Air Conditioning and Heat Pumps
Session I

System Drop-in Tests of R-410A Alternative Refrigerants ARM-70a, DR-5, L-41a, L-41b, and R-32 in a Heat Pump
Outline/Agenda

Purpose of Testing

Description of Tested System

Test Approach

Summary of Results

Conclusions
Low GWP R-410A Alternative Testing

Purpose
Evaluate performance of proposed Low GWP alternatives to replace R-410A

Proposed Refrigerants
R-32
Arkema ARM-70a
DuPont DR-5
Honeywell L-41a
Honeywell L-41b

Test System
Production 14 SEER, 3.0 ton R-410A residential split system heat pump
  Heat pump model: 3 ton heat pump
  Fan coil model: 3 ton fan coil
Low GWP R-410A Alternative Testing

Test System: 14 SEER, 3.0 ton R-410A residential split system HP

System Description:

Standard Production System

Minor Modifications

Calorimeter tested compressor
POE oil with good miscibility with all refrigerants tested
EXV for expansion control
Low GWP R-410A Alternative Testing

Testing Approach:

Psychrometric Test Facility in Indianapolis upgraded for 2L refrigerants
DOE Cooling and Heating Series in accordance with AHRI 210/240

Drop-in Testing

R-410A tested to establish baseline performance
Alternatives tested without modification to test system or test-up
Charge level determined by matching R-410A baseline state points

Cooling State points
Superheat leaving evaporator @ DOE B Conditions
Subcooling leaving condenser @ DOE B Conditions
Superheat leaving evaporator @ DOE A Conditions

Heating State Points
Subcooling leaving condenser (indoor coil) during DOE H1

Charge level determined by these criteria for each refrigerant was held constant for the complete cooling and heating series
Low GWP R-410A Alternative Testing
Performance Results – 3 ton, 14 SEER Heat Pump

Low GWP R-410A Alternative Testing

Performance Results – 3 ton, 14 SEER Heat Pump

Heating

Heating Capacity
DOE H1 Conditions

Heating Seasonal Efficiency

Low GWP R-410A Alternative Testing
Operating Conditions – 3 ton, 14 SEER Heat Pump

Low GWP R-410A Alternative Testing
Operating Conditions – 3 ton, 14 SEER Heat Pump

Heating Discharge Pressures
DOE H1 Conditions

Heating Discharge Temperatures
DOE H1 Conditions

Carrier: Larry Burns, Matthew Austin, Cheng Chen
Conclusions

Proposed alternatives were applied in test system with minimal effort

Miscibility issue with current compressor oil and R-32

No option equivalent to R-410A on drop-in basis
- Most are significantly lower in capacity
- Some significantly lower in efficiency

Additional analysis of system optimization is recommended
- Soft Optimization
  - Charge level
  - Coil circuiting
  - Oil optimization
- Full Technology Optimization
  - Compression
  - Heat exchanger surface
  - Airflow
  - Control systems

Refrigerant flammability must be evaluated and addressed to safely apply Class 2L refrigerants
Bibliography

Questions?

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