 °F) -------------------
pressure, liquid (bubble point): 717.0 kPa (103.99 psia) 8814
pressure, saturated vapor: 961.0 kPa (139.38 psia) 4A07
pressure, vapor (dew point): 703.8 kPa (102.07 psia) 8814
density, saturated liquid: 1246 kg/m³ (77.79 lb/cf) 4A07

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
density, saturated vapor: 1260 kg/m³ (78.67 lb/cf)
50.88 kg/m³ (3.176 lb/cf) 8814
73.53 kg/m³ (4.590 lb/cf) 4A07
specific volume, saturated liquid: 0.794 L/kg (0.0127 cf/lb) 8814
specific volume, saturated vapor: 19.7 L/kg (0.3148 cf/lb) 8814
velocity of sound, saturated liquid: 378 m/s (1241 ft/s) 8814
velocity of sound, saturated vapor: 113 m/s (372 ft/s) 8814
viscosity, saturated liquid: 148 μPa·s (0.148 cp) 8814
viscosity, saturated vapor: 12.4 μPa·s (0.0124 cp) 8814
thermal conductivity, saturated liquid: 0.0546 W/m·K (0.0315
Btu/hr·ft·°F) 8814
thermal conductivity, saturated vapor: 0.01393 W/m·K (0.00805
Btu/hr·ft·°F) 8814

- 60 °C (140 °F) ----------------------
presure, liquid (bubble point): 1938 kPa (281.1 psia) 8814
pressure, saturated vapor: 2536 kPa (367.8 psia) 4A07
pressure, vapor (dew point): 1925 kPa (279.2 psia) 8814
heat of vaporization: 73.4 kJ/kg for liquid and vapor both at nominal
composition (31.6 Btu/lb)
74.2 kJ/kg coexisting liquid and vapor at bubble-point
pressure (31.9 Btu/lb)

- critical point -------------------
temperature: 86.6 °C (188.2 °F) 8814
pressure: 3382 kPa (490.5 psia) 8814
density: 562 kg/m³ (35.1 lb/cf) 8814
specific volume: 1.78 L/kg (0.0285 cf/lb) 8814

ENVIRONMENTAL
ODP (ozone depletion potential): 0.000 mass-weighted average
(model-derived relative to R 11) 5301
GWP (global warming potential): 7210 mass-weighted average
relative to CO2 for 100 yr integration 9501
HGWP (halocarbon GWP): 34 mass-weighted average
relative to R 11 for infinite
integration period

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized
last year production allowed: unrestricted 8C01
R-225ca/225cb (45.0/55.0)

---------- REFRIGERANT DATA SUMMARY ----------
unassigned R-225ca/225cb (45.0/55.0) see
azeotrope binary blend CAS number 127564-92-5 RDB# ----

COMMON USE(S)
replacement for chlorofluorocarbon 113 as an industrial cleaning
solvent, particularly for electronic circuit boards

blends of AK-225 also are marketed as solvents (e.g., with ethanol as
Asahiklin AES and with methanol as Flux Remover AMS)

IDENTIFIERS
common name(s): R-225ca/225cb (45/55)
R225ca/225cb (45/55)
R 225ca/225cb (45/55)
HCFC-225ca/HCFC-225cb (45/55)
not HCFC-225ca/225cb (45/55)
CAS number: 127564-92-5 Chemical Abstracts
Service Registry Number
trade name(s): Asahi Glass Asahiklin AK-225

PHYSICAL
• nominal blend formulation -------
  component weight tolerances:
  molar mass: 202.937456 g/mol (0.447401 lb/mol)
  normal freezing/melting/triple point: -131.0 °C (-203.8 °F)
  normal boiling point --------
  temperature: 54.0 °C (129.2 °F)

SAFETY
• classification ----------------------
  safety group (ASHRAE Standard 34):
  long-term occupational limit consistent to OSHA PEL:
• acute (short-term) toxicity -------
  cardiac sensitization threshold/LOEL:
  flammability ---------------------
  LFL-UFL (flammability limits in air):
  flash point:
• detection ------------------------
  appearance: Tech Spray: clear water-white
  odor: Tech Spray: mild

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-245ca/338mcc

--- REFRIGERANT DATA SUMMARY ---

unassigned  R-245ca/338mcc  see RDB#
azeotrope   binary blend

COMMON USE(S)
under consideration as a replacement for refrigerants 11 and 123

Note: This blend was conceived to inert the flammability of the single-compound refrigerant 245ca.

IDENTIFIERS

common name(s):
R 245ca/338mcc (??/??)
R-245ca/338mcc (??/??)
R245ca/338mcc (??/??)
HFC-245ca/HFC-338mcc (??/??)
not HFC-245ca/338mcc (??/??)

PHYSICAL
nominal blend formulation
composition: R-245ca/338mcc

ENVIRONMENTAL
ODP (ozone depletion potential):
0.000 (model-derived relative to R 11)

SAFETY
classification
safety group (ASHRAE Standard 34):
none (no application pending)
components not classified

PRODUCTION
first commercial use as a refrigerant:
not known to be commercialized
last year production allowed:
unrestricted

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-C270/134a (35.0/65.0)

unassigned  R-C270/134a (35.0/65.0)  see  RDB#
azeotrope  binary blend

COMMON USE(S)
under consideration as an alternative for refrigerant 22

IDENTIFIERS

common name(s):  R-C270/134a (35/65)
                 RC270/134a (35/65)
                 R C270/134a (35/65)
                 HC-C270/HFC-134a (35/65)
                 not HFC-C270/134a (35/65)

ARI container color / Pantone number:  none, use light green grey/413 6601
                                       with red / 185 band

PHYSICAL

• nominal blend formulation --------
  component mole fractions:  56.628 / 43.372 %  8820
• properties ------------------------
  molar mass:  68.08204 g/mol (0.150095  lb/mol)

ENVIRONMENTAL

ODP (ozone depletion potential):  <0.00001 mass weighted average 9501
                                 (model-derived relative to R 11)
                                 <0.00033 mass weighted average 9501
                                 (semi-empirical relative to R 11)

GWP (global warming potential):  1050 mass-weighted average 9501
                                 relative to CO2 for 100 yr
                                 integration
HGWP (halocarbon GWP):  0.18 mass-weighted average 6739
                         relative to R 11 for infinite
                         integration period

SAFETY

• classification ---------------------
  safety group (ASHRAE Standard 34):  none (no application pending)  8601
                                         components are A3 and A1  8601

• flammability ----------------------
  LFL-UFL (flammability limits in air):  probably flammable

PRODUCTION

first commercial use as a refrigerant:  not known to be commercialized
last year production allowed:  unrestricted  8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-290/22/124 (3.0/40.0/57.0)

Common Use(s)

Air conditioners operating at high condensing temperatures, such as those in steel mills, primarily for aftermarket use to retrofit existing systems as an alternative for refrigerant 12

Identifiers

Common name(s): R-290/22/124 (3.0/40.0/57.0)
R290/22/124 (3.0/40.0/57.0)
R 290/22/124 (3.0/40.0/57.0)
HC-290/HCFC-22/HCFC-124
(3/40/57)
not HC-290/22/124 (3/40/57)
not HCFC-290/22/124 (3/40/57)
Trade name(s): Dehon Service Mixiflon DP40

Physical

Nominal blend formulation

Composition: R-290/22/124
Component weight fractions: 3.0 / 40.0 / 57.0 %
Component weight tolerances: ±1.0 / ±1.0 / ±1.0
Component mole fractions: 7.174 / 48.782 / 44.043 %

Properties

Molar mass: 105.45309 g/mol (0.232484 lb/mol)

Normal freezing/melting/triple point: Dehon: < -100 °C (<= -148 °F)

Normal boiling point

Bubble point temperature: -37.0 °C (-34.6 °F)
Dew point temperature: -26.0 °C (-14.8 °F)
Maximum temperature glide: 11.02 °C (19.8 °F)
Density, saturated liquid: 1400 kg/m³ (87.42 lb/cf)
Density, saturated vapor: 5.40 kg/m³ (0.337 lb/cf)
Specific volume, saturated liquid: 0.714 L/kg (0.0114 cf/lb)
Specific volume, saturated vapor: 185.3 L/kg (2.9680 cf/lb)
Heat of vaporization:

Velocity of sound, saturated liquid: 779 m/s (2556 ft/s)
Velocity of sound, saturated vapor: 145 m/s (475 ft/s)
Viscosity, saturated liquid: 366 μPa·s (0.366 cp)
Viscosity, saturated vapor: 9.96 μPa·s (0.00996 cp)
Thermal conductivity, liquid: 0.0963 W/m·K (0.0557 Btu/hr·ft·°F)
Thermal conductivity, vapor: 0.0083 W/m·K (0.0048 Btu/hr·ft·°F)

Normal pressure, 20 °C (68 °F)
Density, vapor: 4.472 kg/m³ (0.2792 lb/cf)

Normal pressure, 21.1 °C (70 °F)
Density, vapor: 4.454 kg/m³ (0.2780 lb/cf)

20 °C (68 °F)
Pressure, liquid (bubble point): 732.5 kPa (106.24 psia)
Pressure, vapor (dew point): 569.3 kPa (82.56 psia)
density, saturated liquid: 687.3 kPa (99.68 psia) 8401
1214 kg/m³ (75.79 lb/cf) mfr
1220 kg/m³ (76.17 lb/cf) 8401

density, saturated vapor: 28.08 kg/m³ (1.753 lb/cf) 8401

specific volume, saturated liquid: 0.820 L/kg (0.0131 cf/lb) 8401

specific volume, saturated vapor: 36.6 L/kg (0.5866 cf/lb) 8401

velocity of sound, saturated liquid: 527 m/s (1728 ft/s) 8401

velocity of sound, saturated vapor: 146 m/s (478 ft/s) 8401

viscosity, saturated liquid: 11.9 µPa·s (0.0119 cp) 8401

viscosity, saturated vapor: 0.0741 W/m·K (0.00428 Btu/hr·ft·°F) 8401

thermal conductivity, saturated liquid: 0.01532 W/m·K (0.00885 Btu/hr·ft·°F) 8401

thermal conductivity, saturated vapor: 1924 kPa (279.1 psia) 8401
1665 kPa (241.5 psia) 8401

pressure, liquid (bubble point): 128.3 kJ/kg for liquid and vapor both at nominal composition (55.2 Btu/lb) 8401
101.9 kJ/kg coexisting liquid and vapor at bubble-point pressure (43.8 Btu/lb) 8401

heat of vaporization:

· critical point -------------------
temperature: 105.1 °C (221.2 °F) 8401
112.5 °C (234.5 °F) mfr

pressure: 4457 kPa (646.4 psia) 8401

density: 511 kg/m³ (31.9 lb/cf) 8401

specific volume: 1.96 L/kg (0.0313 cf/lb) 8401

ENVIRONMENTAL

ODP (ozone depletion potential): 0.028 mass-weighted average (model-derived relative to R 11) 9501
0.035 mass-weighted average (semi-empirical relative to R 11) 9501

GWP (global warming potential):

HGWP (halocarbon GWP): 0.18 mass-weighted average relative to CO2 for 100 yr integration DW
relative to R 11 for infinite integration period

SAFETY

· classification -------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601
components are A3, A1, and A1 8601

· long-term occupational limit ------
exposure limit consistent to OSHA PEL: Dehon Service: 500-1,000 ppm v/v TWA for 8 hr/day and 40 hr/wk MSDS

· flammability ---------------------
LFL-UFL (flammability limits in air): Dehon: nonflammable MSDS
flash point: Dehon: not applicable MSDS

· detection -----------------------
appearance: Dehon: colorless MSDS
odor: Dehon: faintly ethereal MSDS
PRODUCTION

first commercial use as a refrigerant: 1994
last year production allowed: 2029 by refrigerants 22, 124 801 in developed countries under the Montreal Protocol
R-290/124/123 (3.0/40.0/57.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-290/124/123 [3.0/40.0/57.0] see RDB#
zeotrope ternary blend ----

COMMON USE(S)
industrial use in applications with high condensing temperatures, such as air conditioners for overhead crane cabs in steel mills, primarily as a service fluid for retrofit of systems designed for refrigerant 114

Note: The hoses commonly used in systems designed for refrigerant 114 are not compatible with the R-290/124/123 blend.

IDENTIFIERS
common name(s): R-290/124/123 (3.0/40.0/57.0)
R290/124/123 (3.0/40.0/57.0)
R 290/124/123 (3.0/40.0/57.0)
not: R-123/124/290 (57/40/3)
not: R123/124/290 (57/40/3)
not: R 123/124/290 (57/40/3)
HC-290/HCFC-124/HCF-123 2909
(3/40/57) 2909
not: HCFC-290/124/123 2909
(3/40/57) 2909

PHYSICAL
• nominal blend formulation --------
  composition: R-290/124/123
  component weight fractions: 3.0 / 40.0 / 57.0 %
  component mole fractions: 9.271 / 39.939 / 50.790 %
• properties ------------------------
  molar mass: 136.26833 g/mol (0.300420 lb/mol)
  normal boiling point ------------
  bubble point temperature: -15.3 °C (4.4 °F)
  dew point temperature: 6.0 °C (42.8 °F)
  maximum temperature glide: 21.34 °C (38.4 °F)
  density, saturated liquid: 1445 kg/m3 (90.21 lb/cf)
  density, saturated vapor: 6.02 kg/m3 (0.376 lb/cf)
  specific volume, saturated liquid: 0.692 L/kg (0.0111 cf/lb)
  specific volume, saturated vapor: 166.0 L/kg (2.6587 cf/lb)
  heat of vaporization: 200.1 kJ/kg (86.0 Btu/lb)
  velocity of sound, saturated liquid: 771 m/s (2530 ft/s)
  velocity of sound, saturated vapor: 134 m/s (440 ft/s)
  viscosity, saturated vapor: 10.55 µPa·s (0.01055 cp)
  viscosity, saturated liquid: 461 µPa·s (0.461 cp)
  thermal conductivity, liquid: 0.0853 W/m·K (0.0493 Btu/hr·ft·°F)
  thermal conductivity, vapor: 0.0101 W/m·K (0.0058 Btu/hr·ft·°F)
• normal pressure, 20 °C (68 °F) ----
  density, vapor: 5.865 kg/m3 (0.3661 lb/cf)
• normal pressure, 21.1 °C (70 °F) ---
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density, vapor:</td>
<td>5.840 kg/m³ (0.3646 lb/ft³)</td>
<td>8401</td>
</tr>
<tr>
<td>20 °C (68 °F)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure, liquid (bubble point):</td>
<td>311.4 kPa (45.16 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure, vapor (dew point):</td>
<td>132.3 kPa (19.19 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Density, saturated liquid:</td>
<td>1351 kg/m³ (84.32 lb/ft³)</td>
<td>8401</td>
</tr>
<tr>
<td>Density, saturated vapor:</td>
<td>7.74 kg/m³ (0.483 lb/ft³)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume, saturated liquid:</td>
<td>0.740 L/kg (0.0119 cf/ft³)</td>
<td>8401</td>
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<tr>
<td>Specific volume, saturated vapor:</td>
<td>12.9 L/kg (0.2069 cf/ft³)</td>
<td>8401</td>
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<tr>
<td>Velocity of sound, saturated liquid:</td>
<td>628 m/s (2060 ft/s)</td>
<td>8401</td>
</tr>
<tr>
<td>Velocity of sound, saturated vapor:</td>
<td>135 m/s (442 ft/s)</td>
<td>8401</td>
</tr>
<tr>
<td>Viscosity, saturated liquid:</td>
<td>299 µPa·s (0.299 cp)</td>
<td>8401</td>
</tr>
<tr>
<td>Viscosity, saturated vapor:</td>
<td>10.8 µPa·s (0.0108 cp)</td>
<td>8401</td>
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<tr>
<td>Thermal conductivity, saturated liquid:</td>
<td>0.0742 W·m⁻¹·K⁻¹ (0.0429 Btu/hr·ft²·°F)</td>
<td>8401</td>
</tr>
<tr>
<td>Thermal conductivity, saturated vapor:</td>
<td>0.01054 W·m⁻¹·K⁻¹ (0.00609 Btu/hr·ft²·°F)</td>
<td>8401</td>
</tr>
<tr>
<td>60 °C (140 °F)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure, liquid (bubble point):</td>
<td>842 kPa (122.1 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure, vapor (dew point):</td>
<td>487 kPa (70.6 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Heat of vaporization:</td>
<td>145.5 kJ/kg for liquid and vapor both at nominal composition (62.6 Btu/lb)</td>
<td>8401</td>
</tr>
<tr>
<td></td>
<td>87.4 kJ/kg coexisting liquid and vapor at bubble-point pressure (37.6 Btu/lb)</td>
<td>8401</td>
</tr>
<tr>
<td>Critical point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature:</td>
<td>151.1 °C (304.0 °F)</td>
<td>8401</td>
</tr>
<tr>
<td>Pressure:</td>
<td>3985 kPa (578.0 psia)</td>
<td>8401</td>
</tr>
<tr>
<td>Density:</td>
<td>530 kg/m³ (33.1 lb/ft³)</td>
<td>8401</td>
</tr>
<tr>
<td>Specific volume:</td>
<td>1.89 L/kg (0.0302 cf/ft³)</td>
<td>8401</td>
</tr>
</tbody>
</table>

**ENVIRONMENTAL**

- ODP (ozone depletion potential): 0.017 mass-weighted average (model-derived relative to R 11)
- GWP (global warming potential): 320 mass-weighted average relative to CO₂ for 100 yr integration
- HGWP (halocarbon GWP): 0.05 mass-weighted average relative to R 11 for infinite integration period

**SAFETY**

- Classification: none (no application pending)
- Safety group (ASHRAE Standard 34): components are A3, A1, and B1

**PRODUCTION**

- First commercial use as a refrigerant: circa 1995
- Last year production allowed: 2029 by refrigerants 123, 124 in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-290/134a (45.0/55.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned | R-290/134a (45.0/55.0) | see RDB#
azeotrope | binary blend | ----

COMMON USE(S)
under consideration as an alternative for refrigerant 22

IDENTIFIERS
common name(s): R-290/134a (45.0/55.0)
| R290/134a (45.0/55.0)
| R 290/134a (45.0/55.0)
| HC-290/HFC-134a (45/55)
| not HFC-290/134a (45/55)
ARI container color / Pantone number: none, use light green grey/413 6601 with red / 185 band

PHYSICAL
- nominal blend formulation -----------
  composition: R-290/134a
  component weight fractions: 45.0 / 55.0 %
  component mole fractions: 65.436 / 34.564 %
- properties ------------------------
  molar mass: 64.12057 g/mol (0.141362 lb/mol)

ENVIRONMENTAL
- ODP (ozone depletion potential): <0.00001 mass-weighted average 9501 (model-derived relative to R 11)
- GWP (global warming potential): 890 mass-weighted average 9501 relative to CO2 for 100 yr integration
- HGWP (halocarbon GWP): 0.15 mass-weighted average 6739 relative to R 11 for infinite integration period

SAFETY
- classification ----------------------
  safety group (ASHRAE Standard 34): none (no application pending)
  components are A3 and A1
- flammability ----------------------
  LFL-UFL (flammability limits in air): 2.9-11.0 % v/v

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized
last year production allowed: unrestricted
R-290/134a

unassigned R-290/134a (??/??)
azeotrope binary blend

COMMON USE(S)
under consideration as an alternative for refrigerants 12 and 134a to enable use of mineral oil lubricants

IDENTIFIERS
common name(s): R-290/134a (??/??)
R290/134a (??/??)
R 290/134a (??/??)
HC-290/HFC-134a (??/??)
not HFC-290/134a (??/??)

ARI container color / Pantone number: none, use light green grey/413 6601 with red / 185 band

PHYSICAL
• nominal blend formulation ---------
  composition: R-290/134a

ENVIRONMENTAL
ODP (ozone depletion potential): 0.000 (model-derived relative to R 11)

SAFETY
• classification ---------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A3 and A1 8601

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized
last year production allowed: unrestricted 8C01
R-290/134a/ethanol (??/98.0/??)

--- REFRIGERANT DATA SUMMARY ---
unassigned  R-290/134a/ethanol (??/98.0/??)  see
zeotrope     ternary blend               RDB#

COMMON USE(S)
additized version of refrigerant 134a to provide miscibility with
mineral oils and other lubricants for use as a replacement for
refrigerant 12 in domestic and commercial refrigeration, automobile
air conditioners, and transport refrigeration

The following information is preliminary and may be incomplete or
incorrect. Further information may be available from Seco
Technologies, Incorporated (Los Angeles, CA, USA) or Solpower
Australia Pty Limited (Chattenden, Australia). The blend is
described as 98% refrigerant 134a with 2% pharmaceutical grade
refrigerant 290 (propane) and ethanol. A description claims that
this blend is up to 25% more efficient than refrigerant 134a, offers
higher capacities with lower head pressures, and is compatible all
systems designed for refrigerants 12 and 134a, and is compatible with
mineral oil, polyalkylene glycol (PAG), and polyolester (POE)
lubricants. This blend appears to be a revised formulation of
R-134a-E.

IDENTIFIERS

trade name(s): Solpower Australia Pty SP34E

PHYSICAL

- properties -------------------------------
molar mass: 102.0 g/mol (0.224872 lb/mol) mfr
- normal boiling point ---------------------
temperature: -26.1 °C (-15.1 °F) mfr
- 20 °C (68 °F) ---------------------------
  pressure, saturated vapor: 476.6 kPa (69.13 psia) mfr
- 60 °C (140 °F) -------------------------
  pressure, saturated vapor: 1586 kPa (230.0 psia) mfr
- critical point -------------------------
temperature: 101.0 °C (213.9 °F) mfr

ENVIRONMENTAL

  ODP (ozone depletion potential): 0.000 (model-derived relative to R 11)
  HGWP (halocarbon GWP): 0.24-0.29 relative to R 11 for mfr
    infinite integration period

SAFETY

- classification --------------------------
safety group (ASHRAE Standard 34): none (application pending)
- flammability ---------------------------
  LFL-UFL (flammability limits in air): nonflammable as tested % v/v mfr
- detection -----------------------------
  appearance: colorless gas mfr
  odor: ethanol odor mfr

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
PRODUCTION

first commercial use as a refrigerant: circa 1998
R-290/152a/13I1 (formulation not disclosed)

--- REFRIGERANT DATA SUMMARY ---

| unassigned | R-290/152a/13I1 (formulation not disclosed) | see |
| zeotrope | ternary blend | RDBB# |

**COMMON USE(S)**
under consideration as an alternative for refrigerants 12 and 134a

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from Tsinghua University (Beijing, Peoples Republic of China) and refrigerant manufacturers.

The blend consists of refrigerant 13I1, a hydrofluorocarbon (HFC) with a low global warming potential, and hydrocarbon (HC). Papers on the blend indicate that the HFC and HC are both flammable, but that the blend is not. Although unpublished, the composition was identified as R-290/152a/13I1 at a presentation in November 1997, but the formulation was not disclosed.

**IDENTIFIERS**

| common name(s): | R-290/152a/13I1 (??/??/??) |
| | R290/152a/13I1 (??/??/??) |
| | R 290/152a/13I1 (??/??/??) |
| trade name(s): | (China) THR02 |

**PHYSICAL**

- nominal blend formulation

| composition: | R-290/152a/13I1 |
| component weight fractions: | formulation must be indicated % |
- normal boiling point

| maximum temperature glide: | 1.00 °C (1.8 °F) |

**ENVIRONMENTAL**

| ODP (ozone depletion potential): | ~0. (model-derived relative to R 11) |
| GWP (global warming potential): | ~50. relative to CO2 for 100 yr integration |

**SAFETY**

- classification

| safety group (ASHRAE Standard 34): | none (no application pending) |
| | components are A1, A3, and unclassified |
| | unclassified |
- flammability

| LFL-UFL (flammability limits in air): | none (nonflammable as tested) |

**PRODUCTION**

| first commercial use as a refrigerant: | not known to be commercialized |
| last year production allowed: | unrestricted |

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-290/600 (60.0/40.0 by liquid volume)

------------------- REFRIGERANT DATA SUMMARY -------------------
unassigned      R-290/600 (60.0/40.0 by liquid volume)  see
zeotrope         binary blend                         RDB#

COMMON USE(S)

service fluid for refrigerant 12 and 134a in such uses as mobile air conditioning, refrigerators, and ice makers; flammability has spurred restrictions in locations including Florida; while the National Highway Traffic Safety Administration and the U.S. Environmental Protection Agency are investigating potential risks, the manufacturer asserts that OZ-12 poses no unusual danger.

The following information is preliminary and may be incomplete or incorrect. Data may be available from OZ Technology, Incorporated (Rathdrum, ID, USA) and other refrigerant manufacturers.

IDENTIFIERS

  common name(s):  R-290/600 (60/40)
                   R290/600 (60/40)
                   R 290/600 (60/40)
                   HC-290/HC-600 (60/40)
                     not HC-290/600 (60/40)  2909
  trade name(s):   ES112R
                   ES12R
  historical name(s):  OZ Technology OZ-12
  name used in U.S. EPA SNAP Rule:  Hydrocarbon Blend A
  ARI container color / Pantone number:  none, use light green grey/413 6601
                                      with red / 185 band

PHYSICAL

  nominal blend formulation -------
    composition:  R-290/600
    component weight fractions:  60.0 / 40.0 %
    component mole fractions:  66.411 / 33.589 %  8820
  properties ----------------------
    molar mass:  48.80704 g/mol (0.107601 lb/mol)  8820

ENVIRONMENTAL

  ODP (ozone depletion potential):  0.000 mass-weighted average
                                   (model-derived relative to R
                                   11)
  GWP (global warming potential):  unknown, but very low: ~20
                                    relative to CO2 for 100 yr
                                    integration

SAFETY

  classification ---------------------
    safety group (ASHRAE Standard 34):  none (no application pending)  8601
                                      components are both A3  8601
  emergency exposure limit --------
    Refrigerant Concentration Limit (RCL):  4,600 ppm v/v (preliminary
                                             value under review, based on

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
### PRODUCTION

| first commercial use as a refrigerant: | circa 1993 |
| last year production allowed:        | unrestricted |
R-290/600 or R-290/600a

--- REFRIGERANT DATA SUMMARY ---

unassigned  R-290/600 or R-290/600a, formulation not disclosed  see RDB#
zeotrope  binary blend  ----

COMMON USE(S)
service fluid for refrigerant 12 in such uses as mobile air conditioning, refrigerators, and ice makers

The following information is preliminary and may be incomplete or incorrect. Data may be available from Esanty Refrigerants / Boral Energy (Victoria, Australia) and other refrigerant manufacturers.

Product literature describes this refrigerant as "manufactured from a blend of purified hydrocarbons." It further identifies the blend as consisting of refrigerants 290 (propane) and 600a (isobutane), but shows the ingredients by Chemical Abstracts Service (CAS) registry numbers as consisting of 74-98-6 (propane) and 106-97-8 (n-butane). The product sheet shows the each components proportion as "0 to 50%", for which the only mathematical solution, without another component, is 50/50.

IDENTIFIERS

common name(s):  R-290/600 or R-290/600a(??/??)
                 R290/600 or R290/600a(??/??)
                 R 290/600 or R 290/600a(??/??)
                 HC-290/HC-600 (??/??) or
                 HC-290/HC-600a (??/??)
                 not HC-290/600 (??/??) or
                 HC-290/600a (??/??) or
trade name(s):  Boral Energy (Australia) ER12  mfr
                Esanty Refrigerants ER12  mfr
ARI container color / Pantone number:  none, use light green grey/413 6601
                                       with red / 185 band

PHYSICAL

- normal boiling point -----------------
temperature:  -30 to 0 °C (-22 to 32 °F)  mfr
- 20 °C (68 °F) -----------------------
  pressure, saturated vapor:  591.0 kPa (85.72 psia)  mfr

SAFETY

- classification ---------------------
safety group (ASHRAE Standard 34):  none (no application pending) 8601
                                       components are both A3 8601
- flammability ----------------------
  LFL-UFL (flammability limits in air):  1.9-9.5 % v/v  mfr
  flash point:  -104 to 60 °C (-155 to 140 °F)  mfr
  autoignition temperature:  550 °C (1022 °F)  mfr
- detection -------------------------
  odor:  rotten cabbage-like odor  mfr

PRODUCTION

first commercial use as a refrigerant:  circa 1998

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
| Last year production allowed: | unrestricted | 8C01 |
R-290/600a (50.0/50.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-290/600a (50.0/50.0) see RDB#
zeotrope blend ---

COMMON USE(S)
alternative for refrigerant 12 in refrigerators, commercial refrigeration, mobile air conditioning, and ice makers; constrained by high flammability, though accepted in some countries, notably Germany, in systems with small charges

IDENTIFIERS
common name(s): R-290/600a (50.0/50.0)
R290/600a (50.0/50.0)
R 290/600a (50.0/50.0)
HC/HC-290/600a (50/50)
not HC-290/600a (50/50)

ARI container color / Pantone number: none, use light green grey/413 6601 with red / 185 band

PHYSICAL
• nominal blend formulation -------
  composition: R-290/600a
  component weight fractions: 50.0 / 50.0 %
  component mole fractions: 56.861 / 43.139 %

• properties -----------------------
  molar mass: 50.14653 g/mol (0.110554 lb/mol)

• normal boiling point -----------
  bubble point temperature: -32.8 °C (-27.0 °F)
  dew point temperature: -24.1 °C (-11.4 °F)
  maximum temperature glide: 8.68 °C (15.6 °F)
  density, saturated liquid: 592 kg/m³ (36.97 lb/cf)
  density, saturated vapor: 2.55 kg/m³ (0.159 lb/cf)
  specific volume, saturated liquid: 1.688 L/kg (0.0270 cf/lb)
  specific volume, saturated vapor: 392.0 L/kg (6.2797 cf/lb)
  heat of vaporization: 412.8 kJ/kg (177.5 Btu/lb)
  velocity of sound, saturated liquid: 1105 m/s (3625 ft/s)
  velocity of sound, saturated vapor: 210 m/s (688 ft/s)
  viscosity, saturated liquid: 222 µPa·s (0.222 cp)
  viscosity, saturated vapor: 6.35 µPa·s (0.00635 cp)
  thermal conductivity, liquid: 0.1233 W/m·K (0.0712 Btu/hr·ft·°F)
  thermal conductivity, vapor: 0.0123 W/m·K (0.0071 Btu/hr·ft·°F)

• normal pressure, 20 °C (68 °F) ----
  density, vapor: 2.130 kg/m³ (0.1330 lb/cf)

• normal pressure, 21.1 °C (70 °F) ---
  density, vapor: 2.122 kg/m³ (0.1325 lb/cf)

• 20 °C (68 °F) ---------------------
  pressure, liquid (bubble point): 590.4 kPa (85.63 psia)
  pressure, vapor (dew point): 477.1 kPa (69.20 psia)
  density, saturated liquid: 528 kg/m³ (32.93 lb/cf)
  density, saturated vapor: 11.05 kg/m³ (0.690 lb/cf)

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
specific volume, saturated liquid: 1.896 L/kg (0.0304 cf/lb) 8401
specific volume, saturated vapor: 90.5 L/kg (1.4501 cf/lb) 8401
velocity of sound, saturated liquid: 790 m/s (2593 ft/s) 8401
velocity of sound, saturated vapor: 211 m/s (693 ft/s) 8401
viscosity, saturated liquid: 125 μPa·s (0.125 cp) 8401
viscosity, saturated vapor: 7.5 μPa·s (0.0075 cp) 8401
thermal conductivity, saturated liquid: 0.0966 W/m·K (0.0558 Btu/hr·ft°F) 8401
thermal conductivity, saturated vapor: 0.01708 W/m·K (0.00987 Btu/hr·ft°F) 8401

60 °C (140 °F) ----------------
purpose, liquid (bubble point): 1520 kPa (220.4 psia) 8401
pressure, vapor (dew point): 1328 kPa (192.6 psia) 8401
heat of vaporization: 279.6 kJ/kg for liquid and 8401
vapor both at nominal 8401
composition (120.2 Btu/lb) 8401
253.4 kJ/kg coexisting liquid 8401
and vapor at bubble-point 8401
pressure (109.0 Btu/lb) 8401

Critical point -----------------
temperature: 114.8 °C (238.6 °F) 8401
pressure: 4042 kPa (586.2 psia) 8401
density: 218 kg/m³ (13.6 lb/cf) 8401
specific volume: 4.59 L/kg (0.0735 cf/lb) 8401

Environmental
ODP (ozone depletion potential): 0.000 mass-weighted average 8401
(model-derived relative to R 8401
11)
GWP (global warming potential): unknown, but very low: ~20 8401
relative to CO2 for 100 yr 8401
integration
HGWP (halocarbon GWP): <0.01 mass-weighted average 8401
relative to R 11 for infinite 8401
integration period

SAFETY
- classification ----------------- none (no application pending) 8601
  safety group (ASHRAE Standard 34): components are both A3 8601
- emergency exposure limit -------- 4,600 ppm v/v (preliminary 8356
  Refrigerant Concentration Limit (RCL): value under review, based on 8356
draft ASHRAE 34aa)
- flammability ------------------- LFL-UFL (flammability limits in air): 2-10 % v/v 8356

Production
first commercial use as a refrigerant: late 1800s, revived circa 1993 8C01
last year production allowed: unrestricted 8C01
R-290/600a

----------------------- REFRIGERANT DATA SUMMARY -----------------------
unassigned  R-290/600a (formulation not disclosed)  see
zeotrope  binary blend  RDB#

COMMON USE(S)
service fluid for refrigerant 12 in such uses as mobile air conditioning, refrigerators, and ice makers.

The following information is preliminary and may be incomplete or incorrect. Data may be available from Calor Gas Refrigeration (Slough, UK), and other refrigerant manufacturers.

IDENTIFIERS
common name(s):  R-290/600a (??/??)
HC-290/HC-600a (??/??)
not HC-290/600a (??/??)
trade name(s):  Calor Gas (UK) CARE 30  5B12
Ecozone BV (NL) Ecool-PIB
ARI container color / Pantone number:  none, use light green grey/413 6601
with red / 185 band

PHYSICAL
nominal blend formulation ----------
composition:  R-290/600a
component weight fractions:  formulation must be indicated
%

normal boiling point ----------
temperature:  31.5 °C (88.7 °F)  5B12

SAFETY
classification ---------------------
safety group (ASHRAE Standard 34):  none (no application pending)  8601
components are both A3  8601

flammability ---------------------
LFL-UFL (flammability limits in air):  1.95-9.1 % v/v  5B12

PRODUCTION
first commercial use as a refrigerant:  June 1994
last year production allowed:  unrestricted  8C01
R-290/600a/600 (17.1/80.4/2.5)

------------------- REFRIGERANT DATA SUMMARY -------------------

unassigned R-290/600a/600 (17.1/80.4/2.5) see
HC ternary blend RDB#

COMMON USE(S)
not known to be used as a refrigerant; common aerosol propellant

IDENTIFIERS
common name(s): R-290/600a/600 (17.1/80.4/2.5) 6569
R290/600a/600 (17.1/80.4/2.5) 6569
R 290/600a/600 (17.1/80.4/2.5) 6569
A-46 (also A46) 6569
ARI container color / Pantone number: none, use light green grey/413 6601
with red / 185 band

PHYSICAL
nominal blend formulation -------
component weight fractions: 17.1 / 80.4 / 2.5 %
component mole fractions: 21.377 / 76.252 / 2.371 % 8820
properties ------------------------
molar mass: 55.12379 g/mol (0.121527 lb/mol) 8820

ENVIRONMENTAL
ODP (ozone depletion potential): 0.000 (model-derived relative to R 11)
GWP (global warming potential): unknown, but very low: ~20 relative to CO2 for 100 yr integration
HGWP (halocarbon GWP): <0.01 relative to R 11 for infinite integration period

SAFETY
classification -----------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601
all components are A3 8601
flammability -----------------------
LFL-UFL (flammability limits in air): highly flammable

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized
(as aerosol propellant 1970s)
last year production allowed: unrestricted 8C01
### R-600a/600 (50.0/50.0)

#### REFRIGERANT DATA SUMMARY

| unassigned | R-600a/600 (50.0/50.0) | see RDB# |
| zoolopple | binary blend | --- |

#### COMMON USE(S)

Used in small refrigeration systems including household refrigerators in the 1920s and early 1930s; re-emerged in the 1990s as an alternative to refrigerants 12.

The commercial formulation of this blend is subject to wide variation and typically includes other hydrocarbons as minor components. Accordingly, the specific physical and safety data for a given sample may differ from that shown.

#### IDENTIFIERS

| common name(s): | R-600a/600 (50/50) |
|                 | R600a/600 (50/50) |
|                 | R 60a/600 (50/50) |
|                 | HC-60a/HC-600 (50/50) |
|                 | not HC-60a/600 (50/50) |
|                 | isobutane/butane |

| ARI container color / Pantone number: | none, use light green grey/413 6601 with red / 185 band |

#### PHYSICAL

- **nominal blend formulation**

  | composition: | R-600a/600 |
  | component weight fractions: | 50 / 50 % |
  | component mole fractions: | 50.000 / 50.000 % |

- **properties**

  | molar mass: | 58.12220 g/mol (0.128138 lb/mol) |

  | bubble point temperature: | 6.5 °C (20.3 °F) |
  | dew point temperature: | -5.4 °C (22.3 °F) |
  | maximum temperature glide: | 1.12 °C (2.0 °F) |
  | density, saturated liquid: | 598 kg/m3 (37.34 lb/cf) |
  | density, saturated vapor: | 2.76 kg/m3 (0.172 lb/cf) |
  | specific volume, saturated liquid: | 1.672 L/kg (0.0268 cf/lb) |
  | specific volume, saturated vapor: | 362.3 L/kg (5.8033 cf/lb) |
  | heat of vaporization: | 378.6 kJ/kg (162.8 Btu/lb) |
  | velocity of sound, saturated liquid: | 1024 m/s (3359 ft/s) |
  | velocity of sound, saturated vapor: | 199 m/s (652 ft/s) |
  | viscosity, saturated liquid: | 216 µPa·s (0.216 cp) |
  | viscosity, saturated vapor: | 6.32 µPa·s (0.00632 cp) |
  | thermal conductivity, liquid: | 0.1149 W/m·K (0.0664 Btu/hr·ft°F) |
  | thermal conductivity, vapor: | 0.0131 W/m·K (0.0076 Btu/hr·ft°F) |

- **normal boiling point**

- **normal pressure, 20 °C (68 °F)**

  | density, vapor: | 2.491 kg/m3 (0.1555 lb/cf) |

- **normal pressure, 21.1 °C (70 °F)**

  | density, vapor: | 2.481 kg/m3 (0.1549 lb/cf) |
\[20 ^\circ C (68 ^\circ F)\] 
- pressure, liquid (bubble point): 254.1 kPa (36.85 psia)  
- pressure, vapor (dew point): 246.2 kPa (35.71 psia)  
- density, saturated liquid: 568 kg/m\(^3\) (35.46 lb/cf)  
- density, saturated vapor: 6.36 kg/m\(^3\) (0.397 lb/cf)  
- specific volume, saturated liquid: 1.761 L/kg (0.0282 cf/lb)  
- specific volume, saturated vapor: 157.3 L/kg (2.5191 cf/lb)  
- velocity of sound, saturated liquid: 881 m/s (2890 ft/s)  
- velocity of sound, saturated vapor: 201 m/s (658 ft/s)  
- viscosity, saturated liquid: 164 \(\mu\)Pa\(\cdot\)s (0.164 cp)  
- viscosity, saturated vapor: 6.9 \(\mu\)Pa\(\cdot\)s (0.0069 cp)  
- thermal conductivity, saturated liquid: 0.1036 W/m\(\cdot\)K (0.0599 Btu/hr\(\cdot\)ft\(\cdot\)F)  
- thermal conductivity, saturated vapor: 0.01554 W/m\(\cdot\)K (0.00898 Btu/hr\(\cdot\)ft\(\cdot\)F)  

\[60 ^\circ C (140 ^\circ F)\] 
- pressure, liquid (bubble point): 751 kPa (108.9 psia)  
- pressure, vapor (dew point): 737 kPa (106.9 psia)  
- heat of vaporization: 303.8 kJ/kg for liquid and vapor both at nominal composition (130.6 Btu/lb)  
- specific volume, saturated liquid: 4.41 L/kg (0.0707 cf/lb)  

**ENVIRONMENTAL**

- ODP (ozone depletion potential): 0.000 (model-derived relative to R 11)  
- GWP (global warming potential): unknown, but very low: ~20 relative to CO2 for 100 yr integration  
- HGWP (halocarbon GWP): ~0 relative to R 11 for infinite integration period  

**SAFETY**

- classification: none (no application pending)  
- safety group (ASHRAE Standard 34): components are both A3  
- NFPA 704 degrees of hazard (H-F-R-S): Texaco: 1-4-1 MSDS  
- health-flammability-reactivity [-special]: 0=no, 4=severe  
- NPCA HMIS hazard ratings (H-F-R): Texaco: 1-4-1 MSDS  
- health-flammability-reactivity 0=insignificant, 4=extreme  
- LFL-UFL (flammability limits in air): Texaco: 1.8-8.4 \(\%\) v/v MSDS  
- flash point: Texaco: <-51 \(^\circ\)C (<-60 \(^\circ\)F) MSDS  
- detection: Texaco: colorless  
- odor: Texaco: odorless  

**PRODUCTION**

- first commercial use as a refrigerant: 1920s  
- last year production allowed: unrestricted  

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
**R-610/217cal1**

--- REFRIGERANT DATA SUMMARY ---

<table>
<thead>
<tr>
<th>unassigned</th>
<th>R-610/217cal1 (formulation not disclosed)</th>
<th>see</th>
</tr>
</thead>
<tbody>
<tr>
<td>zeotrope</td>
<td>binary blend</td>
<td>RDB#</td>
</tr>
</tbody>
</table>

**COMMON USE(S)**

developmental blend, examined circa 1994, as an alternative for refrigerant 11

The designations "Ikon-11A" and "R-11A" were trade names and not refrigerant numbers conforming to ASHRAE Standard 34.

**IDENTIFIERS**

historical name(s): Ikon(R) 11A

**SAFETY**

- flammability
  - LFL-UFL (flammability limits in air): Ikon: nonflammable

**PRODUCTION**

first commercial use as a refrigerant: not known to be commercialized

---

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-717/E170 (60/40)

UNASSIGNED  

AZEOTROPE  

BINARY BLEND

COMMON USE(S)

Candidate refrigerant to exploit the thermodynamic properties of R-717 (ammonia) and offer at least partial miscibility with common lubricants, reduced compressor discharge temperature, and high performance; targeted for air-cooled refrigeration systems with capacities of up to 25 kW (7 ton), but constrained by flammability and toxicity considerations.

The designation "R723" does not conform to ASHRAE Standard 34. The blend appears eligible for a designation in the R-5xx series.

IDENTIFIERS

common name(s): R-717/E170 (60.0/40.0)
R717/E170 (60.0/40.0)
R 717/E170 (60.0/40.0)
"R723"
NH3/DME; ammonia/DME

ARI container color / Pantone number: none, use light green grey/413 6601 with red / 185 band

 PHYSICAL

nominal blend formulation --------

composition: R-717/E170

component weight fractions: 60.0 / 40.0 %

component mole fractions: 80.228 / 19.772 %

properties -----------------------

molar mass: 22.77203 g/mol (0.050204 lb/mol)

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative to R 11)

GWP (global warming potential): unknown, but very low: <1 relative to CO2 for 100 yr integration

SAFETY

classification ---------------------

safety group (ASHRAE Standard 34): none (no application pending)
components are B2 and unclassified

flammability ---------------------

LFL (lower flammability limit in air): 6.0 % v/v

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized

last year production allowed: unrestricted

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-744/32/134a (7/31/62)

------------------------- REFRIGERANT DATA SUMMARY -------------------------
unassigned R-744/32/134a (7/31/62) see
zeotrope ternary blend RDB#

COMMON USE(S)
candidate refrigerant for refrigerant 22

IDENTIFIERS
common name(s): R-744/32/134a (7.0/31.0/62.0)
R744/32/134a (7.0/31.0/62.0)
R 744/32/134a (7.0/31.0/62.0)
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL
• nominal blend formulation -------
  composition: R-744/32/134a 9321
  component weight fractions: 7.0 / 31.0 / 62.0 % 9322
  component mole fractions: 11.673 / 43.731 / 44.596 % 8820
• properties ---------------------
  molar mass: 73.38903 g/mol (0.161795 lb/mol) 8820

ENVIRONMENTAL
  ODP (ozone depletion potential): 0.000 (model-derived relative to R 11)
  GWP (global warming potential): >1260 relative to CO2 for 100 yr integration 9501
  HGWP (halocarbon GWP): 0.22 relative to R 11 for infinite integration period DW

SAFETY
• classification ------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  components are A1, A2, and A1 8601

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized
last year production allowed: unrestricted 8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-1132a/134a (5.0/95.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned  R-1132a/134a (5.0/95.0) see RDB#
zeotrope  binary blend

COMMON USE(S)
under consideration as a replacement for refrigerator 22

IDENTIFIERS

common name(s):  R-1132a/134a (5/95)
                 R1132a/134a (5/95)
                 R 1132a/134a (5/95)
                 HFC-1132a/HFC-134a (5/95)
                 not HFC-1132a/134a (5/95) 2909
trade name(s):  Solvay VFP2/134a (5/95) 7849

PHYSICAL
· nominal blend formulation ---------
  composition:  R-1132a/134a
  component weight fractions:  5.0 / 95.0 %
  component mole fractions:  7.737 / 92.263 %  8820
· properties -----------------------
  molar mass:  99.09094 g/mol (0.218458 lb/mol) 8820

ENVIRONMENTAL
  ODP (ozone depletion potential):  <0.00002 mass-weighted average 9501
                                 (model-derived relative to R 11)
                                 <0.00048 mass-weighted average 9501
                                 (semi-empirical relative to R 11)
  GWP (global warming potential):  1520 mass-weighted average relative to CO2 for 100 yr integration 7849

SAFETY
· classification ---------------------
  safety group (ASHRAE Standard 34):  none (no application pending) 8601

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized
promoted 1995 by Solvay 7849
last year production allowed: unrestricted 8001

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-1216/600a/600 (98.0/1.0/1.0)

--- REFRIGERANT DATA SUMMARY ---

| unassigned | R-1216/600a/600 (98.0/1.0/1.0) | see RDB# |
| zeotrope | ternary blend | --- |

**COMMON USE(S)**

alternative for refrigerant 12 for aftermarket use to service or retrofit existing automobile air conditioners, other mobile air-conditioning (MAC) systems, transport refrigeration, vending machines, and water coolers

The following information is preliminary and may be incomplete or incorrect. Further data may be available from TACIP International, Incorporated (Mobile, AL, USA), or refrigerant manufacturers. This ternary blend is believed to be the base for TACIP's ADAK-29 blend, which also contains an undisclosed component described as a "friction modifier."

**IDENTIFIERS**

| common name(s): | R-1216/600a/600 (98.0/1.0/1.0) |
| | R1216/600a/600 (98.0/1.0/1.0) |
| | R 1216/600a/600 (98.0/1.0/1.0) |

**PHYSICAL**

- nominal blend formulation --------
  - composition: R-1216/600a/600
  - component weight fractions:  98.0 / 1.0 / 1.0 %
  - component mole fractions: 94.996 / 2.502 / 2.502 % 8820

- properties ------------------------
  - molar mass: 145.42376 g/mol (0.320605 lb/mol) 8820

**ENVIRONMENTAL**

- ODP (ozone depletion potential): 0.000 mass-weighted average (model-derived relative to R 11)
- GWP (global warming potential): 2.0 relative to CO2 for 100 yr 7C31 integration

**SAFETY**

- classification ---------------------
  - safety group (ASHRAE Standard 34): none (no application pending) 8601

**PRODUCTION**

- last year production allowed: unrestricted 8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
R-1216/600a/600/undisclosed (97.5/1.0/1.0/0.5)

------------------------------ REFRIGERANT DATA SUMMARY ------------------------------

unassigned  R-1216/600a/600/undisclosed (97.5/1.0/1.0/0.5)  see
zeotrope       tetracy blend  RDB#

COMMON USE(S)
alternative for refrigerant 12 for aftermarket use to service or
retrofit existing automobile air conditioners, other mobile
air-conditioning (MAC) systems, transport refrigeration, vending
machines, and water coolers

The following information is preliminary and may be incomplete or
incorrect. Further data may be available from TACIP International,
Incorporated (Mobile, AL, USA), or refrigerant manufacturers. The
undisclosed component is described as a "friction modifier" having a
CAS registry number of 64742-53-6, believed to made of a treated
light petroleum distillate. Product literature describes this
refrigerant as "a blend of inert gases and hydrocarbons" and further
indicates that it also contains a "nonflammable inert gas lubricating
oil, known as HIGH-TECH 2." The literature asserts that the boiling
points of these components bracket that of the hydrocarbon, making
the refrigerant "nonflammable when leakage occurs." The literature
states that synthetic lubricant used with refrigerant 134a must be
removed, but does not indicate whether this refers to polyalkylene
glycols, polyolesters, or both.

IDENTIFIERS

trade name(s): TACIP International ADAK-29
historical name(s): TACIP International ADAK-12
name used in U.S. EPA SNAP Rule: Blend Mu

PHYSICAL

· normal boiling point  ---------------------
  bubble point temperature: -32.0 °C (-25.5 °F)  mfr
  dew point temperature: -30.5 °C (-22.8 °F)  mfr
  maximum temperature glide: 1.50 °C (2.7 °F)  mfr
· 20 °C (68 °F)  --------------------------
  pressure, vapor (dew point): 652.7 kPa (94.67 psia)  mfr
· 60 °C (140 °F)  -------------------------
  pressure, vapor (dew point): 1492 kPa (216.4 psia)  mfr
· critical point  --------------------------
  temperature: 94.9 °C (202.7 °F)  mfr
  specific volume: 1.81 L/kg (0.0290 cf/lb)  mfr

ENVIRONMENTAL

ODP (ozone depletion potential): TACIP: 0.000 (model-derived
relative to R 11)

SAFETY

· classification  ------------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
· flammability  ------------------------
  LFL-UFL (flammability limits in air): TACIP: nonflammable gas  MSDS
  heat of combustion (by ASHRAE 34-92): 449.4 MJ/kg (193212 Btu/lb)  MSDS
<table>
<thead>
<tr>
<th>Property</th>
<th>TACIP: nonflammable as tested</th>
<th>MSDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autoignition</td>
<td>TACIP: 310 °C (590 °F)</td>
<td>MSDS</td>
</tr>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Appearance</td>
<td>TACIP: colorless, transparent</td>
<td>MSDS</td>
</tr>
<tr>
<td>Odor</td>
<td>TACIP: slight odor</td>
<td>MSDS</td>
</tr>
</tbody>
</table>

**Production**
- First commercial use as a refrigerant: projected 1998
- Last year production allowed: unrestricted
R-1270/290 (98.0/2.0)

--- REFRIGERANT DATA SUMMARY ---

unassigned R-1270/290 (98.0/2.0) see RDB#
azeotrope binary blend

IDENTIFIERS

common name(s): R-1270/290 (98.0/2.0)
               R1270/290 (98.0/2.0)
               R 1270/290 (98.0/2.0)
               HC-1270/HC-290 (98/2)
               not HC-1270/290 (98/2)
               mappolene
               propene/propane
               propylene/propane

ARI container color / Pantone number: none, use light green grey/413 6601
                                    with red / 185 band

PHYSICAL

• nominal blend formulation

  composition: R-1270/290
  component weight fractions: 98.0 / 2.0 %
  component weight tolerances: ±2.0 / ±2.0
  component mole fractions: 98.090 / 1.910 % 8820

• properties

  molar mass: 42.11825 g/mol (0.092855 8820
                             lb/mol)

• normal boiling point

  bubble point temperature: -47.7 °C (-53.9 °F) 8814
  dew point temperature: -47.7 °C (-53.9 °F) 8814
  maximum temperature glide: 0.00 °C (0.0 °F) 8814
  density, saturated liquid: 608 kg/m3 (37.98 lb/cf) 8814
  density, saturated vapor: 2.36 kg/m3 (0.147 lb/cf) 8814
  specific volume, saturated liquid: 1.644 L/kg (0.0263 cf/lb) 8814
  specific volume, saturated vapor: 423.7 L/kg (6.7875 cf/lb) 8814
  heat of vaporization: 438.6 kJ/kg (188.6 Btu/lb) 8814
  velocity of sound, saturated liquid: 1168 m/s (3832 ft/s) 8814
  velocity of sound, saturated vapor: 224 m/s (734 ft/s) 8814
  viscosity, saturated liquid: 243 µPa·s (0.243 cp) 8814
  viscosity, saturated vapor: 5.86 µPa·s (0.00586 cp) 8814
  thermal conductivity, liquid: 0.1566 W/m·K (0.0905
                             Btu/hr·ft°F) 8814
  thermal conductivity, vapor: 0.0104 W/m·K (0.0060
                               Btu/hr·ft°F) 8814

• normal pressure, 20 °C (68 °F)

  density, vapor: 1.778 kg/m3 (0.1110 lb/cf) 8814

• normal pressure, 21.1 °C (70 °F)

  density, vapor: 1.771 kg/m3 (0.1105 lb/cf) 8814

• 20 °C (68 °F)

  pressure, liquid (bubble point): 1019.7 kPa (147.90 psia) 8814
  pressure, vapor (dew point): 1019.7 kPa (147.90 psia) 8814
  density, saturated liquid: 512 kg/m3 (31.99 lb/cf) 8814
  density, saturated vapor: 21.46 kg/m3 (1.340 lb/cf) 8814
  specific volume, saturated liquid: 1.951 L/kg (0.0313 cf/lb) 8814
  specific volume, saturated vapor: 46.6 L/kg (0.7464 cf/lb) 8814

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
velocity of sound, saturated liquid: 727 m/s (2384 ft/s) 8814
velocity of sound, saturated vapor: 222 m/s (730 ft/s) 8814
viscosity, saturated liquid: 106 µPa·s (0.106 cp) 8814
viscosity, saturated vapor: 7.7 µPa·s (0.0077 cp) 8814
thermal conductivity, saturated liquid: 0.1108 W/m·K (0.0640 Btu/hr·ft·°F) 8814
thermal conductivity, saturated vapor: 0.01723 W/m·K (0.00995 Btu/hr·ft·°F) 8814

60 °C (140 °F)----------------------
pressure, liquid (bubble point): 2532 kPa (367.2 psia) 8814
pressure, vapor (dew point): 2532 kPa (367.2 psia) 8814
heat of vaporization: 249.2 kJ/kg for liquid and vapor both at nominal composition (107.1 Btu/lb) 8814
249.2 kJ/kg coexisting liquid and vapor at bubble-point pressure (107.1 Btu/lb) 8814

critical point ---------------------
temperature: 92.5 °C (198.5 °F) 8814
pressure: 4670 kPa (677.3 psia) 8814
density: 223 kg/m³ (13.9 lb/cf) 8814
specific volume: 4.48 L/kg (0.0717 cf/lb) 8814

ENVIRONMENTAL
ODP (ozone depletion potential): 0.000 mass-weighted average (model-derived relative to R 11) 8814
GWP (global warming potential): unknown, but very low: ~20 relative to CO2 for 100 yr integration 8814
HGWP (halocarbon GWP): ~0 relative to R 11 for infinite integration period 8814

SAFETY
· classification ----------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601
components are A3 and A3 8601
components are B3 and A3 8601
pend

NFPA 704 degrees of hazard (H-F-R-S):
BOC Gases: 1-4-0 MSDS
health-flammability-reactivity [-special]: 0=no, 4=severe

NPCA HMIS hazard ratings (H-F-R):
BOC Gases: 1-4-0 MSDS
health-flammability-reactivity 0=insignificant, 4=extreme

· flammability ----------------------
LFL-UFL (flammability limits in air): BOC Gases: 2.0-11.1 % v/v MSDS
flash point: BOC Gases: <-104 °C (<-162 °F) MSDS

· detection ------------------------
appearance: BOC Gases: colorless MSDS
odor: BOC Gases: natural gas odor MSDS

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized 8C01
last year production allowed: unrestricted 8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
chymogene

---------------- REFRIGERANT DATA SUMMARY ----------------
unassigned petroleum distillates see
zeotrope blend RDB#

COMMON USE(S)
used in the 1870s for ice making

IDENTIFIERS
common name(s): "condensed petroleum gas" 2113
historical name(s): chymogene
(also chemogene or chimogene) 2113

PRODUCTION
first commercial use as a refrigerant: 1869 by D. L. Holden 2115
last year production allowed: unrestricted 8C01
caoutchoucine

<table>
<thead>
<tr>
<th>unassigned</th>
<th>solvent distillate of rubber</th>
<th>see</th>
<th>RDB#</th>
</tr>
</thead>
<tbody>
<tr>
<td>zeotrope</td>
<td>blend</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**COMMON USE(S)**
the first refrigerant used in a vapor-compression machine (1830s), "the volatile liquid arising from destructive distillation of caoutchouc" (French for rubber, also a contemporary name for India rubber); formerly used as an industrial solvent in printing and engraving

**IDENTIFIERS**

historical name(s): caoutchoucine 2113

**PRODUCTION**

first commercial use as a refrigerant: 1834 by J. Perkins, associates 2113
gasoline

--- REFRIGERANT DATA SUMMARY ---
unassigned gasoline: complex mixture of volatile hydrocarbons see organic blend CAS number 8006-61-9 RDB#

COMMON USE(S)
experimental use as a refrigerant in the 1920s; transportation fuel

IDENTIFIERS

common name(s): gasoline
motor fuel, petrol

CAS number: 8006-61-9 Chemical Abstracts
Service Registry Number

NIOSH RTECS number: LX3300000 (Registry of Toxic Effects of Chemical Substances)
historical name(s): motor spirits

PHYSICAL

- properties ---------------
molar mass: approximately 72 g/mol (0.000000 lb/mol) 5204

- normal boiling point -------
temperature: 38.8 °C (101.8 °F) 5204

SAFETY

- classification -------------
NIOSH caution: potential occupational carcinogen (limit exposures to lowest feasible)

ACGIH carcinogenicity category: A3, animal carcinogen 9504

- occupational exposure warnings -----
substance under study: ACGIH 8810

- short-term occupational limit ------
ACGIH TLV-STEI (short-term exp limit): 500 ppm v/v TWA for 15 min 9504

- long-term occupational limit ------
ACGIH TLV-TWA (time-weighted average): 300 ppm v/v TWA for 8 hr/day 9504
and 40 hr/wk

- flammability ---------------------
LFL-UFL (flammability limits in air): 1.4-7.6 % v/v 5204
flash point: -43 °C (-45 °F) 5204
autoignition temperature: 280 °C (536 °F) 4B64

PRODUCTION

first commercial use as a refrigerant: 1923 by U.S. Bureau of Mines 2113
last year production allowed: unrestricted 8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
undisclosed blend: ATG 2032, G2032

------------- REFRIGERANT DATA SUMMARY -------------
unassigned composition not disclosed
blend

COMMON USE(S)
developmental blend under consideration as a replacement for refrigerants 12, 22, and 502 as a service fluid

Further information may be available from American Technologies Group (Monrovia, CA, USA), Greencool Washington, Incorporated (Beltsville, MD, USA), and other refrigerant manufacturers. ATG indicates that field testing is underway; Greencool indicates that it is not available in the USA. Greencool also indicates that it is a hydrofluorocarbon (HFC) based refrigerant.

IDENTIFIERS

trade name(s): ATG 2032
Greencool (Gu) G2032

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
undisclosed blend: ATG X-11

<table>
<thead>
<tr>
<th>REFRIGERANT DATA SUMMARY</th>
<th>see</th>
<th>RDB#</th>
</tr>
</thead>
<tbody>
<tr>
<td>unassigned composition not disclosed</td>
<td>blend</td>
<td>----</td>
</tr>
</tbody>
</table>

**COMMON USE(S)**
- developmental blend under consideration as a replacement for refrigerant 11 as a service fluid

Further information may be available from American Technologies Group (Monrovia, CA, USA), Greencool Washington, Incorporated (Beltsville, MD, USA), and other refrigerant manufacturers. ATG indicates that field testing is underway in large, low-pressure chillers; Greencool indicates that this refrigerant is "in final stage of development."

**IDENTIFIERS**
- trade name(s): ATG X-11

**SAFETY**
- flammability
  - LFL-UFL (flammability limits in air): none (nonflammable as tested) mfr

**PRODUCTION**
- first commercial use as a refrigerant: not known to be commercialized
undisclosed blend: AZ-LT

------------------------ REFRIGERANT DATA SUMMARY ------------------------
unassigned composition not disclosed  see
blend blend  RDB#

 COMMON USE(S)
replacement for refrigerant 503; extremely low temperature
refrigeration as in freezers for biological, medical, and
pharmaceutical use

The following information is preliminary and may be incomplete or
incorrect. Data on this blend may be available from AlliedSignal
Incorporated (Morristown, NJ, USA) and other refrigerant
manufacturers.

 IDENTIFIERS
trade name(s): AlliedSignal Genetron(R) AZ-LT

 ENVIRONMENTAL
ODP (ozone depletion potential): 0.000 (model-derived relative
to R 11)
undisclosed blend: EC-12a

--- REFRIGERANT DATA SUMMARY ---

unassigned hydrocarbon blend, composition not disclosed see RDB# ---

zeotrope blend

COMMON USE(S)

service fluid to replace refrigerant 12 in such uses as mobile air conditioning, refrigerators, ice makers, and industrial refrigeration; marketed as a "second-generation replacement" for refrigerant 134a and other non-ozone-depleting substitutes; flammability concerns have constrained acceptance

The following information is preliminary and may be incomplete or incorrect. Data may be available from OZ Technology, Incorporated (Rathdrum, ID, USA), DURACOOL Limited (Edmonton, Alberta, Canada, and Brisbane, Australia), and other refrigerant manufacturers. OZ Technology describes the composition as a compressed hydrocarbon mixture with "HC Friction Fighters" that contain "no graphite, paraffin, or Teflon." Unconfirmed data suggest that the blend contains refrigerants 290 (propane), 600 (butane), 600a (isobutane), and other components.

"HC-12a" and variants with other prefixes are trade names; they are not refrigerant designations conforming to ASHRAE Standard 34.

IDENTIFIERS

trade name(s):

DURACOOL(TM) 12a
Enviro-Cold EC-12a
HR Technology EC-12a
OZ Technology HC-12a(R)

name used in U.S. EPA SNAP Rule:
Hydrocarbon Blend B

ARI container color / Pantone number:
none, use light green grey/413 6601 with red / 185 band

SAFETY

 classification ---------------------

safety group (ASHRAE Standard 34):
none (no application pending) 8601

flammability ---------------------

LFL-UFL (flammability limits in air):
HR Technology: 3.0-9.7 % v/v MSDS
OZ Technology: 1.9-8.5 % v/v MSDS

autoignition temperature:
OZ Technology: 810°C (1490°F) MSDS

 detection ---------------------

appearance:
HR: colorless gas MSDS
OZ Technology: colorless gas MSDS

odor:
OZ: natural gas odor MSDS
OZ: contains mercaptan odorant

PRODUCTION

first commercial use as a refrigerant: 1994
last year production allowed: unrestricted 8C01

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
undisclosed blend: EC-22a, OZ HC-22

------------------------ REFRIGERANT DATA SUMMARY ------------------------
unassigned hydrocarbon blend, composition not disclosed  see
zeotrope blend  RDB#

COMMON USE(S)
service fluid to replace refrigerant 22; marketed as a
"second-generation replacement" for refrigerant 134a and other
non-ozone-depleting substitutes

The following information is preliminary and may be incomplete or
incorrect. Data may be available from OZ Technology, Incorporated
(Rathdrum, ID, USA), DURACOOL (Edmonton, Alberta, Canada, and
Brisbane, Australia), and other refrigerant manufacturers. OZ
Technology describes the composition as "a compressed hydrocarbon
mixture" with "HC Friction Fighters" that contain "no graphite,
paraffin, or Teflon."

"HC-22a" and variants with other prefixes are trade names; they are
not refrigerant designations conforming to ASHRAE Standard 34.

IDENTIFIERS
• trade name(s): DURACOOL(TM) 22a
  Enviro-Cold EC-22a
  HR Technology EC-22a
  OZ Technology HC-22(R)

• ARI container color / Pantone number: none, use light green grey/413 6601
  with red / 185 band

SAFETY
• classification ---------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601

• flammability ---------------------
  LFL-UFL (flammability limits in air): HR Technology: 3.0-9.7 % v/v  MSDS

• detection ------------------------
  appearance: HR: colorless gas  MSDS
  odor: HR: contains mercaptan odorant

PRODUCTION
first commercial use as a refrigerant: 1995
last year production allowed: unrestricted 8C01
undisclosed blend: EC-502a, OZ HC-502a

------------------------ REFRIGERANT DATA SUMMARY ------------------------
unassigned hydrocarbon blend, composition not disclosed see RDB#
zeotrope blend

COMMON USE(S)
service fluid to replace refrigerant 502; marketed as a "second-generation replacement" for refrigerant 404A, 507A, and other non-ozone-depleting substitutes

The following information is preliminary and may be incomplete or incorrect. Data may be available from OZ Technology, Incorporated (Rathdrum, ID, USA), DURACOOL (Edmonton, Alberta, Canada, and Brisbane, Australia), and other refrigerant manufacturers. OZ Technology describes the composition as "a compressed hydrocarbon mixture" with "HC Friction Fighters" that contain "no graphite, paraffin, or Teflon."

"HC-502a" and variants with other prefixes are trade names; they are not refrigerant designations conforming to ASHRAE Standard 34.

IDENTIFIERS

trade name(s): DURACOOL(TM) 502a
Enviro-Cold EC-502a
HR Technology EC-502a
OZ Technology HC-502a(TM)

ARI container color / Pantone number: none, use light green grey/413 6601 with red / 185 band

SAFETY

- classification -------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601

- flammability -------------------
LFL-UFL (flammability limits in air): HR Technology: 3.0-9.7 % v/v MSDS

- detection ----------------------
appearance: HR: colorless gas MSDS
odor: HR: contains mercaptan odorant MSDS

PRODUCTION

- first commercial use as a refrigerant: circa 1997
last year production allowed: unrestricted 8C01
undisclosed blend: ES-12

--------------------- REFRIGERANT DATA SUMMARY ---------------------
unassigned hydrocarbon blend, composition not disclosed see
zeotrope blend RDB#

COMMON USE(S)
service fluid for refrigerant 12 in such uses as mobile air
conditioning, refrigerators, ice makers, and industrial
refrigeration; flammability concerns may constrain acceptance

The following information is preliminary and may be incomplete or
incorrect. Data may be available from Intervest Environmental
Incorporated (USA) and other refrigerant manufacturers.

The designation "ES-12" is a trade name and not a refrigerant number
conforming to ASHRAE Standard 34.

IDENTIFIERS
trade name(s): Intervest Environmental ES-12
ARI container color / Pantone number: none, use light green grey/413 6601
with red / 185 band

SAFETY
* classification -------------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601

PRODUCTION
first commercial use as a refrigerant: 1994
last year production allowed: unrestricted 8C01
undisclosed blend: FX-21

--- REFRIGERANT DATA SUMMARY ---

unassigned composition not disclosed
zeotrope blend

COMMON USE(S)
under consideration as an alternative for refrigerant 502

The following information is preliminary and may be incomplete or incorrect. Further data may be available from Elf Atochem (Philadelphia, PA, USA) or other refrigerant manufacturers.

IDENTIFIERS
trade name(s): Elf Atochem Forane(R) FX-21

PHYSICAL

- normal boiling point
  - bubble point temperature: -49.4 °C (-56.9 °F)
  - maximum temperature glide: 0.00 °C (0.0 °F)
  - density, saturated vapor: 6.35 kg/m³ (0.396 lb/ft³)
  - heat of vaporization: 173.0 kJ/kg (74.4 Btu/lb)
- critical point
  - temperature: 73.0 °C (163.4 °F)
  - pressure: 3800 kPa (551.1 psia)

ENVIRONMENTAL
ODP (ozone depletion potential): 0.05 (model-derived relative to R 11)

SAFETY
- classification
  - safety group (ASHRAE Standard 34): none (no application pending)
  - flammability
    - LFL-UFL (flammability limits in air): none (nonflammable as tested)

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
undisclosed blend: FX-30

--------------------------- REFRIGERANT DATA SUMMARY ----------------------------

unassigned composition not disclosed see RDB#
zeotrope blend

COMMON USE(S)
under consideration as an alternative for refrigerant 502

The following information is preliminary and may be incomplete or incorrect. Further data may be available from Elf Atochem (Philadelphia, PA, USA) or other refrigerant manufacturers.

IDENTIFIERS
trade name(s): Elf Atochem Forane(R) FX-30 2A06

PHYSICAL

• normal boiling point
  bubble point temperature: -46.7 °C (-52.1 °F) 2A06
  maximum temperature glide: 0.00 °C (0.0 °F) 2A06
  density, saturated vapor: 5.40 kg/m3 (0.337 lb/cf) 2A06
  heat of vaporization: 205.0 kJ/kg (88.1 Btu/lb) 2A06
• critical point
  temperature: 70.0 °C (158.0 °F) 2A06
  pressure: 3700 kPa (536.6 psia) 2A06

ENVIRONMENTAL
ODP (ozone depletion potential): 0.000 (model-derived relative to R 11) 2A06

SAFETY
• classification
  safety group (ASHRAE Standard 34): none (no application pending) 8601
• flammability
  LFL-UFL (flammability limits in air): none (nonflammable as tested) 2A06

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized
undisclosed blend: FX-50

--- REFRIGERANT DATA SUMMARY ---

unassigned  composition not disclosed  see
zeotrope blend  RDB#

COMMON USE(S)
under consideration as an alternative for refrigerant 502

The following information is preliminary and may be incomplete or
incorrect. Further data may be available from Elf Atochem
(Philadelphia, PA, USA) or other refrigerant manufacturers.

IDENTIFIERS

trade name(s): Elf Atochem Forane(R) FX-50  2A06

PHYSICAL

- normal boiling point
  - bubble point temperature: -44.3 °C (-47.7 °F)  2A06
  - maximum temperature glide: 0.90 °C (1.6 °F)  2A06
  - density, saturated vapor: 4.51 kg/m³ (0.282 lb/cf)  2A06
  - heat of vaporization: 248.0 kJ/kg (106.6 Btu/lb)  2A06

- critical point
  - temperature: 83.0 °C (181.4 °F)  2A06
  - pressure: 4500 kPa (652.7 psia)  2A06

ENVIRONMENTAL

ODP (ozone depletion potential): 0.05 (model-derived relative
to R 11)  2A06

SAFETY

- classification
  - safety group (ASHRAE Standard 34): none (no application pending)  8601
  - flammability
    - LFL-UFL (flammability limits in air): none (nonflammable as tested)  2A06

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
**undisclosed blend: FX-71**

---

**REFRIGERANT DATA SUMMARY**

<table>
<thead>
<tr>
<th>unassigned composition not disclosed</th>
<th>see RDB#</th>
</tr>
</thead>
<tbody>
<tr>
<td>zeotrope blend</td>
<td></td>
</tr>
</tbody>
</table>

**COMMON USE(S)**

under consideration as an alternative for refrigerant 502

The following information is preliminary and may be incomplete or incorrect. Data may be available from Elf Atochem (Philadelphia, PA, USA) or other refrigerant manufacturers.

---

**IDENTIFIERS**

| trade name(s): Elf Atochem Forane(R) FX-71 2A06 |

**PHYSICAL**

<table>
<thead>
<tr>
<th>normal boiling point</th>
</tr>
</thead>
<tbody>
<tr>
<td>bubble point temperature: -45.7 °C (-50.3 °F) 2A06</td>
</tr>
<tr>
<td>maximum temperature glide: 1.20 °C (2.2 °F) 2A06</td>
</tr>
<tr>
<td>density, saturated vapor: 5.63 kg/m³ (0.351 lb/cf) 2A06</td>
</tr>
<tr>
<td>heat of vaporization: 197.0 kJ/kg (84.7 Btu/lb) 2A06</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>critical point</th>
</tr>
</thead>
<tbody>
<tr>
<td>temperature: 71.0 °C (159.8 °F) 2A06</td>
</tr>
<tr>
<td>pressure: 3700 kPa (536.6 psia) 2A06</td>
</tr>
</tbody>
</table>

**ENVIRONMENTAL**

| ODP (ozone depletion potential): 0.000 (model-derived relative to R 11) 2A06 |

**SAFETY**

<table>
<thead>
<tr>
<th>classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>safety group (ASHRAE Standard 34): none (no application pending) 8601</td>
</tr>
<tr>
<td>flammability</td>
</tr>
<tr>
<td>LFL-UFL (flammability limits in air): none (nonflammable as tested) 2A06</td>
</tr>
</tbody>
</table>

**PRODUCTION**

| first commercial use as a refrigerant: not known to be commercialized |

---

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
undisclosed blend: GF2010

----------------------- REFRIGERANT DATA SUMMARY -----------------------
unassigned composition not disclosed see blend RDB#

COMMON USE(S)
replacement for refrigerant 12 in systems with small charge amounts such as refrigerators and freezers

Further information may be available from Greencool Washington, Incorporated (Beltsville, MD, USA) and other refrigerant manufacturers. Greencool describes it both as "a hydrocarbon based refrigerant" that is flammable, but suitable for small systems, and as a hydrofluorocarbon (HFC) type. The company indicates that this refrigerant is not available in the USA.

IDENTIFIERS
trade name(s): Greencool GF2010

SAFETY
· flammability ---------------------
LFL-UFL (flammability limits in air): Greencool: flammable mfr

PRODUCTION
first commercial use as a refrigerant: not known to be commercialized
undisclosed blend: GHG X8

-------------------------  REFRIGERANT DATA SUMMARY  -------------------------
unassigned composition not disclosed see RDB#
zeotrope blend ----

COMMON USE(S)
alternative for refrigerant 134a for automobile air conditioners and other mobile air-conditioning (MAC) systems to increase cooling capacity, primarily for aftermarket use to service or retrofit existing equipment

The following information is preliminary and may be incomplete or incorrect. Further data may be available from GHG Dev Labs (West Lafayette, IN, USA) or refrigerant manufacturers. Product literature indicates that this zeotropic blend of hydrofluorocarbons (HFCs). The description indicates that a polyalkylene glycol (PAG) or polyolester (POE) lubricant is required.

IDENTIFIERS
trade name(s): Autofrost GHG X8
MonroeAirTech Autofrost X8(TM)
Peoples Welding Supply GHG-X8

SAFETY
• classification -----------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601

PRODUCTION
first commercial use as a refrigerant: October 1998

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
undisclosed blend: Isceon 39TC, RX5

------------------------------- REFRIGERANT DATA SUMMARY -----------------------------
unassigned composition not disclosed see
blend binary zotrope RDB#
---

COMMON USE(S)
alternative for refrigerant 12 for centrifugal chillers for
aftermarket use to retrofit existing equipment

The following information is preliminary and may be incomplete or
incorrect. Data may be available from Rhodia Limited (Avonmouth,
Bristol, UK) and other refrigerant manufacturers. Rhodia describes
this refrigerant as a near-azeotropic blend of two hydrofluorocarbons
(HFCs) designed for use "without the need for engineering
modification ... or oil change" and offering performance "comparable
to R 12 even without changes to the impeller or gear". A product
bulletin indicates that the blend is compatible with mineral oil,
alkylbenzene, and ester-based lubricants. Although the composition
has not been disclosed, unconfirmed information on the blend suggests
that it may be R-134a/227ea in approximately a (60/40) formulation.
If so, suitability for use with mineral oil may warrant verification.

IDENTIFIERS

trade name(s): Rhodia Isceon 39 TC
Rhodia Isceon 39TC
historical name(s): Rhodia Isceon RX5
CSDS
ARI container color / Pantone number: none, use light green grey/413 6601

PHYSICAL

• properties ------------------------
molar mass: 121.4 g/mol (0.267641 lb/mol) mfr
• normal boiling point ------------
bubble point temperature: -24.7 °C (-12.5 °F) mfr
dew point temperature: -24.1 °C (-11.4 °F) mfr
maximum temperature glide: 0.60 °C (1.1 °F) mfr
heat of vaporization: 181.5 kJ/kg (78.0 Btu/lb) mfr
• 25 °C (77 °F) ------------------
pressure, saturated vapor: 619.0 kPa (89.78 psia) mfr
density, saturated liquid: 1280 kg/m3 (79.91 lb/cf) mfr
viscosity, saturated liquid: 220 µPa·s (0.220 cp) mfr
• critical point -----------------
temperature: 110.6 °C (231.1 °F) mfr
pressure: 37 kPa (5.4 psia) mfr

ENVIRONMENTAL

ODP (ozone depletion potential): 0.000 (model-derived relative mfr
to R 11)

SAFETY

• classification -------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601
• flammability ---------------------
LFL-UFL (flammability limits in air): nonflammable mfr
flash point: Rhodia: nonflammable CSDS
<table>
<thead>
<tr>
<th>Detection</th>
<th>Appearance: colorless</th>
<th>Odor: slightly ethereal</th>
</tr>
</thead>
</table>

**PRODUCTION**

First commercial use as a refrigerant: 1998
undisclosed blend: MT-31

--- REFRIGERANT DATA SUMMARY ---

unassigned composition not disclosed
zeotrope binary blend

COMMON USE(S)
alternative for refrigerant 12 for aftermarket use for retrofit and
service of stationery and transport refrigeration equipment

The following information is preliminary and may be incomplete or
incorrect. Further data may be available from Millennia Tech
Corporation (Decatur AL and/or South Haven MI USA) or other
refrigerant manufacturers. The Material Safety Data Sheet (MSDS)
describes the blend as "a nontoxic, nonflammable and noncorrosive
homogeneous blend of Fluorocarbons and Hydrochlorofluorocarbons." A
product data sheet indicates that the it "is a nontammable,
homogeneous blend of natural organic fluorocarbon,
hydrochlorofluorocarbon and hydrocarbon gases." These descriptions
are inconsistent with indications in product data sheets that the
ozone depletion potential (ODP) is zero. Although the composition
has not been disclosed, the limited information available suggests a
near-azeotropic, binary blend of a hydrofluorocarbon - possibly R
1216 - and a hydrocarbon. The manufacturer indicates that the
refrigerant is miscible with both mineral oil (MO) and alkylbenzene
(AB) lubricants, but is not compatible with polyalkylene glycol
(PAG), polyalphaolefin (PAO), or polyolester (POE) lubricants.

IDENTIFIERS

trade name(s): Millennia Tech MT-31

PHYSICAL

properties ------------------

normal freezing/melting/triple point: -180.3 °C (-292.6 °F) mfr
normal boiling point ---------------

temperature: -35.0 °C (-31.0 °F) mfr
density, saturated liquid: 1221 kg/m3 (76.20 lb/cf) mfr
heat of vaporization: 210.3 kJ/kg (90.4 Btu/lb) mfr

20 °C (68 °F) -----------------------
pressure, saturated vapor: 668.8 kPa (97.00 psia) MSDS

60 °C (140 °F) ---------------------
pressure, saturated vapor: 724 kPa (105.0 psia) MSDS

critical point ---------------------

temperature: 120.2 °C (248.3 °F) mfr
129.1 °C (264.3 °F) mfr
pressure: 4011 kPa (581.7 psia) mfr
density: 221 kg/m3 (13.8 lb/cf) mfr
specific volume: 4.52 L/kg (0.0725 cf/lb) mfr

ENVIRONMENTAL

average atmospheric lifetime (TATM): Millennia Tech: <1 yr mfr
ODP (ozone depletion potential): Millennia Tech: 0 mfr
(model-derived relative to R11)
GWP (global warming potential): Millennia Tech: 8 relative to mfr

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
SAFETY

- classification ---------------------
  safety group (ASHRAE Standard 34): none (no application pending) 8601
  NFPA 704 degrees of hazard (H-F-R-S): Millennia Tech: 2-0-0
  health-flammability-reactivity
  [-special]: 0=no, 4=severe
  Millennia Tech: "nonflammable" mfr

- flammability -----------------------
  LFL-UFL (flammability limits in air): Millennia Tech: "nonflammable" mfr
  autoignition temperature: Millennia Tech: "nonflammable" mfr

- detection -------------------------
  appearance: Millennia Tech: colorless MSDS
  odor: Millennia Tech: slight natural MSDS
gas odor

PRODUCTION

first commercial use as a refrigerant: 1997
undisclosed blend: MT-31-1

--- REFRIGERANT DATA SUMMARY ---

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assigned composition</td>
<td>undisclosed blend</td>
</tr>
<tr>
<td>Zeotrope</td>
<td>binary blend</td>
</tr>
</tbody>
</table>

**COMMON USE(S)**
alternative for refrigerant 22 for aftermarket use for retrofit and service of commercial refrigeration equipment, air conditioners, and chillers

The following information is preliminary and may be incomplete or incorrect. Further data may be available from Millennia Tech Corporation (Decatur AL and/or South Haven MS USA) or other refrigerant manufacturers. The Material Safety Data Sheet (MSDS) describes the blend as "a nontoxic, nonflammable and noncorrosive homogeneous blend of Fluorocarbons and Hydrochlorofluorocarbons." A product data sheet indicates that it "is a nonflammable, homogeneous blend of natural organic fluorocarbon and hydrochlorofluorocarbon gases." These descriptions are inconsistent with indications in product data sheets that the ozone depletion potential (ODP) is zero. Although the composition has not been disclosed, the limited information available suggests a near-azeotropic, binary blend of a hydrofluorocarbon - possibly R 1216 - and a hydrocarbon. The manufacturer indicates that the refrigerant is miscible with both mineral oil (MO) and alkylbenzene (AB) lubricants, but not compatible with polyalkylene glycol (PAG), polyalphaolefin (PAO), and polyolester (POE) lubricants.

**IDENTIFIERS**

| Trade name(s):     | Millennia Tech MT-31-1 |

**PHYSICAL**

- Normal freezing/melting/triple point: -180.3 °C (-292.6 °F)
- Normal boiling point:
  - temperature: -39.4 °C (-39.0 °F)
  - density, saturated liquid: 1357 kg/m³ (84.70 lb/cf)
  - heat of vaporization: 210.3 kJ/kg (90.4 Btu/lb)
- 20 °C (68 °F) pressure, saturated vapor:
  - temperature: 97.8 °C (208.0 °F)
  - pressure: 5029 kPa (729.4 psia)
  - density: 221 kg/m³ (13.8 lb/cf)
  - specific volume: 4.52 L/kg (0.0725 cf/lb)

**SAFETY**

- Classification:
  - Safety group (ASHRAE Standard 34): none (no application pending) 8601
  - NFPA 704 degrees of hazard (H-F-R-S): Millennia Tech: 2-0-0 MSDS health-flammability-reactivity [-special]: 0=no, 4=severe
- Flammability:
  - LFL-UFL (flammability limits in air): Millennia Tech: "nonflammable" mfr

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
autoignition temperature: Millennia Tech: "nonflammable" mfr
  detection ------------------------------------- appearance: Millennia Tech: colorless MSDS
  odor: Millennia Tech: slight natural MSDS
gas odor

PRODUCTION
first commercial use as a refrigerant: 1997
undisclosed blend: Polycold CFC, Flammable CFC-Free

----------------------------------------------- REFRIGERANT DATA SUMMARY -----------------------------------------------

| unassigned multiple blends, compositions not disclosed | see RDB# |
| zeotrope blend | ___ |

COMMON USE(S)
commercial, industrial, and specialty refrigeration systems

The following information is preliminary and may be incomplete or incorrect. Further data may be available from Polycold Systems International (San Rafael, CA, USA) or refrigerant manufacturers. Material Safety Data Sheets (MSDSs) from Polycold dated 10 August 1995 and 28 September 1995 identify multiple blends. This summary addresses those identified as "CFC refrigerants" and "CFC-free (non-CFC) refrigerants" for "refrigeration units & premixes that have already been shipped." They are described as a "mixture of halocarbons, hydrocarbons, and inert gases" with an indication that the formulations are deemed a trade secret.

Based on identified decomposition products and stability data, the blends appear to contain both chlorinated and fluorinated components, possibly including hydrochlorofluorocarbons (HCFCs) or hydrofluorocarbons (HFCs). Limited toxicity data suggest that the components may include refrigerants 22 and 123, but these possibilities have not been confirmed.

IDENTIFIERS
trade name(s): Polycold CFC Refrigerants
Polycold Flammable CFC-Free

SAFETY
classification ------------

- safety group (ASHRAE Standard 34): none (no application pending) 8601
- short-term occupational limit ------
  - recommended short-term exposure limit:
    Polycold EEL: 1000 ppm (brief) MSDS
    Polycold: possible asphyxiating MSDS
- long-term occupational limit ------
  - exposure limit consistent to OSHA PEL:
    Polycold AEL: 30 ppm v/v TWA MSDS
    for 8 hr/day and 40 hr/wk
- acute (short-term) toxicity ------
  - cardiac sensitization threshold/LOEL: component, Polycold: ≥20,000 ppm v/v (lowest observed effect level in test animals)
- flammability ---------------------
  - LFL-UFL (flammability limits in air):
    Polycold, widest range: 9-23 % MSDS v/v
  - flash point:
    Polycold: not determined MSDS
  - autoignition temperature:
    Polycold: not determined MSDS
- detection -----------------------
  - appearance: Polycold: clear and colorless MSDS
  - odor: Polycold: slight ethereal or foul odor MSDS

PRODUCTION

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
first commercial use as a refrigerant: circa 1994
last year production allowed: 1995 for CFC components in developed countries under the Montreal Protocol
? 2029 based on HCFC component BCO1 in developed countries under the Montreal Protocol
undisclosed blend: Polycold Flammable CFC-Free

--- REFRIGERANT DATA SUMMARY ---

unassigned multiple blends, compositions not disclosed see RDB#
zeotrope blend

COMMON USE(S)
commercial, industrial, and specialty refrigeration systems

The following information is preliminary and may be incomplete or incorrect. Further data may be available from Polycold Systems International (San Rafael, CA, USA) or refrigerant manufacturers. Material Safety Data Sheets (MSDS) from Polycold dated 18 August 1995 identify multiple blends. This summary addresses those identified as "flammable CFC-free refrigerants shipped after January 1, 1995." It is described as a "mixture of halocarbons, hydrocarbons, and inert gases" with an indication that the formulation is deemed a trade secret.

Based on identified decomposition products and stability data, the blend appears to contain both chlorinated and fluorinated components, possibly including hydrochlorofluorocarbons (HCFCs) or hydrofluorocarbons (HFCs). Limited toxicity data suggest that the components may include refrigerants 22 and 123, but these possibilities have not been confirmed.

IDENTIFIERS
trade name(s): Polycold Flammable CFC-Free

SAFETY

- classification
  safety group (ASHRAE Standard 34): none (no application pending) 8601
- short-term occupational limit -----
  recommended short-term exposure limit: Polycold EEL: 1000 ppm (brief) MSDS
  Polycold: possible asphyxiant MSDS
- long-term occupational limit -------
  exposure limit consistent to OSHA PEL: Polycold AEL: 30 ppm v/v TWA for 8 hr/day and 40 hr/wk
- acute (short-term) toxicity -------
  cardiac sensitization threshold/LOEL: component, Polycold: ≥20,000 ppm v/v (lowest observed effect level in test animals)
- flammability ------------
  flash point: Polycold: not determined MSDS
  autoignition temperature: Polycold: not determined MSDS
- detection ------------
  appearance: Polycold: clear and colorless MSDS
  odor: Polycold: slight ethereal or foul odor MSDS

PRODUCTION
first commercial use as a refrigerant: circa 1995
last year production allowed: ? 2029 based on HCFC component 8C01 in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
undisclosed blend: Polycold Nonflammable CFC-Free

--- REFRIGERANT DATA SUMMARY ---

unassigned multiple blends, compositions not disclosed see RDB#
zeotrope blend

COMMON USE(S)
commercial, industrial, and specialty refrigeration systems

The following information is preliminary and may be incomplete or incorrect. Further data may be available from Polycold Systems International (San Rafael, CA, USA) or refrigerant manufacturers. Material Safety Data Sheets (MSDSs) from Polycold dated 18 August 1995 identify multiple blends. This summary addresses those identified as "non-flammable CFC-free refrigerants shipped after January 1, 1995." It is described as a "mixture of halocarbons, hydrocarbons, and inert gases" with an indication that the formulation is deemed a trade secret.

Based on identified decomposition products and stability data, the blend appears to contain both chlorinated and fluorinated components, possibly including hydrochlorofluorocarbons (HCFCs) or hydrofluorocarbons (HFCs). Limited toxicity data suggest that the components may include refrigerants 22 and 123, but these possibilities have not been confirmed.

IDENTIFIERS
trade name(s): Polycold Nonflammable CFC-Free

SAFETY
- classification
  - safety group (ASHRAE Standard 34): none (no application pending) 8601
  - short-term occupational limit
    - recommended short-term exposure limit: Polycold EEL: 1000 ppm (brief) MSDS
    - Polycold: possible asphyxiant MSDS
  - long-term occupational limit
    - exposure limit consistent to OSHA PEL: Polycold AEL: 30 ppm v/v TWA MSDS
    - for 8 hr/day and 40 hr/wk
  - acute (short-term) toxicity
    - cardiac sensitization threshold/LOEL: component, Polycold: ≥220,000 ppm v/v (lowest observed effect level in test animals)
  - flammability
    - LFL-UFL (flammability limits in air):
      - flash point: Polycold: varies with mixture MSDS
      - autoignition temperature: Polycold: not determined MSDS
    - detection
      - appearance: Polycold: clear and colorless MSDS
      - odor: Polycold: slight ethereal MSDS

PRODUCTION
first commercial use as a refrigerant: circa 1995
last year production allowed: 2029 based on HCFC component 8C01 in developed countries under the Montreal Protocol

SEE DATA LIMITATIONS AND NOTES ON PAGE 2
undisclosed blend: RX4

--------------------------- REFRIGERANT DATA SUMMARY ---------------------------
unassigned composition not disclosed see
zeotrope ternary blend RDB#

COMMON USE(S)
under consideration as an alternative for refrigerant 13B1 for very low temperature refrigeration

The following information is preliminary and may be incomplete or incorrect. Data may be available from Rhône-Poulenc (Avonmouth, Bristol, UK), Star Refrigeration (Glasgow, Scotland, UK), and other refrigerant manufacturers.

IDENTIFIERS

  trade name(s): Rhodia RX4
  historical name(s): Rhône-Poulenc RX4

SAFETY

  classification
    safety group (ASHRAE Standard 34): none (no application pending) 8601
undisclosed blend: THR03

------------------------ REFRIGERANT DATA SUMMARY ------------------------

unassigned composition not disclosed see
zeotrope ternary blend RDB#

COMMON USE(S)
under consideration as an alternative for refrigerants 22 and 502

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from Tsinghua University (Beijing, Peoples Republic of China) and refrigerant manufacturers.

IDENTIFIERS

trade name(s): (China) THR03

SAFETY

classification ------------------------
safety group (ASHRAE Standard 34): none (no application pending) 8601

PRODUCTION

first commercial use as a refrigerant: not known to be commercialized
undisclosed blend: THR04

---------------------- REFRIGERANT DATA SUMMARY ----------------------
unassigned composition not disclosed see
zeotrope ternary blend RDB#

COMMON USE(S)
interim alternative for refrigerant 502 in commercial refrigeration systems

The following information is preliminary and may be incomplete or incorrect. Data on this blend may be available from Tsinghua University (Beijing, Peoples Republic of China) and refrigerant manufacturers.

IDENTIFIERS
trade name(s): (China) THR04

SAFETY
- classification
  safety group (ASHRAE Standard 34): none (no application pending) 8601

PRODUCTION
first commercial use as a refrigerant: circa 1998 in China
last year production allowed: 2029 by HCFC component in 8C01 developed countries under the Montreal Protocol
The Refrigerant Database is supported, in part, by the U.S. Department of Energy (Office of Building Technology) grant number DE-FG02-91CE23810, Materials Compatibility and Lubricant Research (MCLR) on CFC-Refrigerant Substitutes. Federal funding supporting the MCLR program constitutes 93.57% of allowable costs. Additional funding and in-kind support are provided by the air-conditioning and refrigeration industry, through the Air-Conditioning and Refrigeration Institute (ARI), and - for the Refrigerant Database - by copper producers and fabricators, through the Copper Development Association (CDA), and in-kind cost sharing by James M. Calm, Engineering Consultant. Development of the database is part of the MCLR Program, managed by the Air-Conditioning and Refrigeration Technology Institute (ARTI). Support by the cited parties does not constitute an endorsement of the views expressed in the database.