

Air-Conditioning, Heating, and Refrigeration Institute

50111241

Health, Comfort, Preservation: Bringing the Benefits of Humidity Home

004

Humidifiers Educational Working Group

February 4, 2020



Presenters



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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.



Course Description

Attendees will learn about the science of humidity and health, and how indoor moisture affects both occupants and the home itself.

We will explore the causes of indoor dryness as well as solutions for increasing indoor humidity during dry winter months.

We will conclude with best practices to ensure the continued success of humidity control in the home including controlling condensation, understanding maintenance requirements, and educating homeowners.



Learning Objectives

At the end of the course, participants will understand:

1. Fundamental humidity control terminology
2. The causes of dryness in homes
3. Interactions between humidity, the home, and its contents
4. The relationship between humidity and human health at home
5. Understanding product solutions to indoor dryness



Agenda

1. The Basics of Humidity
2. Humidity and Your Home
3. Product Solutions for Any Home
4. Getting Home Humidity Right
5. Summary
6. Questions

The Basics of Humidity

Humidity Terms and Terminology

Humidity

- The amount of water vapor in the air
- Measured in “Absolute” or “Relative” terms

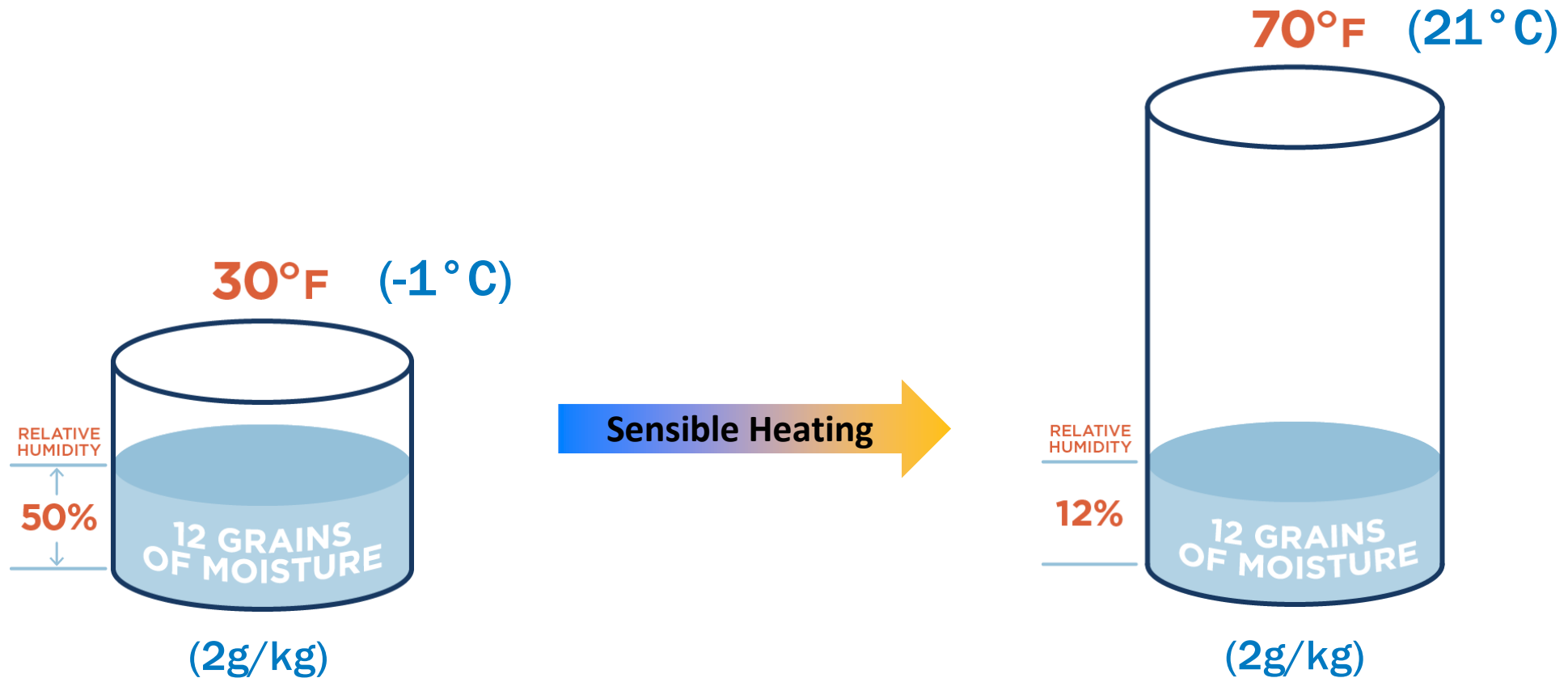
Absolute Humidity

- Mass of water in particular volume of air
- Expressed as mass (grains/lb_{da} or g_w/kg_{da})

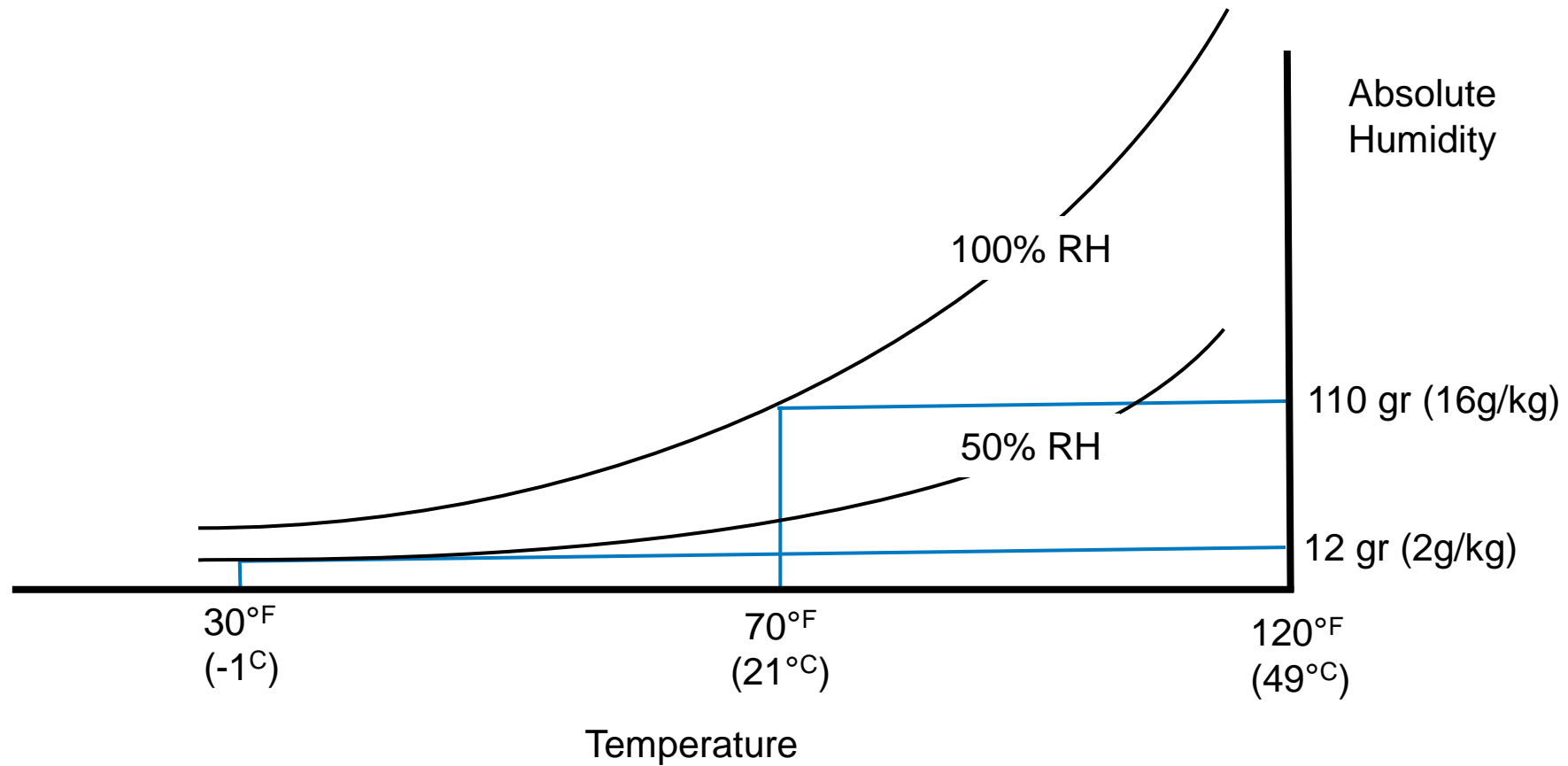
Relative Humidity

- Amount of water vapor in the air relative to how much it can hold at a given temperature (%)

Humidity: Relative to Temperature



Humidity vs. Temperature Charted



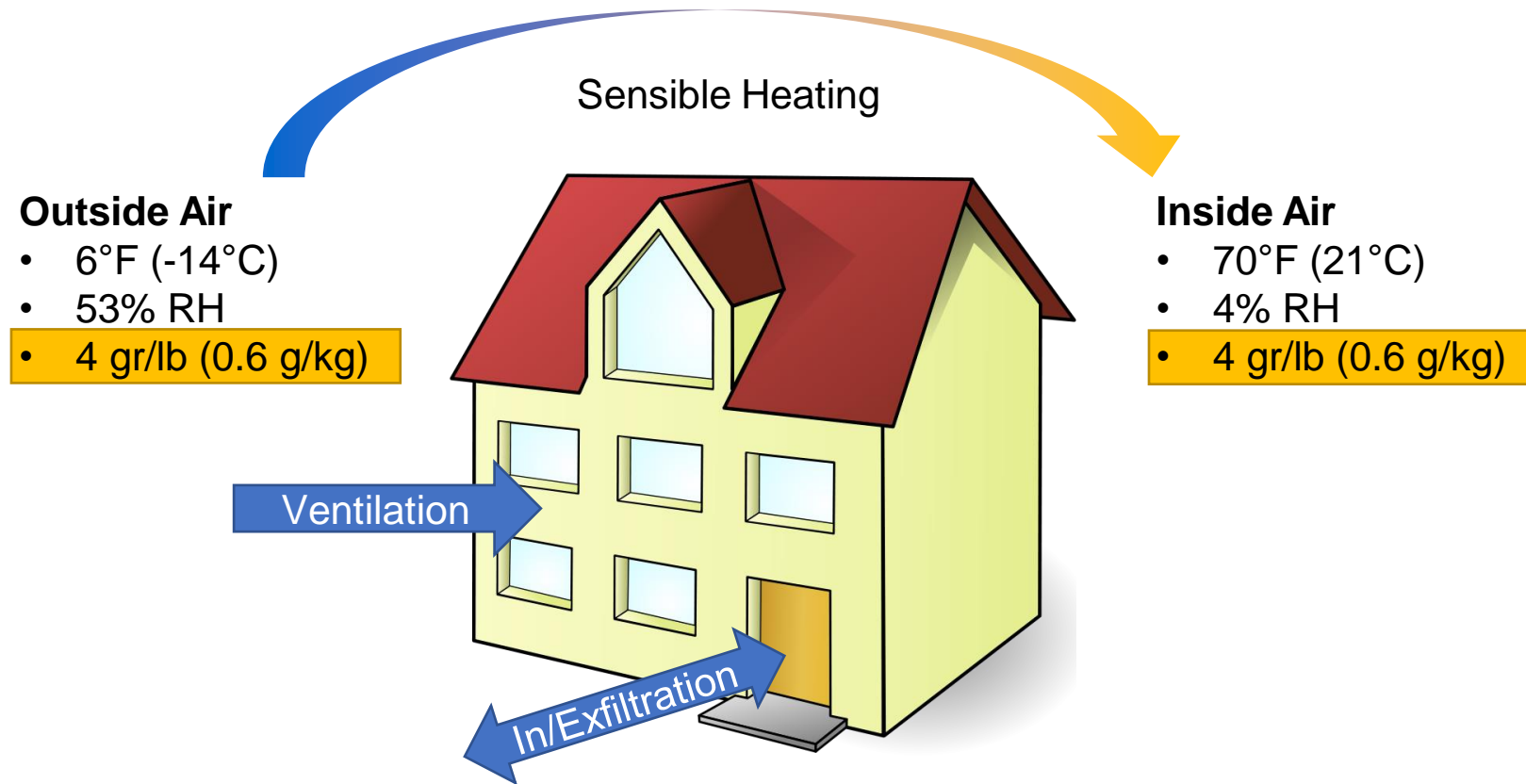
What Causes Indoor Dryness?

High outdoor RH does not necessarily translate indoors!

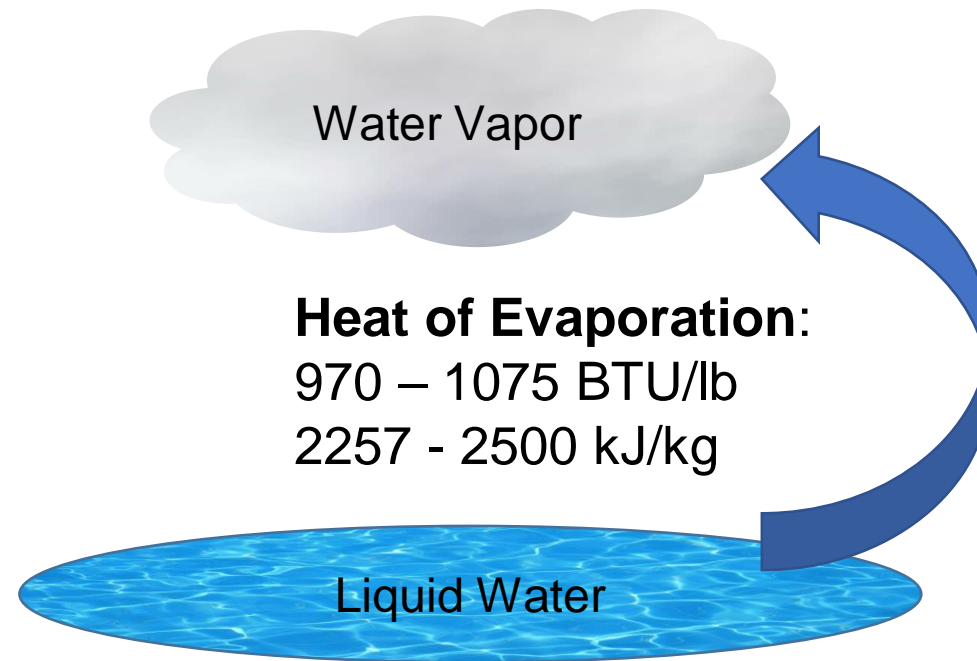
RH %	Indoor RH% When Heated to 70°F													
100	2	4	5	6	7	9	12	17	19	23	29	36	42	53
60	1	2	3	3	4	5	7	9	11	14	17	21	26	31
50	1	1	3	3	4	4	6	8	9	12	14	18	22	26
45	1	1	2	3	3	4	6	7	8	11	13	16	20	24
40	1	1	2	3	3	4	5	7	7	10	12	14	18	21
35	1	1	2	2	2	4	5	6	6	7	10	12	15	18
30	0	1	2	1	2	3	4	5	5	7	9	11	13	15
25	0	1	1	1	2	3	4	4	4	5	7	9	11	13
20	0	1	1	1	2	2	3	3	3	5	5	7	9	10
	-20	-10	-5	0	5	10	15	20	25	30	35	40	45	50
Outdoor Temperature (°F)														

What Causes Indoor Dryness?

Outside air with low absolute humidity dries building



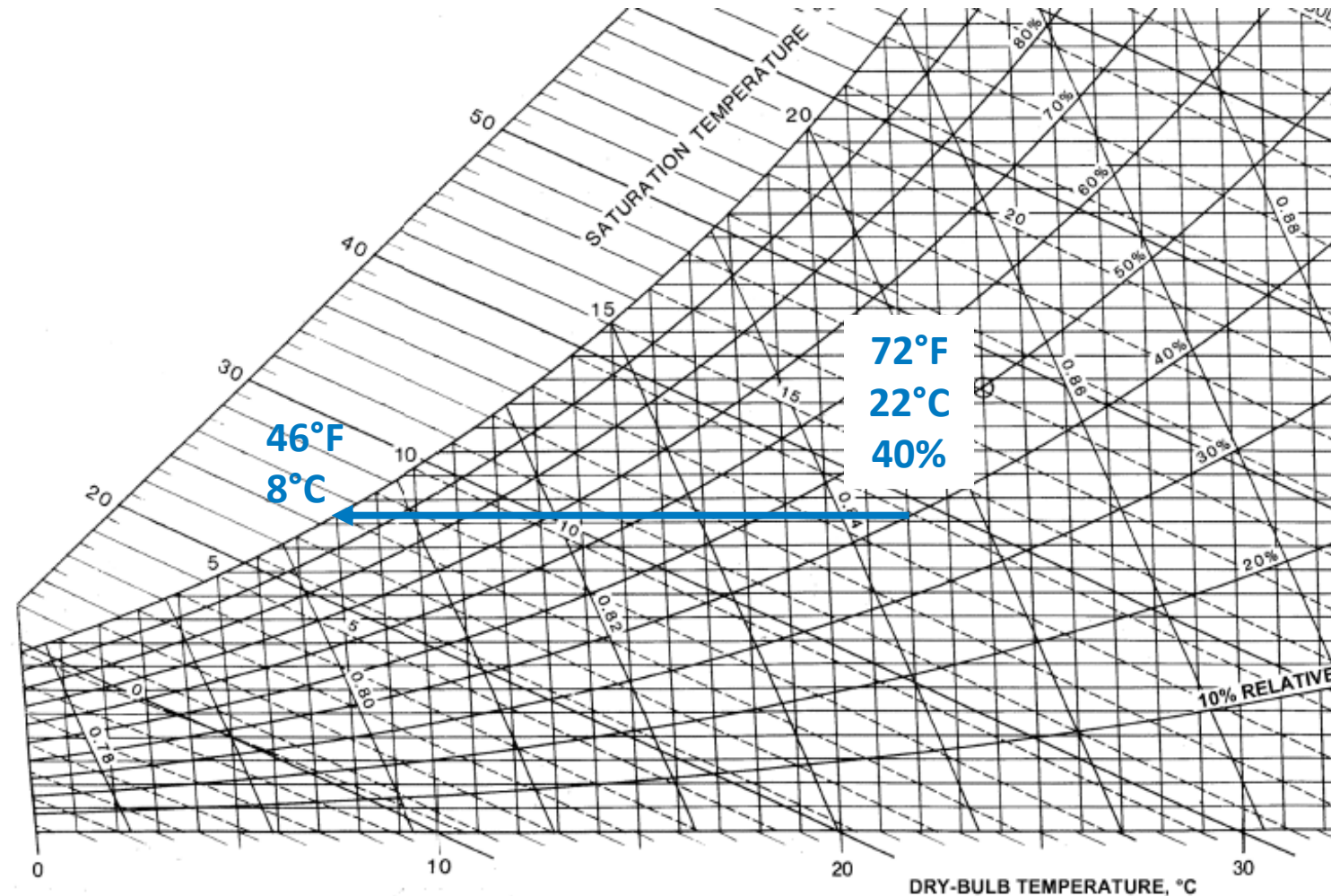
Practical Humidity



Steam: Energy comes from electricity, gas, or heat exchange process

Spray / Evaporative: Energy comes from the air = SENSIBLE COOLING!

How Humidity Leaves the Air



Condensation: Humid air

- Cools below dew point
- Contacts surface cooler than dew point

Absorption: Moisture is dissolved by liquid or solid absorbent

Adsorption: Moisture becomes adhered to an adsorbent surface

Controlling Condensation

Condensation occurs when humid air interacts with temperatures below the dew point



Image Credit: creativity103.com, Cropped

Fenestration, Exterior Walls, Pipes

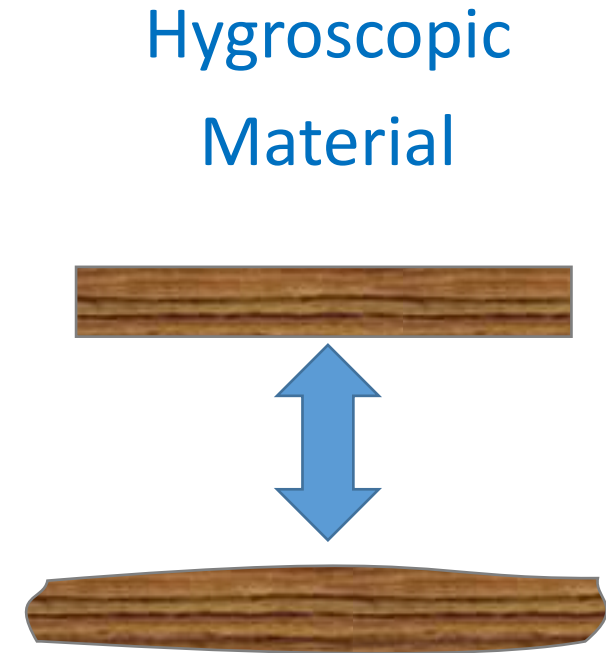
Strategies:

- Cold temperature setback: 45% → 30%
- Condensation sensors (automatic setback)
- Ventilate / supplemental heat for glass
- Focus on quality in construction / vapor barriers
- Use exhaust fans for bathrooms and cooking

Resources: ASHRAE Journal Column: Building Sciences by Joe Lstiburek

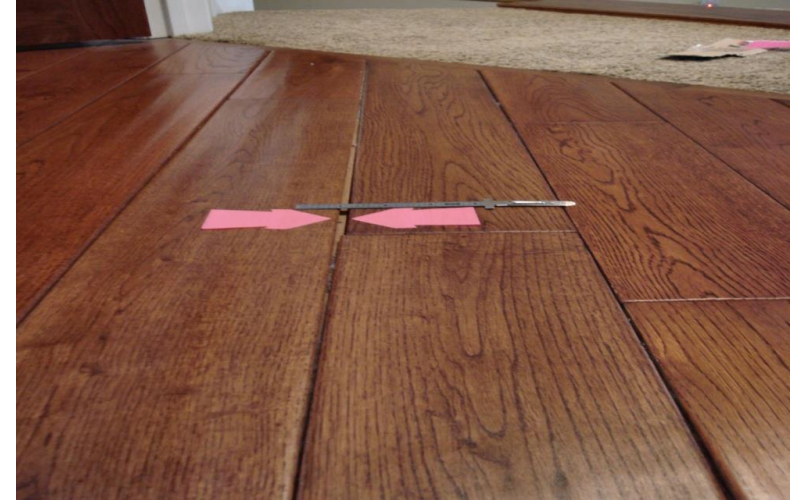
Humidity Absorption

- Moisture absorbs/desorbs in hygroscopic materials
- Low Relative Humidity
 - Moisture migration from material
 - Most shrink in size
- High Relative Humidity
 - Moisture migration into material
 - Increase in size
 - $A_w > \sim 0.7$ risk of mold formation



Absorption in Wood

- Dimension changes with moisture
 - Stress / warping with wetting / drying
 - Cracking and gaps may form
 - Embrittlement in dry environments
- Furniture
- Floors – Read warranty!



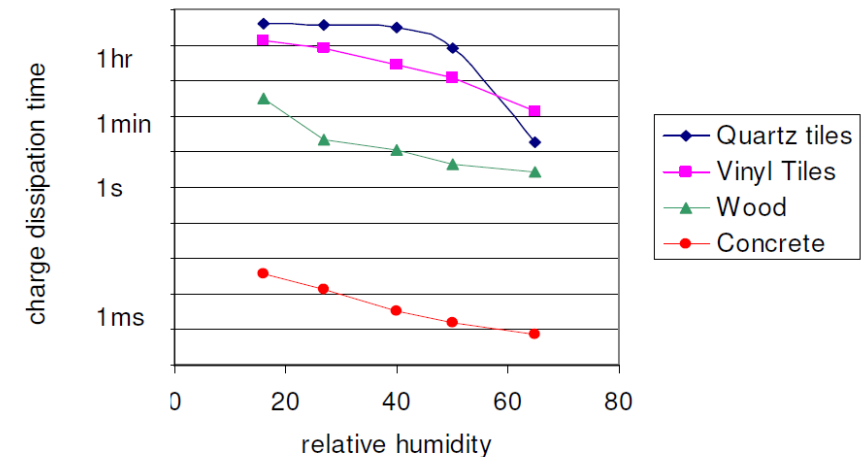
Absorption in Common Items

- Art
 - Paint can become brittle in low humidity, causing cracks.
 - Wooden frame joints may also de-glue.
- Instruments
 - Instruments with wooden components will change in pitch with RH levels.
- Wallpaper
 - Low humidity levels may cause wallpaper to peel off.



Static Electricity

- Build up of electric charges on material
 - Usually caused by friction at home
 - Walking Carpeted floors
 - Moving on furniture
 - Clothing / bedding
- Sparks / shocks are release of charge
 - Air moisture allows charges a path to dissipate into the environment
 - Dry environments allow charge to build up
 - Electronic home devices could be damaged by a static-electricity event



Humidity and Your Home

Occupant Health and Wellness

- Residential humidity has impact on occupant's:

- **Skin**

- Eyes
- Throat
- Nasal Passages
- Lungs



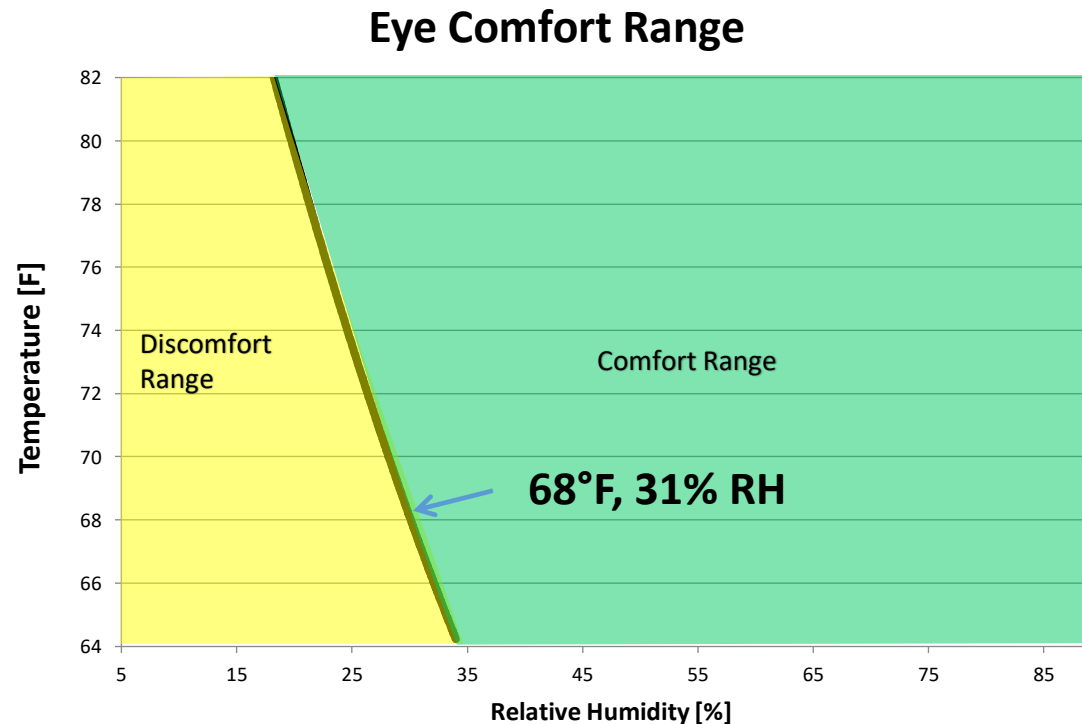
- Skin is the first layer of defense against infection
- Below ~30% RH conditions, the skin becomes dry
- Dry skin symptoms include itching, cracking, and chapping
- Skin conditions such as psoriasis may become aggravated at lower RH

Occupant Health and Wellness

- Residential humidity has impact on occupant's:

- Skin
- **Eyes**
- Throat
- Nasal Passages
- Lungs

- Low humidity causes a breakdown of the tear film
- Discomfort to the eye increases with time if the dew point is below 26°F



Occupant Health and Wellness

- Residential humidity has impact on occupant's:

- Skin
- Eyes
- **Throat**
- Nasal Passages
- Lungs



- Humidity below 30% RH can irritate vocal chords
 - Dryness of throat
 - Increased hoarseness or laryngitis
- National Institute for Health (NIH) recommends:
 - Drink water, six to eight glasses a day
 - Use a humidifier
 - Keep relative humidity > 30% RH

Occupant Health and Wellness

- Residential humidity has impact on occupant's:

- Skin
- Eyes
- Throat
- **Nasal Passages**
- Lungs



- Membranes in the nose dry out quicker in low humidity

- Humidity above 30% RH is needed for the mucous membranes in the nose to properly filter the air we breathe
- More significant impact on the elderly or health compromised

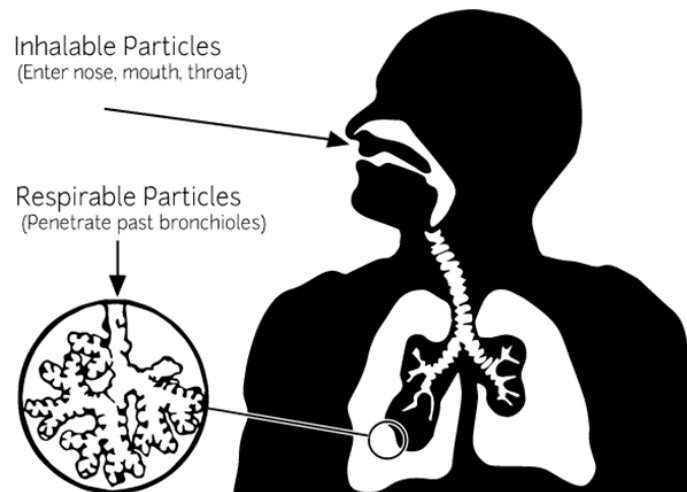
Occupant Health and Wellness

- Residential humidity has impact on occupant's:

- Skin
- Eyes
- Throat
- Nasal Passages
- **Lungs**

- Lungs – Low humidity results in breathing smaller particles

- Low humidity can increase creation of smaller exhaled breath aerosols that can retransmit microbes
- Greater likelihood of particles being inhaled deeply

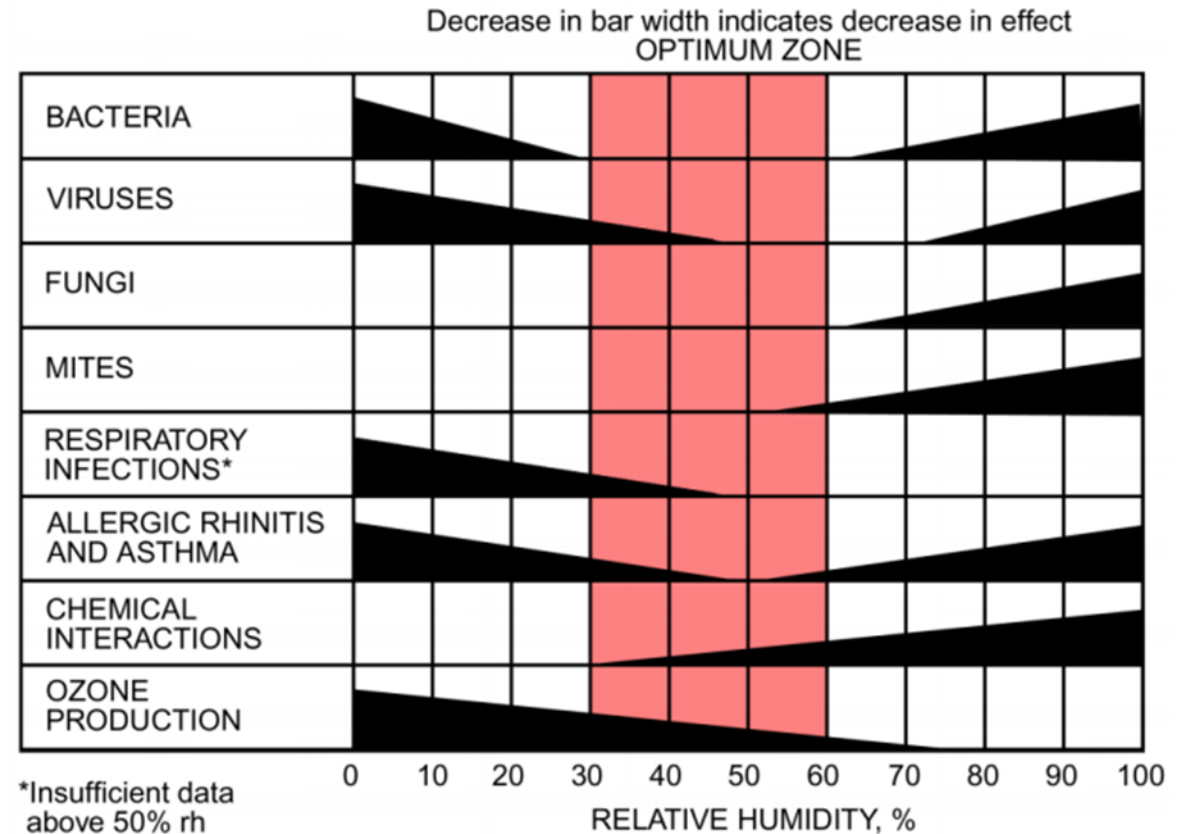


particles in the nose, throat, and lungs
an edited version of Figure 4-1 EPA/600/R-95/115

Respiratory Illness

Less incidence of respiratory illnesses where humidity is kept in optimal zone, due to two reasons:

- Increase in viruses and bacteria both at low and high relative humidity values
- Weakening of the airways due to mucus drying out at low relative humidity values



Occupant Comfort and Energy

Warm up with No Heat!

- At **70 °F**, for every **5%** you increase the indoor relative humidity, you increase the “apparent temperature” approximately **1° F**.
- For every **1° F** that you reduce your thermostat setting, you save approximately **4%** on your heating consumption.
- This means that if customers raise the RH by **20% (from 15% to 35%)** they can save **16%** or more on their heating costs while being way more comfortable and healthier.
- Dry air also shrinks the framing around doors and windows, resulting in gaps that let in cold air from the outside. This makes the home less energy efficient.

Residential Humidification

2,000 Sq. Ft. | 8 Ft. Ceilings | 16,000 Cu. Ft. | 1,185 lbs. of Air

To bring relative humidity from 12% to 50% you need to add 52 grains of moisture per pound of air.

$$1,185 \times 52 = 61,620 \text{ grains}$$

$$61,620 / 7,000 = 8.8 \text{ pints (7,000 grains of moisture in a pint)}$$

$$\frac{1}{2} \text{ ACH} = 4.4 \text{ Pints per hour (ACH = Air exchanges per hour)}$$

$$4.4 \text{ pints} \times 24 \text{ hours in a day} = 105.6 \text{ pints per day}$$

$$105.6 \text{ pints per day} / 8 \text{ (pints in a gallon)} = 13.2 \text{ GPD}$$

All Source Information Generated From Thermodynamic Properties Of Moist Air,
Compiled From The ASHRAE Handbook Of Fundamentals, Bulletin 400



Sizing a Humidifier

Variables to Consider:

Cubic Feet vs Square Feet
(ceiling height)

A family of 4 will add 2 gallons of humidity per day through everyday activities like breathing, cooking, bathing and washing.

Structure Tightness
(8 Foot Ceilings)

Tight

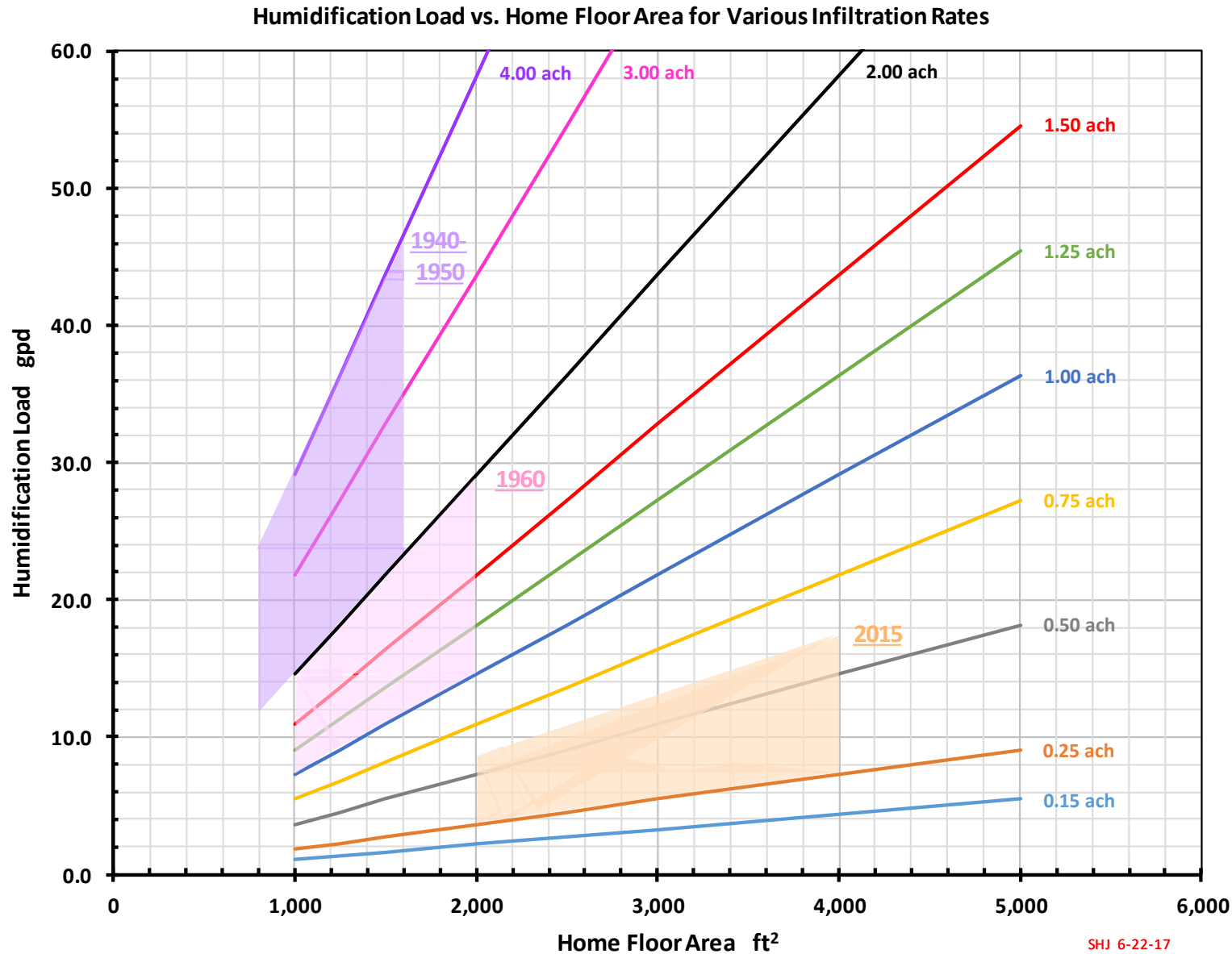
Average

Loose

Humidifier Sizing Guidelines Gallons Per Day needed Per Square Foot

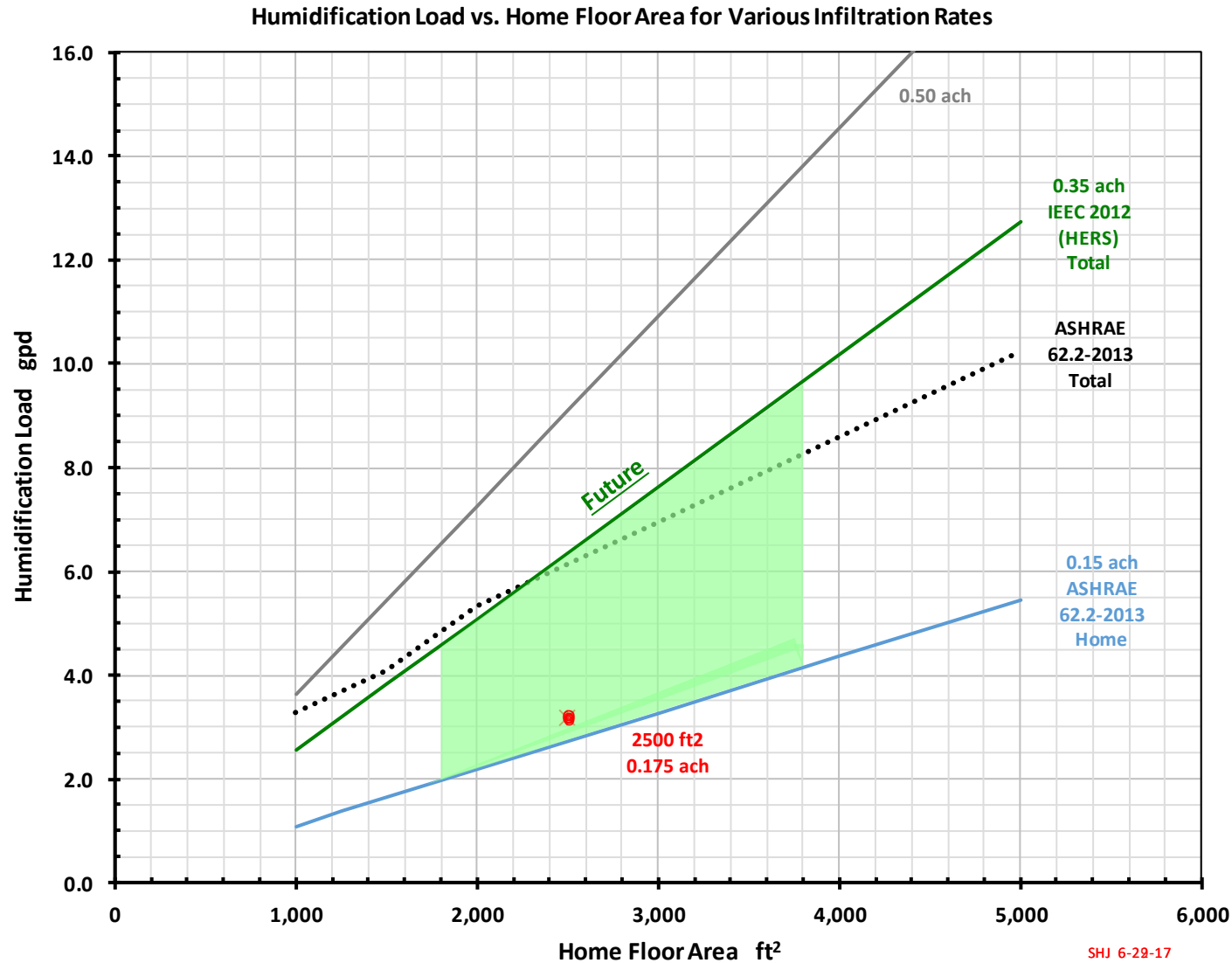
	1000 Ft ²	1500 Ft ²	2000 Ft ²	2500 Ft ²	3000 Ft ²
Tight	4.3 GPD	6.4 GPD	8.5 GPD	10.6 GPD	12.7 GPD
Average	8.6 GPD	12.8 GPD	17.0 GPD	21.3 GPD	25.4 GPD
Loose	12.7 GPD	19.1 GPD	25.5 GPD	31.8 GPD	38.1 GPD

Residential Humidification over the years



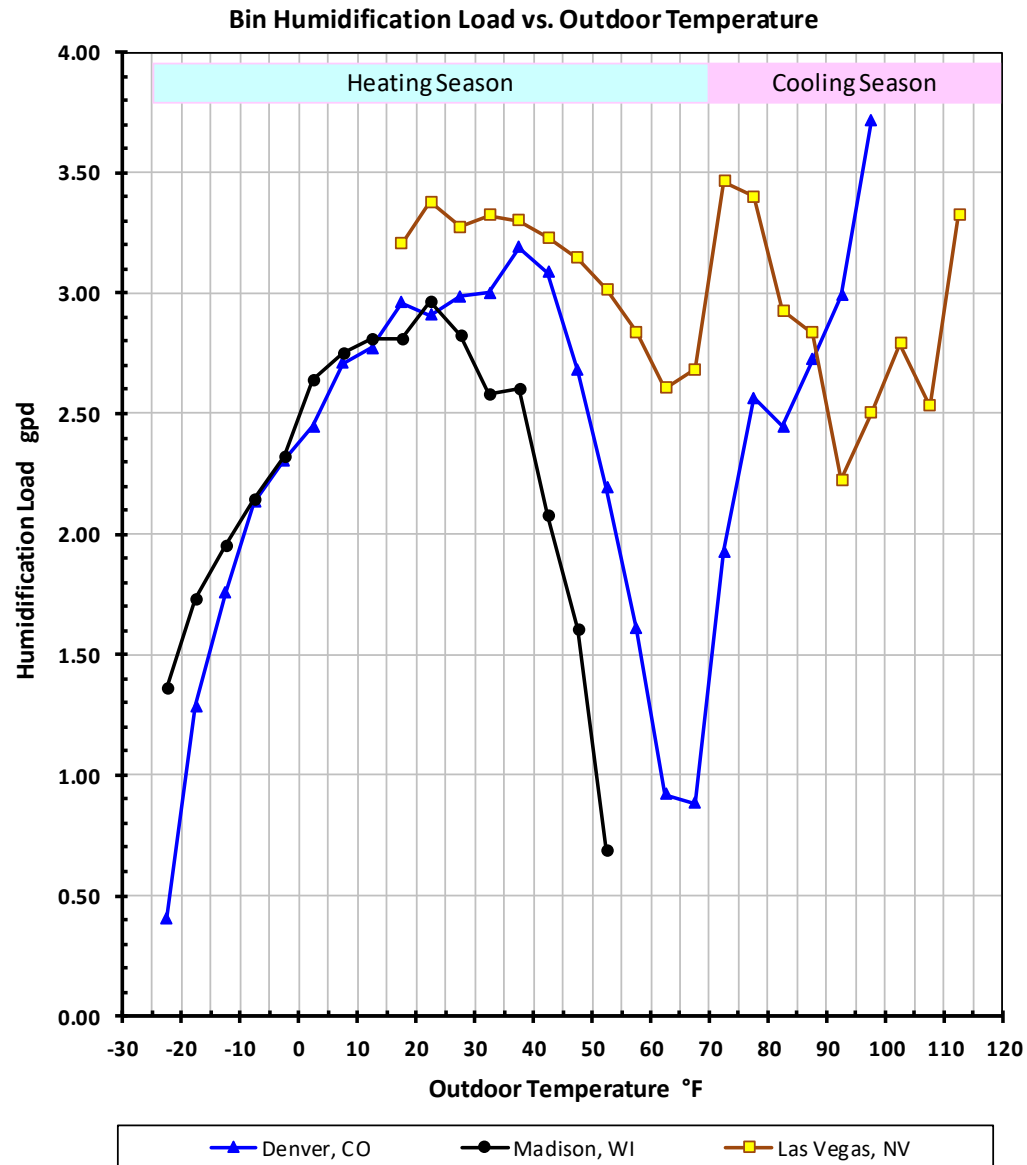
Improved building practices have decreased the humidification load in homes, however humidification is still needed in the best built homes

Residential Humidification - Today



Homes built to latest standards still require humidification

Residential Humidification - Today



Model Home

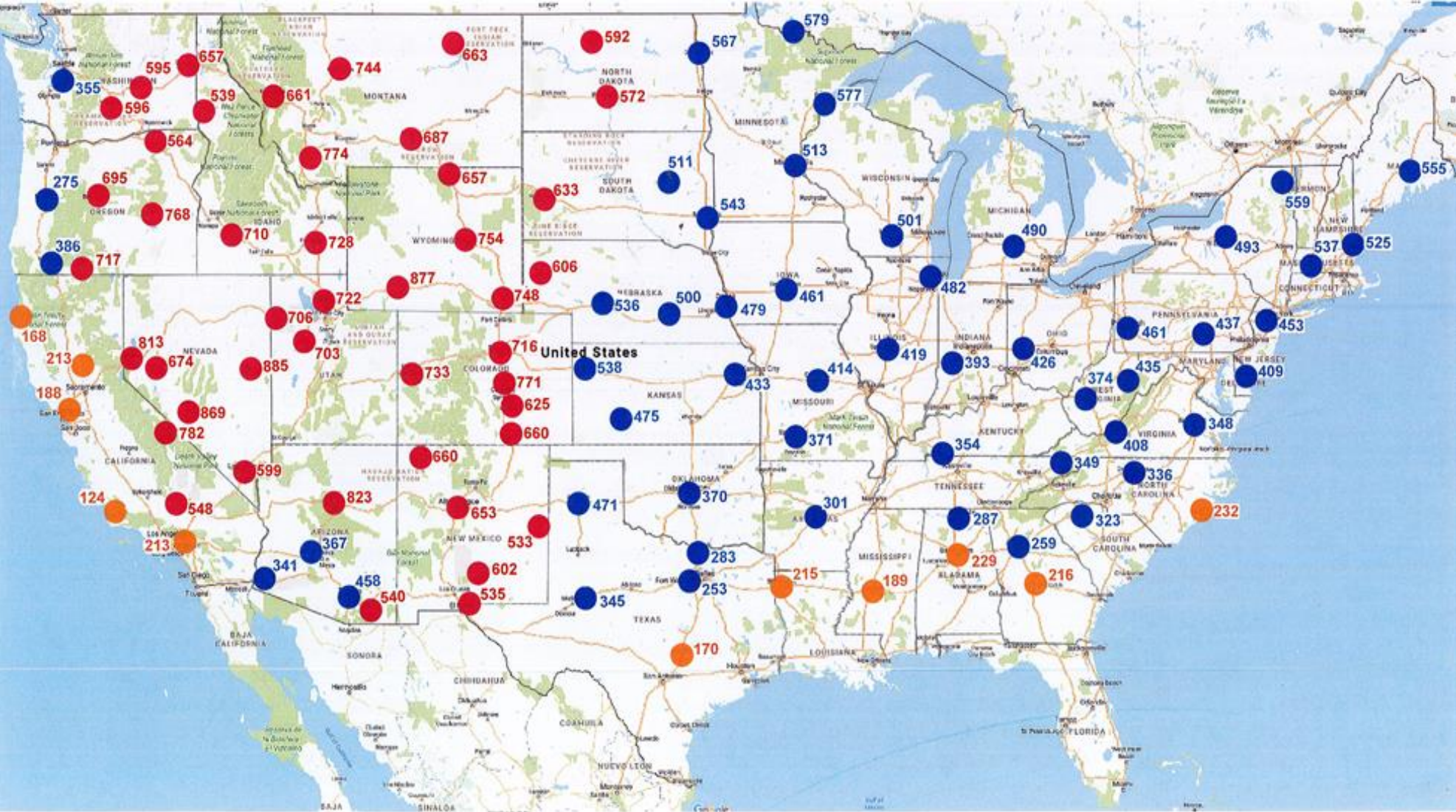
- 2500 ft² & 0.175 ach
- Indoor humidity 20-40% depending out outdoor conditions

Madison WI – what industry thinks is the area where humidifiers are needed

Denver – Winter humidification similar to Madison but high loads during cooling seasons

Las Vegas – Highest humidification loads year round.

Residential Humidification - Today



Blue: humidification & DH Red: humidification load all year Orange: marginal humidification & DH

Product Solutions for Any Home

Portable / Manual Fill Product

Applications:

- Spot or localized humidification

Pros:

- Easy to obtain (retail)
- Portable

Cons:

- Limited to no controls
- Mist (ultrasonic) humidifiers require deionized water to avoid white dust.
- Standing water
- Limited capacity
- Require refilling of water



Evaporative Humidifier – How it works

Solenoid Valve:

- Solenoid valve opens and water flows through feed tube.

Water Distribution Tray:

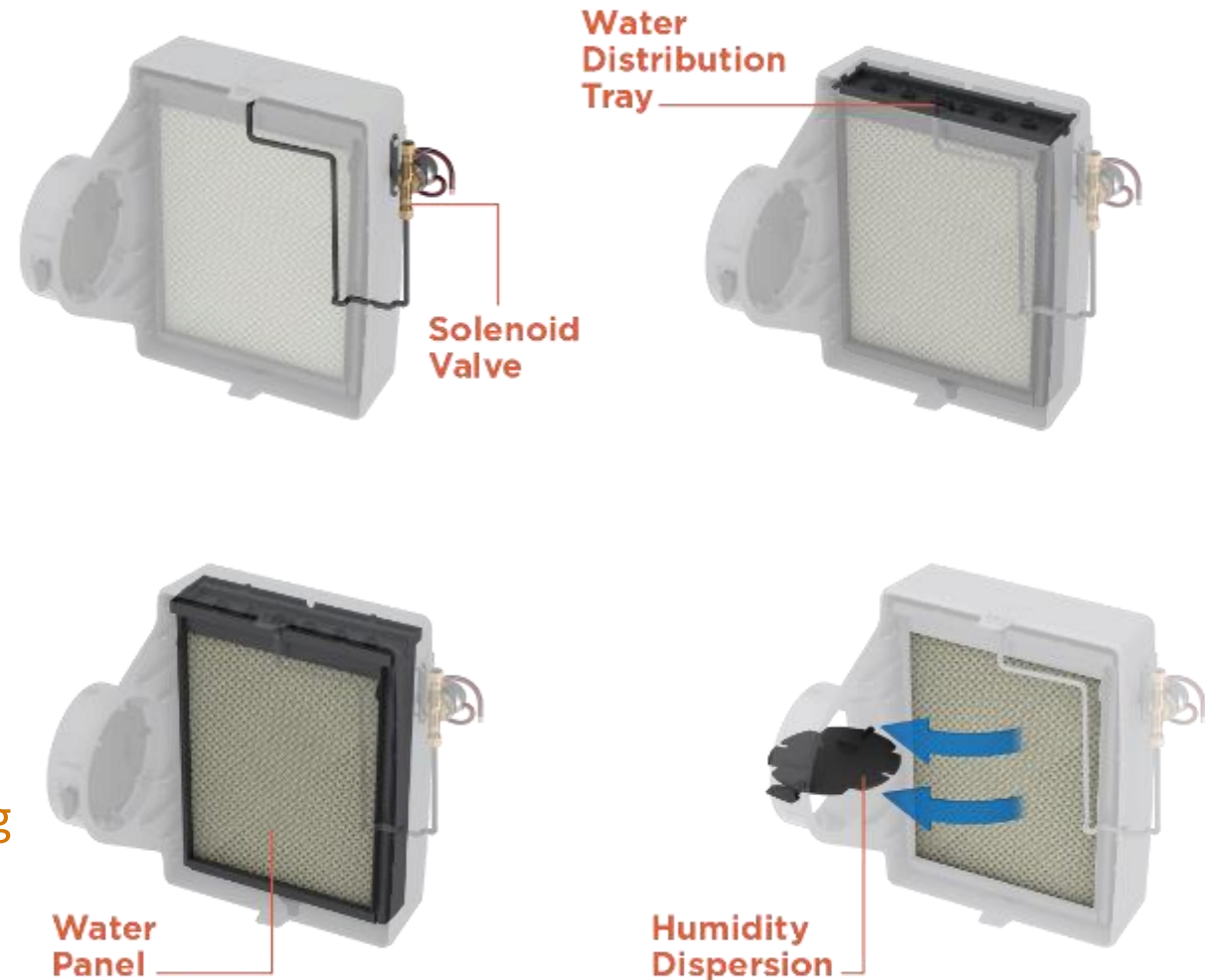
- Water is dispersed throughout the water distribution tray.

Water Panel:

- Water drips from the water distribution tray through 6 holes and disperses throughout the water panel.

Humidity Dispersion:

- Humidity disperses through the 6" opening into the bypass duct which is attached to either the return or supply ductwork and travels throughout the home.



Forced Air Applications - Evaporative

Applications:

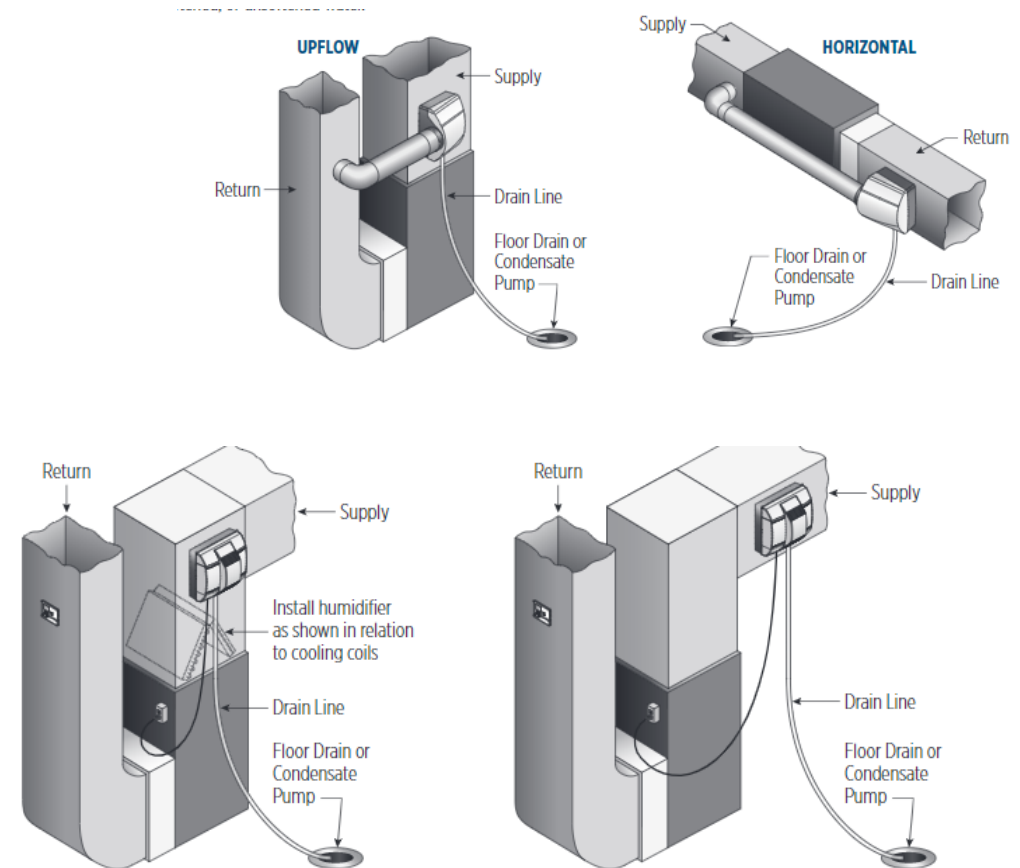
- Forced air Systems
- Bypass and Power Configurations

Pros:

- Whole home capacities
- No standing water
- Flexible installations
- Manual, Automatic and Thermostat controls
- Easy maintenance
- Low cost installation

Cons:

- Capacity effected by plenum temperatures
- Requires forced air system



Forced Air Applications – Steam

Applications:

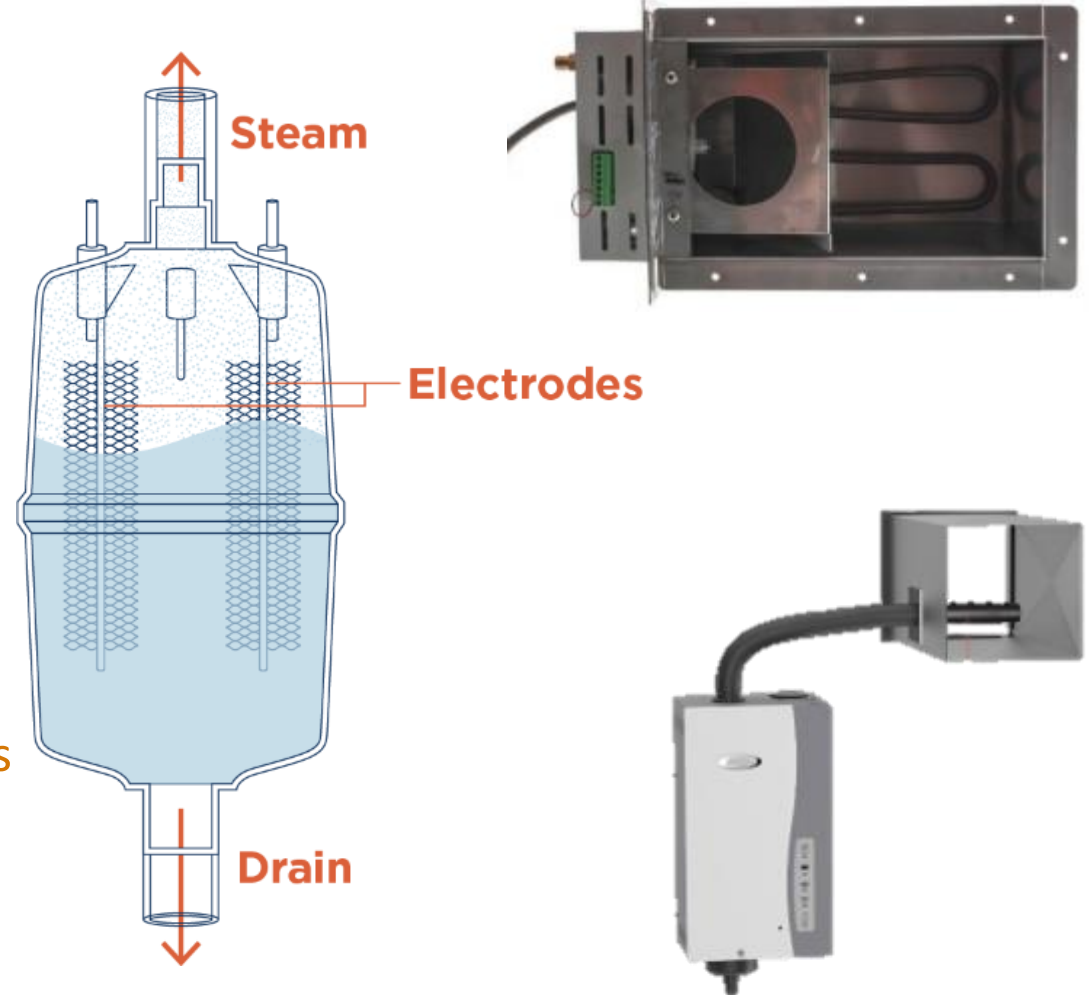
- Forced air and non forced air systems
- Large capacities available
- Steam generator and dispersion units can be mounted remotely from each other

Pros:

- Whole home capacities
- No standing water
- Flexible installations
- Manual, Automatic and Thermostat controls
- Easy maintenance (canister type)
- Capacity not effected by plenum temperatures

Cons:

- Installation cost higher than evaporator
- Can require separate electrical circuit



Direct Room & Non-Ducted Air Applications

Non-Ducted Evaporative Humidifiers are designed specifically for a whole-home solution that helps you achieve total comfort through humidity control.

While designed for homes with radiators or baseboard heating systems, they are so effective and flexible that they work equally well in homes with central heating and cooling systems.

Installed by a local HVAC professional.



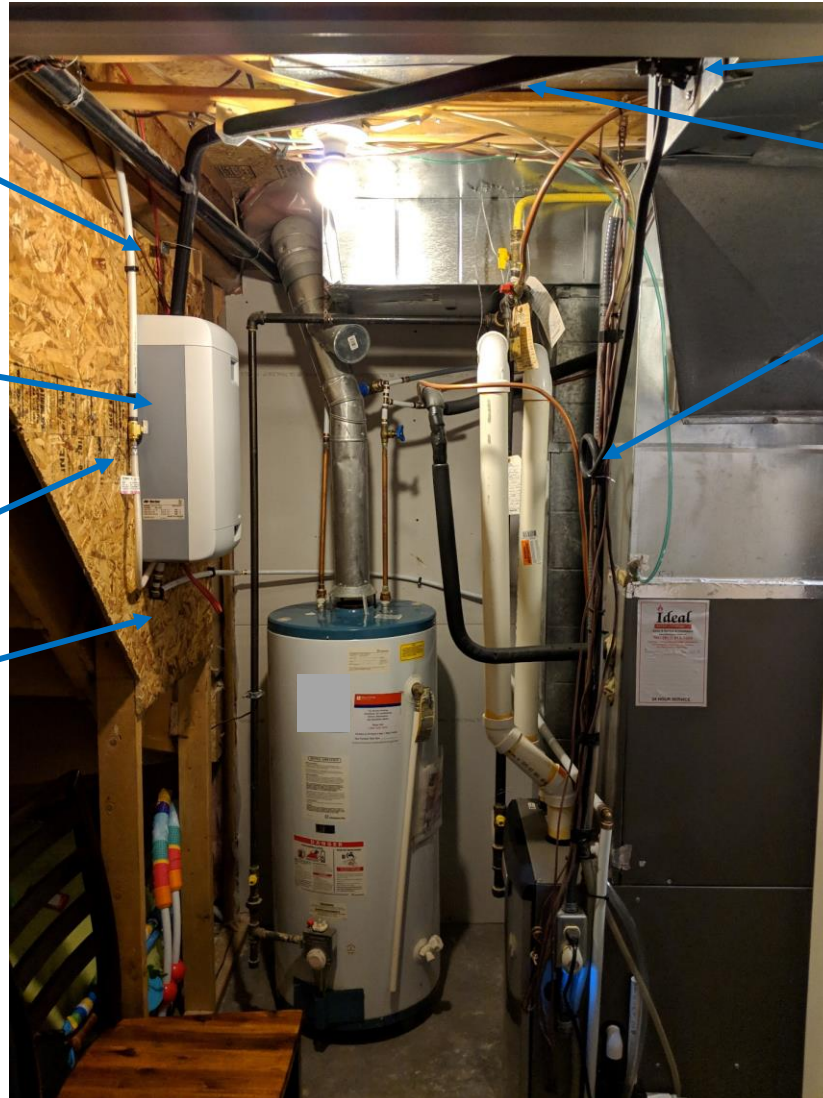
Sample Installation: Steam Humidifier

120V or 240V
Dedicated Circuit

Steam
Humidifier

¼" Water Supply
+ Isolation Valve

Drain Line



Steam Pipe

Steam Hose

Condensate
Drain + Trap



Controls

- Smart Thermostat / Humidistat for user
- Airflow interlock wired to terminal on furnace
- Configured to humidify only when heating

Getting Home Humidity Right

Controlling a Humidifier

The table shows the typical recommended indoor RH based on outdoor temperature.

Actual humidity levels will vary based on home construction

Recommended Indoor Humidity Levels

Outdoor Temp (°F)	Recommended Humidity
+40	45%
+30	40%
+20	35%
+10	30%
0	25%

Controlling a Humidifier

Application:

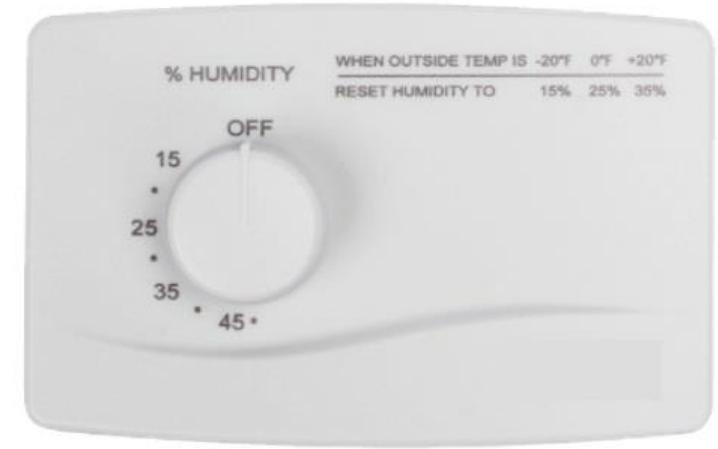
- Basic humidifier control

Pros:

- Typically lower cost than digital
- No power required

Cons:

- Requires homeowner to adjust based on outdoor temp
- No display of indoor RH%
- No outdoor temperature reading
- No frost protection
- No blower activation capability
- No service indicators
- Limited accuracy



Automatic Controls

Application:

- Dew point type control. Automatically adjust humidity based on outdoor conditions to maximize RH in the home.

Pros:

- Automatic adjustments
- Reduces condensation
- Maximizes home humidity
- Blower activation
- Service indicators
- Duct and living space mounts
- Accurate

Cons:

- May require wires to be pulled through wall in retrofit applications



Thermostat Controls

Application:

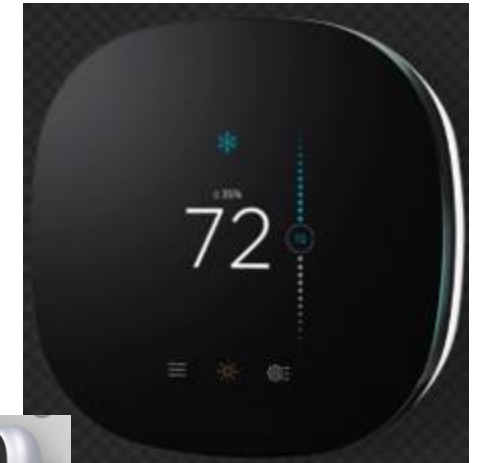
- Humidifier control built into thermostat

Pros:

- Typically runs in automatic or manual modes
- Reduces clutter in living space
- Intuitive user interfaces (Thermostat & App)

Cons:

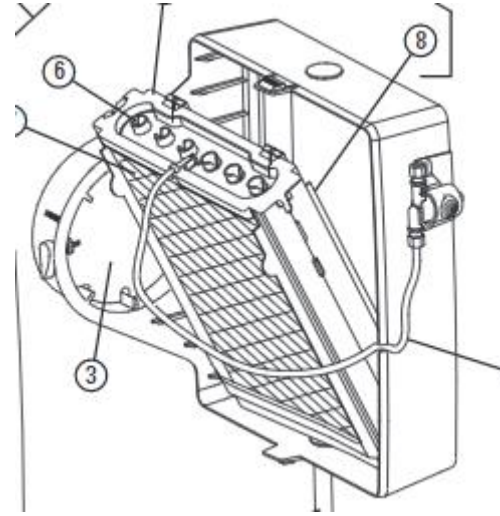
- May require wires in retrofit applications
- Sensing in one location vs return duct
- Humidifier control algorithm may not be same as humidifier manufacture.



Maintenance

Simple yearly maintenance is needed for all humidifiers

- Replace water panel or steam canister
- Clean or replace heated tank humidifiers
- Inspect water lines for leaks or plugs
- Close damper on bypass humidifiers



Homeowner Education – Most Important!

Explain what to expect

- How unit operates
- Mineral build up is normal
- Normal operating sounds
- Normal variations and fluctuations in RH%
- Home may not be able to handle high humidity levels they desire
- May be a time lag before humidity level is reached

Explain and show proper operation and cleaning

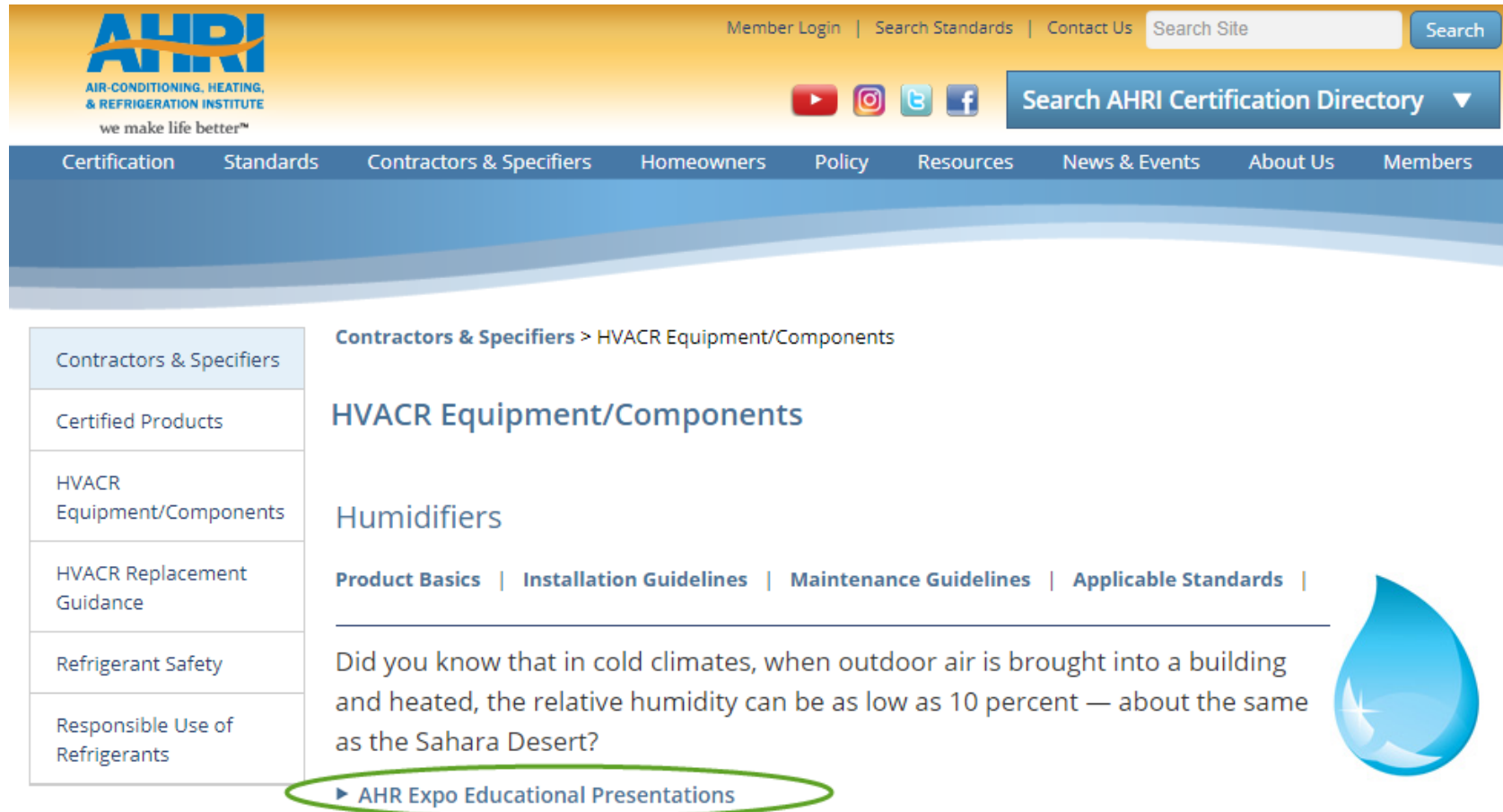


In Summary...

- Indoor dryness occurs when outdoor absolute humidity is low.
- Proper humidity control provides:
 - Preservation of home furnishings, finishes, and electronics
 - Occupant health benefits, and
 - Improved comfort
- Humidity control is needed throughout the country (except Orlando!)
- Products are readily available, easy to install and maintain
- Opportunity for the HVAC provider to deliver total comfort and optimal IAQ to the homeowner

More resources

- Presentation online here: www.ahrinet.org/humidifiers



The screenshot shows the AHRI website interface. At the top left is the AHRI logo with the tagline "we make life better™". To the right are links for "Member Login", "Search Standards", and "Contact Us", along with a search box. Below this is a navigation bar with links for "Certification", "Standards", "Contractors & Specifiers", "Homeowners", "Policy", "Resources", "News & Events", "About Us", and "Members". A secondary navigation bar contains social media icons and a "Search AHRI Certification Directory" dropdown.

The main content area shows the breadcrumb path: **Contractors & Specifiers > HVACR Equipment/Components**. Below this is the heading **HVACR Equipment/Components** and the sub-heading **Humidifiers**. A horizontal menu includes links for **Product Basics**, **Installation Guidelines**, **Maintenance Guidelines**, and **Applicable Standards**.

The text below reads: "Did you know that in cold climates, when outdoor air is brought into a building and heated, the relative humidity can be as low as 10 percent — about the same as the Sahara Desert?"

A blue water drop icon is positioned to the right of the text.

At the bottom, a link **▶ AHR Expo Educational Presentations** is circled in green.

Contractors & Specifiers	Contractors & Specifiers > HVACR Equipment/Components
Certified Products	HVACR Equipment/Components
HVACR Equipment/Components	Humidifiers
HVACR Replacement Guidance	Product Basics Installation Guidelines Maintenance Guidelines Applicable Standards
Refrigerant Safety	Did you know that in cold climates, when outdoor air is brought into a building and heated, the relative humidity can be as low as 10 percent — about the same as the Sahara Desert?
Responsible Use of Refrigerants	▶ AHR Expo Educational Presentations

Questions?