The Latest in Humidity Technologies and Applications

AHRI Humidifiers Section

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Presenters

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Agenda

1. Introduction
2. What is Humidity and Why is it Important?
3. Humidification Technologies
4. Did You Know?
5. Questions

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What is Humidity and Why is it Important?

Jeremy Wolfe

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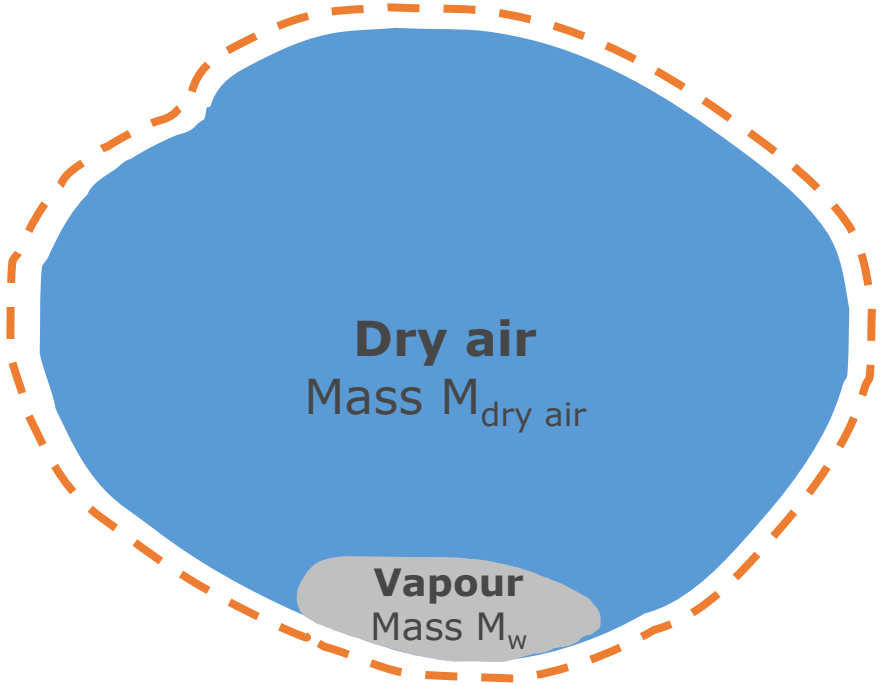
What is humidity?

Humidity is the water vapor contained in the air.

Humid (real) air
Volume V
Temperature t
Pressure p



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What is humidity?

Measured in “Absolute” or “Relative” terms

- Absolute Humidity
  - Mass of water in particular volume of air
  - Expressed as mass (grains/lbda or gw/kgda)

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

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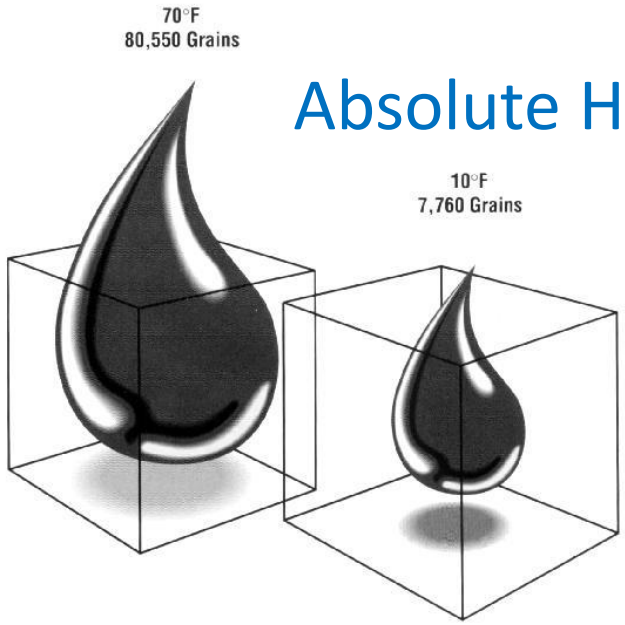
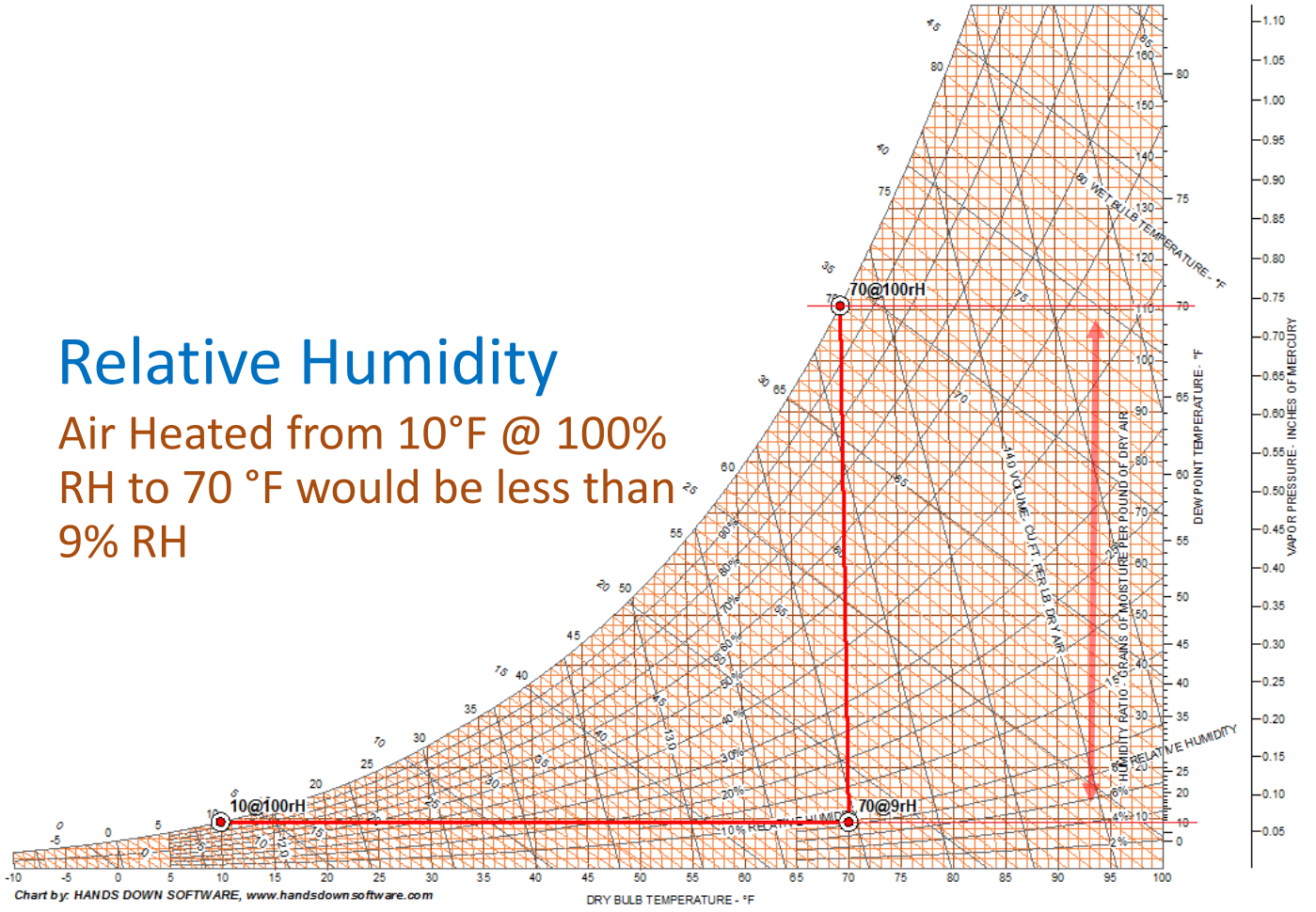
What is humidity?



Absolute Humidity

Relative Humidity

Air Heated from 10°F @ 100% RH to 70 °F would be less than 9% RH



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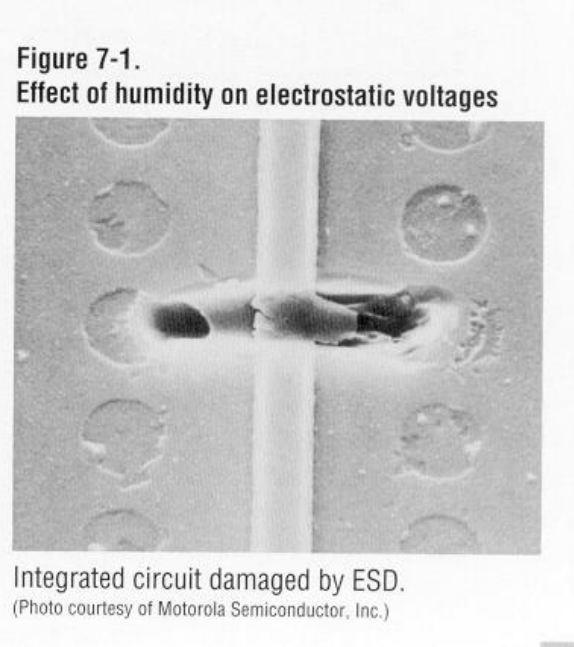
Why is Humidity Important?

Electrostatic Discharges can cause equipment malfunctions and considerable damage.

- Electrostatic discharges are generated due to friction between materials and their subsequent separation.
  - If the electric field generated by separation exceeds the dielectric strength of the medium that separates them (e.g. air), electrostatic discharges will occur.
- The electric field that is generated depends on:
  - The Type of materials
  - The relative humidity in the environment



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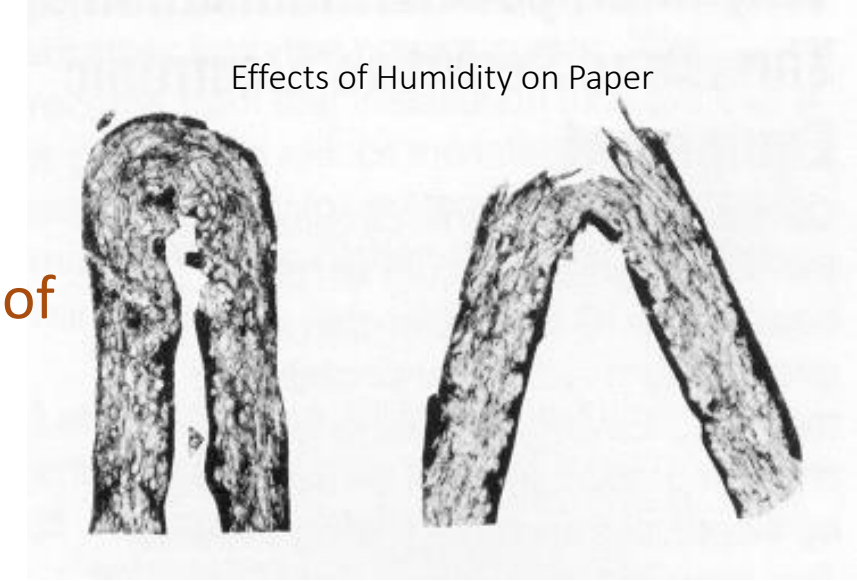
Why is Humidity Important?

Conservation of Hygroscopic Materials

The moisture contained in many materials, substances and products tends to reach equilibrium with the humidity of the environment that the product is stored in. This property is called hygroscopy.



- Low Relative Humidity
  - If the environment is too dry, there will be a transfer of moisture from the products, with consequent modifications to their aesthetic, geometrical and mechanical properties.

- High Relative Humidity
  - Conversely, an environment that is too humid may lead to the transfer of moisture from the air to the product, with possible damage, formation of mold, etc.

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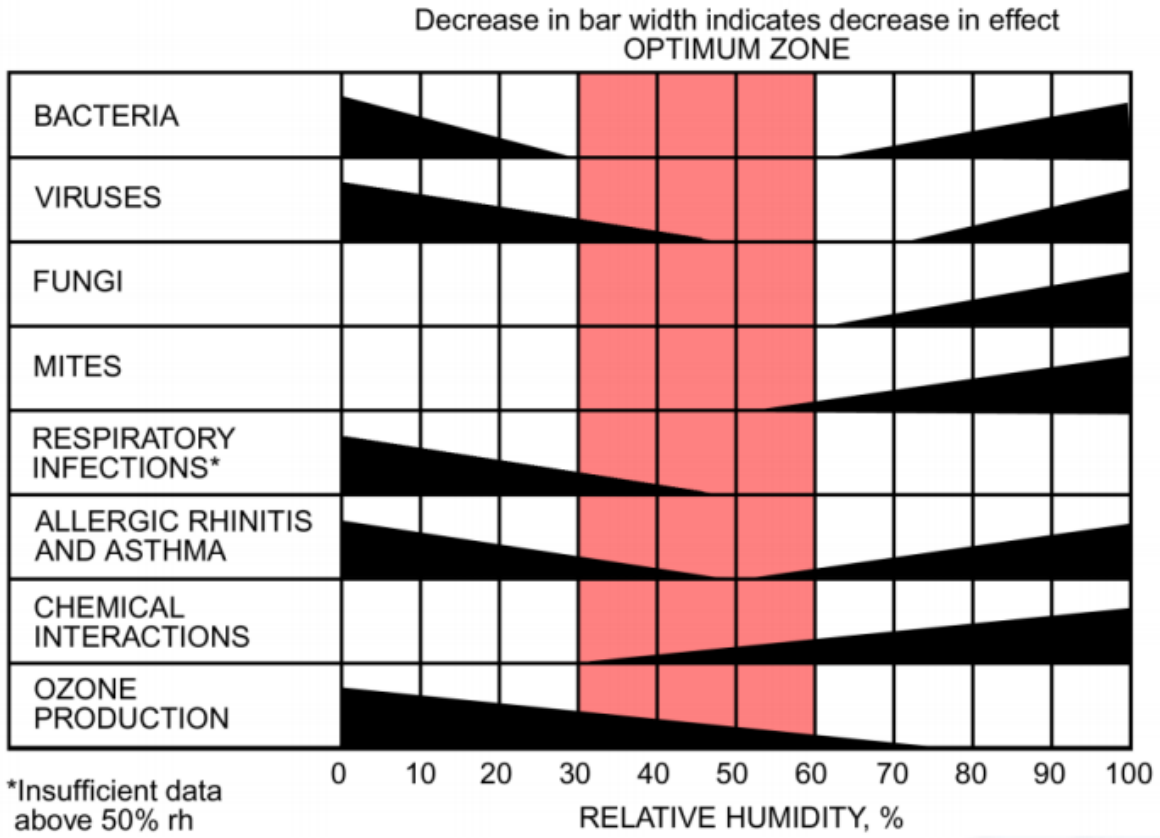
Why is Humidity Important?

Health and Wellness of the Population



[2]2016 ASHRAE HVAC Systems and Equipment Handbook – Ch 22 The Sterling Chart

In general, there is less incidence of respiratory illnesses in places where humidity is controlled, mainly for two reasons:

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

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Humidification Technologies

Sukru Erisgen

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Methods of Humidification

ISOTHERMAL

- Method of boiling water and introducing into air
- Energy to heat water comes from electricity, gas, or boiler steam

ADIABATIC

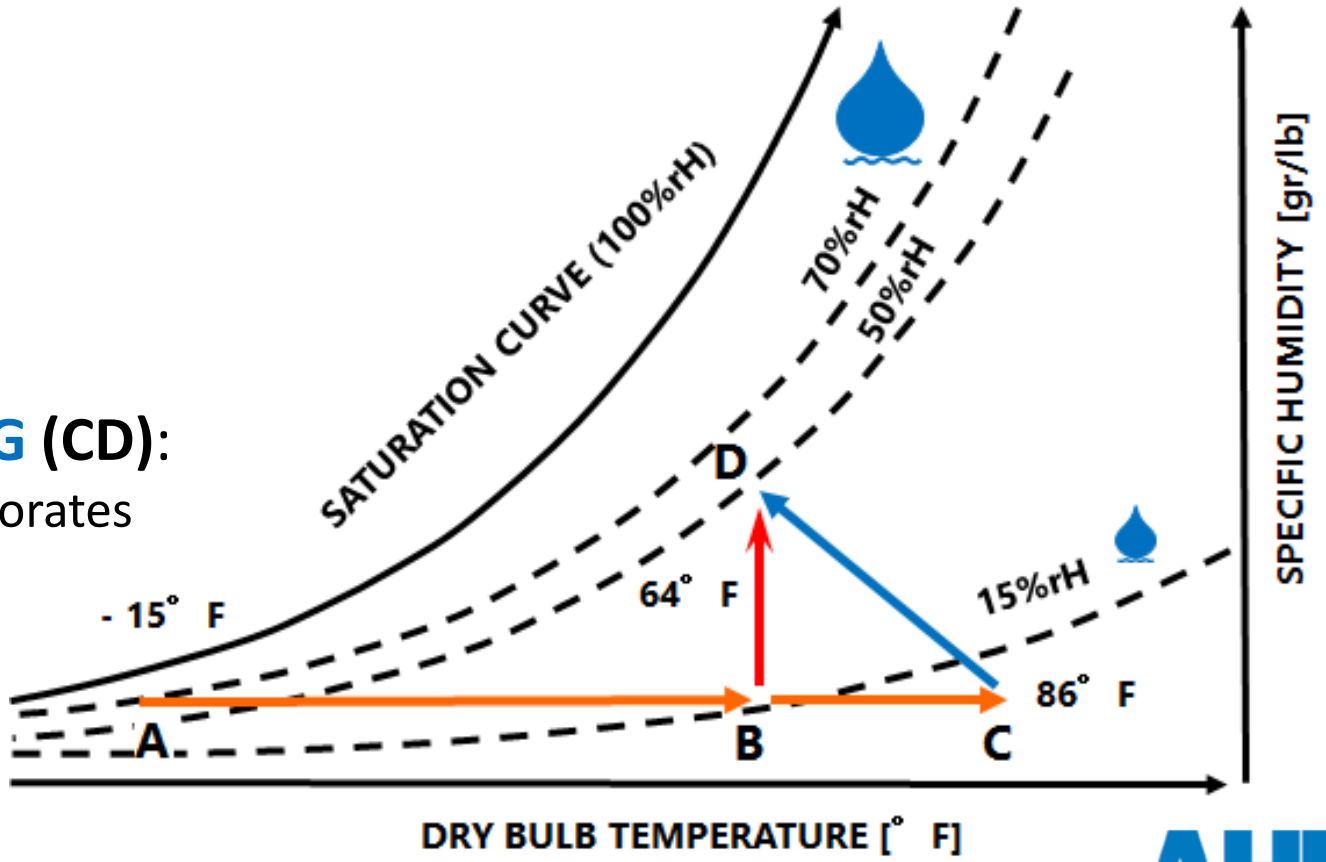
- Method of evaporating water into air by atomizing or wetting a media
- Takes advantage of available energy already in the air to evaporate water

Humidifying with Isothermal & Adiabatic Systems

MECHANICAL HEATING (ABC):
moisture content = constant

ISOTHERMAL HUMIDIFYING (BD):
temp = constant
(i.e. excepted steam baths)

ADIABATIC HUMIDIFYING & COOLING (CD):
temp decreases because sprayed water evaporates absorbing heat from the air



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Methods of Humidification

Steam vs. Atomizing

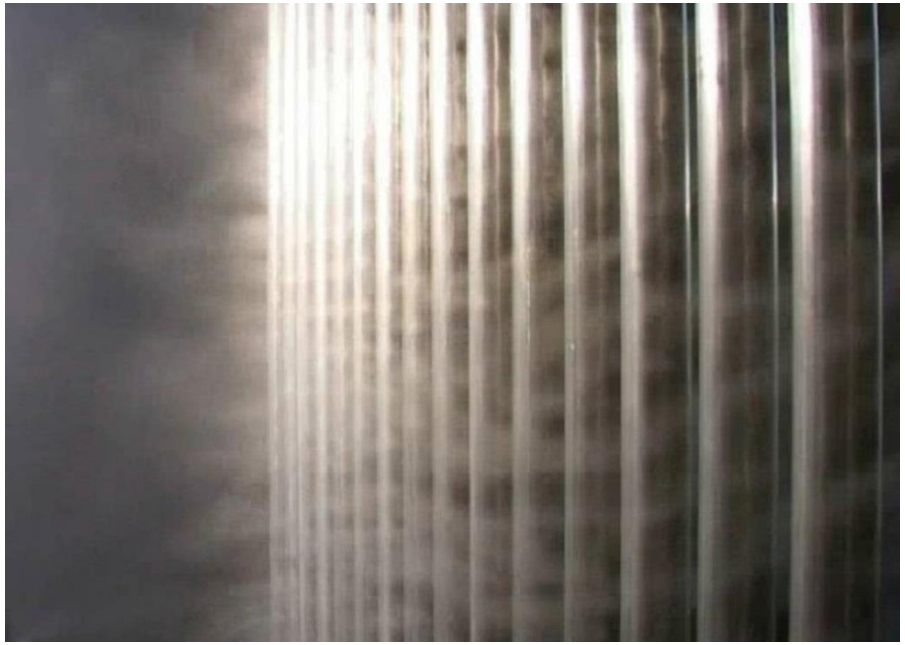
	Isothermals	***Adiabatics***
ASEPTIC HUMIDIFICATION	Steam doesn't carry bacteria	Water droplets introduced in the air: no recirculation Treated water
CAPACITY	Small to **Medium** sized loads (100's)	Small to **Large** sized loads (1000's)
POWER CONSUMPTION	High	Very low
REQUIRED FREE SPACE	Steam is easily and quickly absorbed by the air	Minimum evaporation space (> 36"- **60"** typ.)
TEMPERATURE CHANGE	Temperature doesn't change significantly	Yes **COOLING EFFECT**
WATER	Tap and treated (maintenance)	Tap and treated (maintenance)

***Typical for the industry**

Isothermal Humidification Systems

Steam Generation Methods

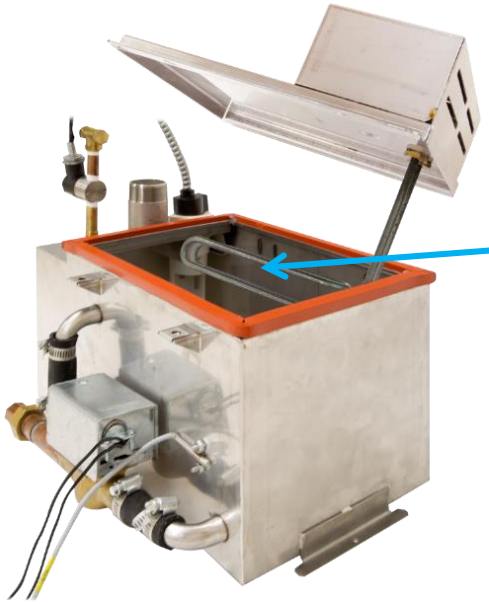
- Resistive electric
- Immersed electrode
- Gas-fired
- Steam-to-steam
- Direct Steam Injections



Steam Dispersion Methods

- Steam dispersion tubes
- Room dispersion ventilators

Resistive Electric Humidifier



Heating elements immersed in the fill water boils water into humidification steam

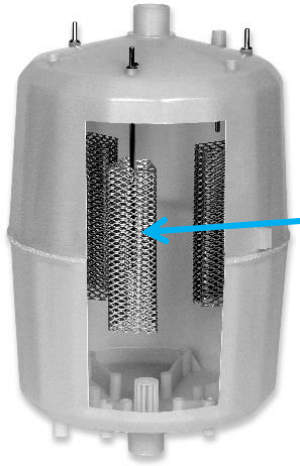
Applications

- Small to large humidification needs

Advantages

- Simple equipment design
- Wide range of voltage options
- Wide range of water options

Immersed Electrode Humidifier



Heat caused by electrical resistance (current) in conductive fill water between submerged electrodes boils water into humidification steam

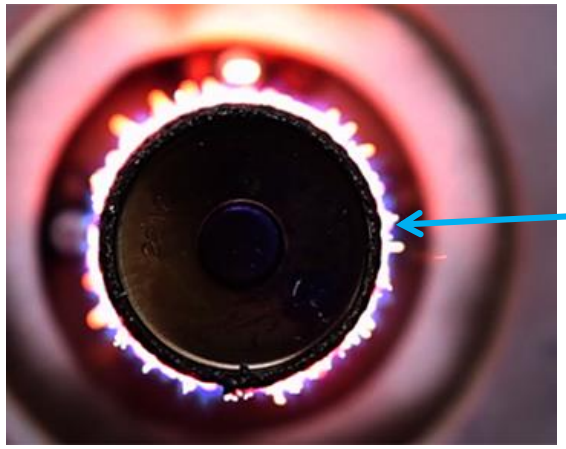
Applications

- Doesn’t require high level of control (+/- 5%)
- Minimal on-site maintenance expertise

Advantages

- Easy maintenance
- Low first cost

Gas-to-Steam Humidifier



Natural or propane gas heats fill water to boil it into humidification steam

Applications

- Natural or propane gas available
- Larger capacities available

Advantages

- Low cost of operation
- Indoor and outdoor installations

Steam-to-Steam Humidifier

Boiler steam passes through the humidifier heat exchanger, vaporizing clean fill water into humidification steam

Applications

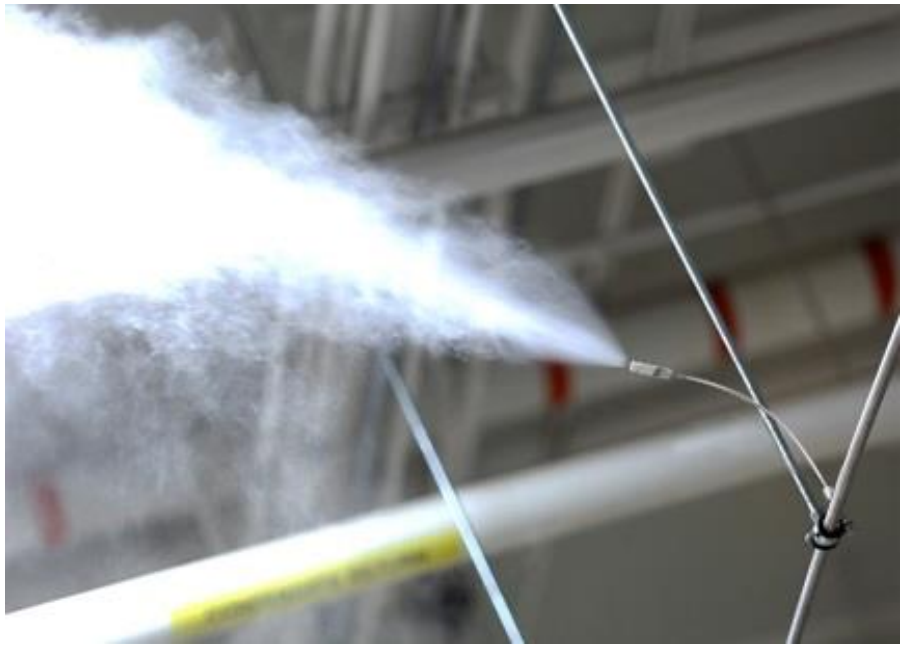
- Commonly used in hospitals and schools

Advantages

- Boiler chemicals are contained and returned to boiler
- Clean steam

Adiabatic Humidification Systems

- Wetted media
- High-pressure atomization
- Ultrasonic
- Compressed air and water



Wetted Media Systems

Water sprays over multiple banks of replaceable, corrugated media made of absorptive material, to produce humidification and evaporative cooling

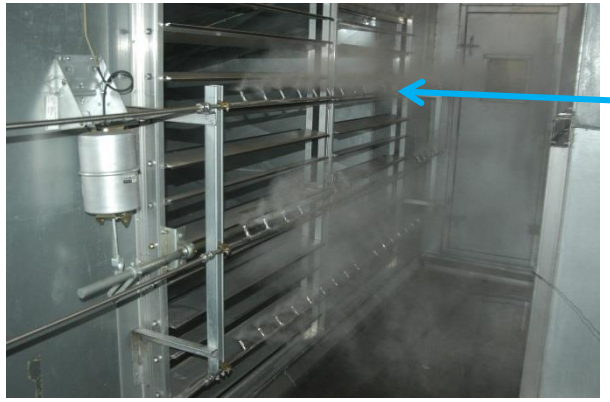
Applications

- Where there is a need for humidification and cooling

Advantages

- Water treatment is not required
- Low cost operation

High-pressure Atomization



Pressurized water is sprayed through small orifice nozzles to provide humidification and evaporative cooling

Applications

- Where there is a need for humidification and cooling

Advantages

- Instant ON and OFF
- Small to large capacities
- Zoning capability

Ultrasonic

Piezoelectric disks vibrate at high frequency, creating small water droplets

Applications

- Ducted or direct space

Advantages

- Instant ON and OFF
- Energy efficient

Compressed Air and Water

Compressed air and line-pressure water is mixed inside nozzles

Applications

- Typically direct to space

Advantages

- Instant ON and OFF
- Lower up front cost
- Good modulation

Did You Know?

Fun Facts about Residential Humidification

James Aycock

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Two Basic Types of Residential Humidifiers

- Room Humidifiers
  - Localized, individual room humidification
  - Portable
  - Inexpensive
- Whole House Humidifiers
  - Controls humidity throughout the house
  - Connected to HVAC system
  - Long product life
  - Automatic (no filling required)

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Typical Room Humidifier Types

- Cool Mist, centrifugal
  - Longevity
  - Simple design

- Evaporative Wick
  - Can have digital controls
  - Greater output

- Cool Mist, ultrasonic
  - Finer mist
  - Very quiet

- Warm mist (steam)
  - Greater output
  - Allow medication products

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Typical Whole House Humidifiers

- Adiabatic: No heat added (cooling effect)
  - Atomizer type
    - Direct, no bypass
  - Wetted media
    - Bypass

- Isothermal (steam) Heat added (heating effect)
  - Electrode (canister) type
    - Canister contains the electrodes
    - No cleaning required
    - Water is the resistive element
  - Resistive element (tank) type
    - Lower cost
    - Simplicity
    - Water is not the heating element

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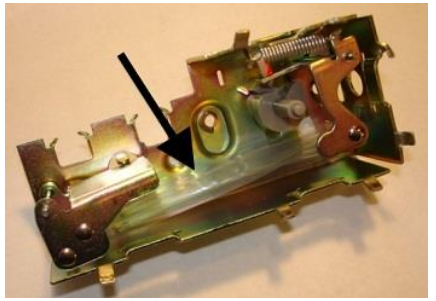
Types of Automatic Humidity Controls

- Hygroscopic Element Type:
  - Lower cost
  - Simplicity
- Electronic Type:
  - Digital readout
  - Typically can be calibrated
  - Options for automatic setpoint adjustment depending on outdoor temperature
- High-End Thermostat:
  - Integral to thermostat
- Wi-Fi enabled:
  - Remote monitoring and control



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Home Humidification Done Right

- Control the minimum RH:
  - Health benefits,
  - Preservation of instruments,
  - Wood flooring, artwork, etc.
  - Reduce ESD (Electrostatic Discharge)
- Control the maximum RH:
  - Condensation on windows
  - Mold/Mildew control
  - Duct wetting
  - Poor vapor/moisture barrier protecting envelope

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Other Fun Facts

- Energy required to raise 1 gallon from 50°F to 212°F:
  - 1351 Btu (.396 kWh)
- Energy required to convert 1 gallon of 212°F water to 212°F steam:
  - 8073 Btu (2.37 kWh)
- Energy is always conserved!
  - The phase change (water to steam) is 86% of the energy to create steam from 50°F water
  - The energy either goes into the home (isothermal, or steam), or is absorbed from the home (adiabatic)

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Did You Know?

Fun Facts about Commercial Humidification

Nicholas Lea

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Did You Know?
Humidity Solutions for Commerce and Industry

Humidity for Process

Humidity for Occupants

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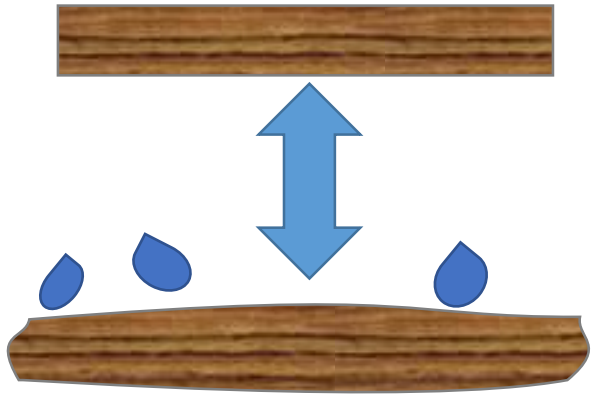
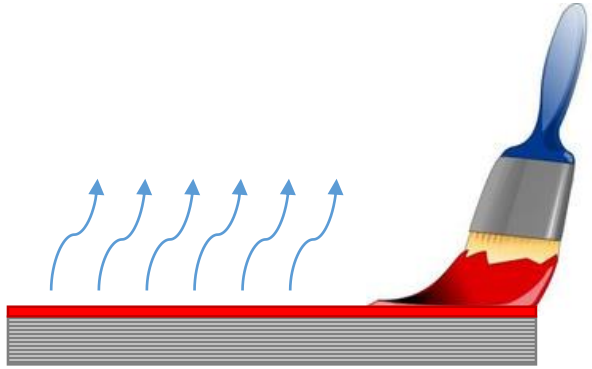
Mechanics of Humidity in Process

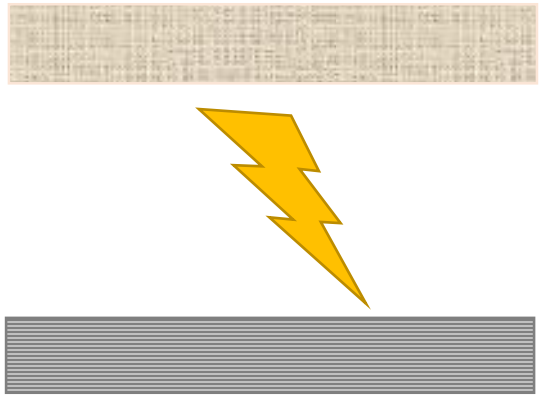
Hygroscopic Materials



Evaporation Rates



Static Charges



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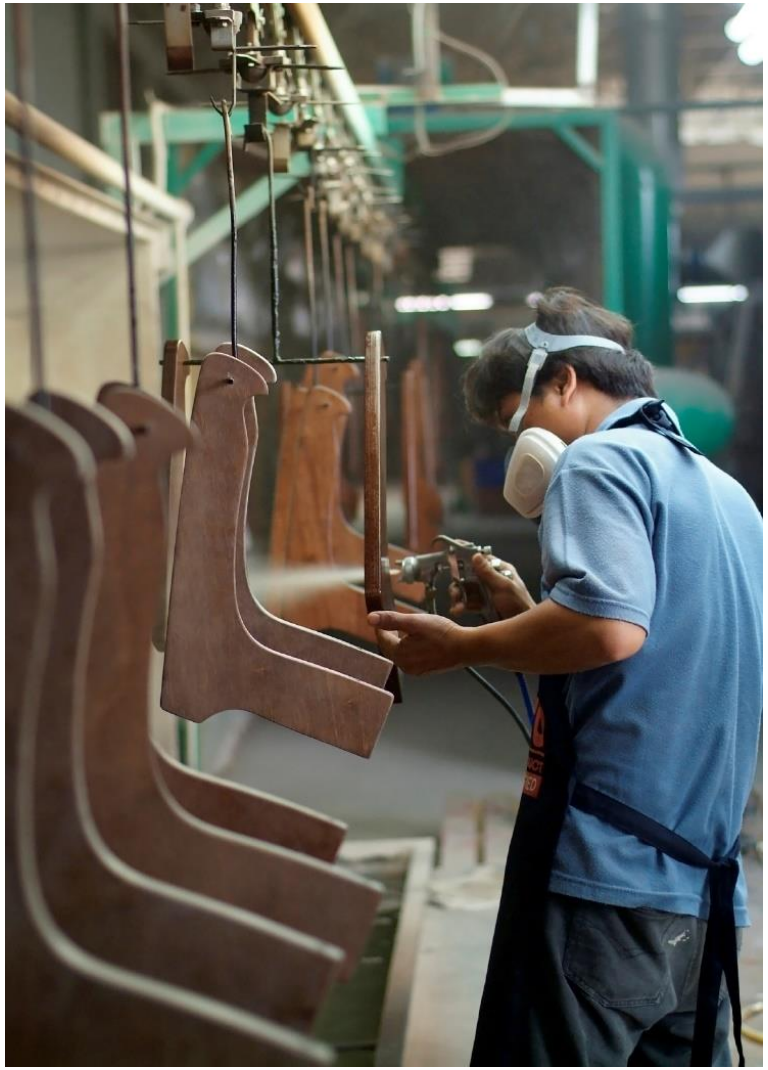
Did you know humidity affects drying?



iStock: 000002955937

- Vapor pressure differential drives moisture flow
- Quality concerns:
  - Shrinkage
  - Adhesion
  - Runs / drips
  - Inclusions
- Example Applications:
  - Automotive
  - Furniture
  - Leather

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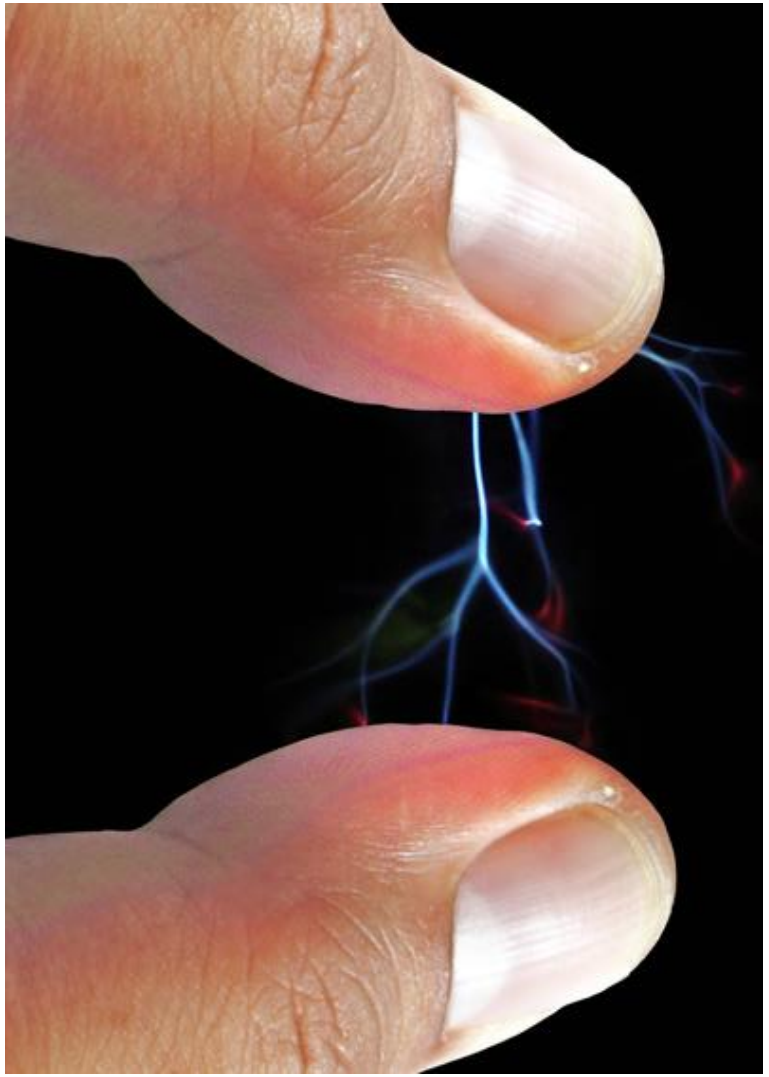
Did you know humidity dissipates static?



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- Moisture provides conductive path for electrons
- Quality concerns:
  - Electrical component damage
  - Static cling
  - Spray pattern changes / paint defects
  - Ignition of flammable substances
- Example Applications:
  - Electronics
  - Printing and Textiles
  - Chemicals

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Did you know humidity affects materials?

iStock

- Moisture absorbs/desorbs in hygroscopic materials
- Quality concerns:
  - Dimensional instability
  - Cracks / deterioration
  - Delamination of coatings
- Example Applications:
  - Printing
  - Woodworking
  - Museums and artifacts
  - Instruments
  - Dust suppression

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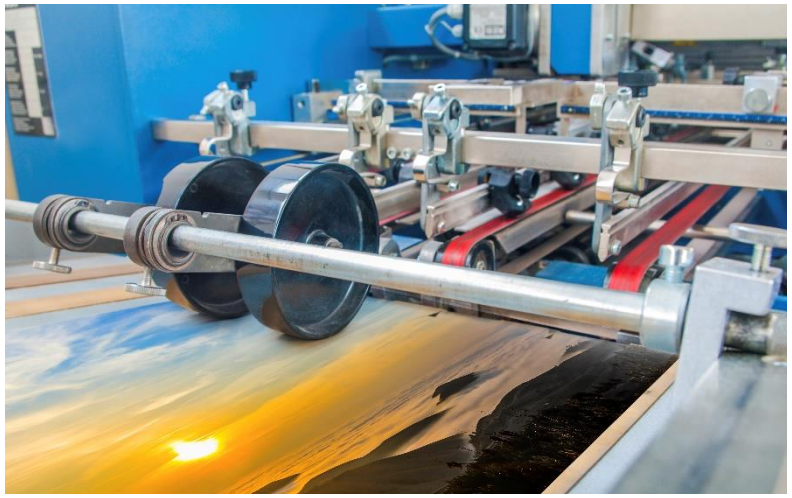
Applications: Humidity in Printing



- Conditions: 76-80°F (24–27°C), 43–47 ±2% RH
- Static electricity:
  - Paper cling
  - Ink mist control
- Drying:
  - Ink run / smudge
  - Ink bleed to other prints
- Hyrgoscopic materials:
  - Paper distortion / misregistering
  - +3% moisture, +0.2% size
  - Paper ordered to match pressroom RH

Photo: iStock
Video: Courtesy Gary Berlin

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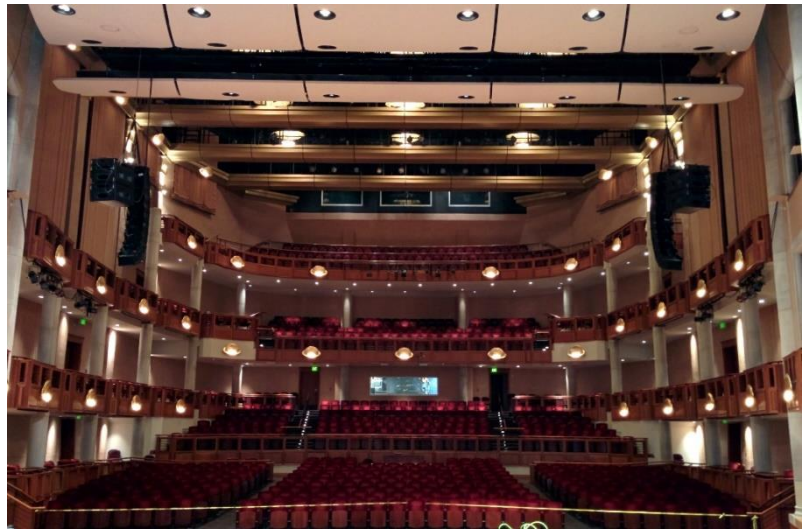
Applications: Humidity in Performing Arts



Photos Courtesy: William Truong

- Conditions: 68-72°F (20–22°C), 40–60% RH
- Static electricity:
  - Costume / textile cling
  - Guest comfort
- Hygroscopic materials:
  - Longevity of wood finishes
  - Art and décor
  - Instruments
- Human Factors

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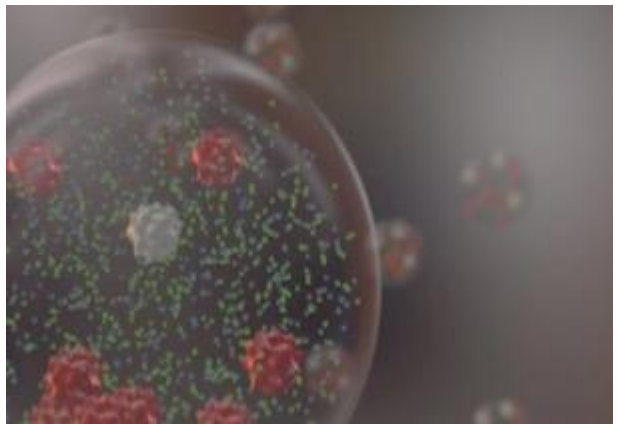
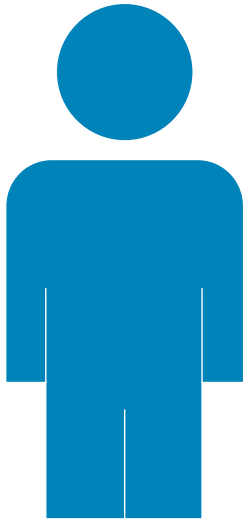
Mechanics of Humidity for People

Infectious Particles



Bodily Defenses



Physiological Effects

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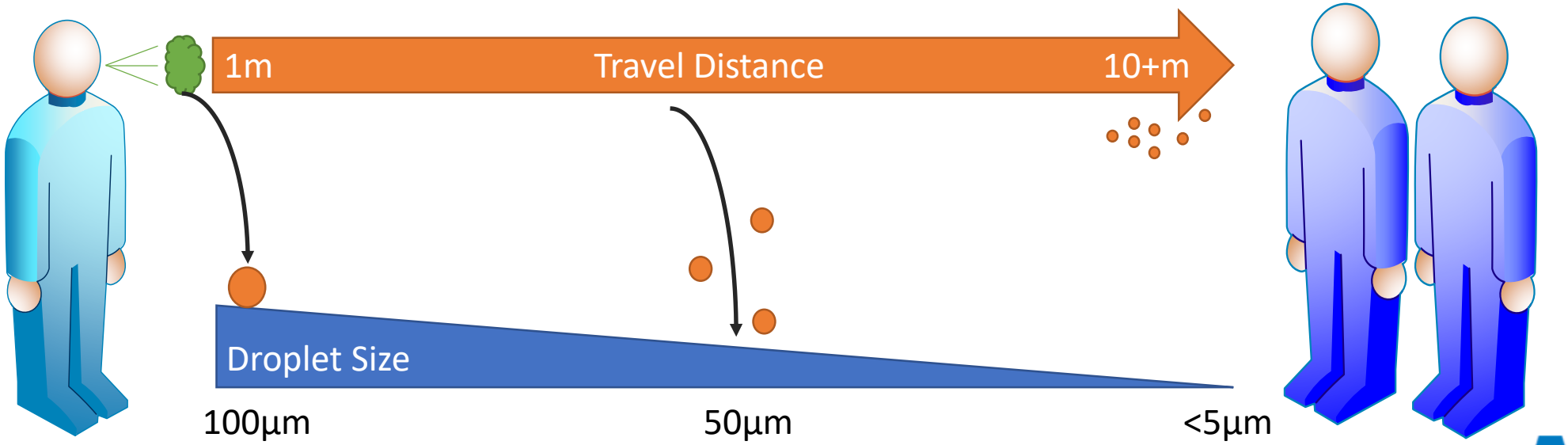
Did you know infectious particles prefer dry air?

- Infectious payloads travel farther
  - Particles lose mass quickly in dry environment
  - Smaller light particles fly farther
  - Infectivity is retained[1]



[1] **Noti JD et. al,** High Humidity Leads to Loss of Infections Influenza Virus from Simulated Coughs, PLoS ONE 8(2): e57485, 2013

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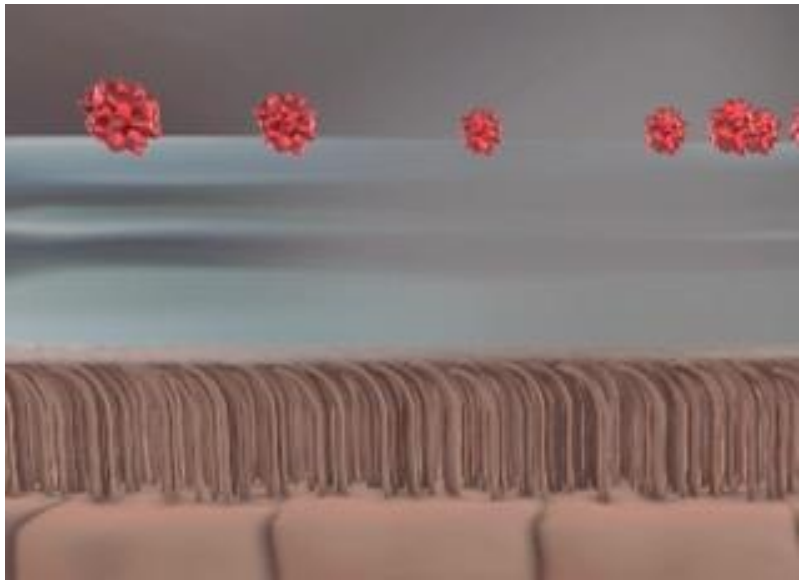
Did you know dry air inhibits body defenses?

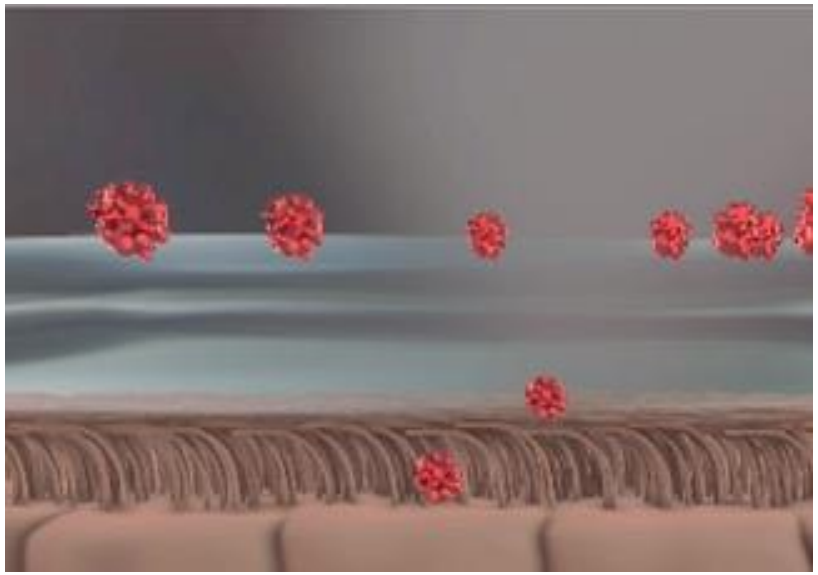
- Mucous membranes and cilia
  - Protect body with a mucous layer moved by cilia hairs
  - Rely on moisture to maintain motion and layer thickness

Mucous Layer

Cilia



Normal Function ~50% RH



Dry Function ~30% RH

Images Courtesy AHRI Member Company

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Did you know dry air affects your body?

- Human body is over 50% water but doesn't sense moisture
- Air humidity influences[2]:
  - Eye irritation
  - Vocal stress
  - Dryness of skin and thermal sensation
- ASHRAE 55: Thermal Comfort Standard
  - "There are no established lower level humidity limits for thermal comfort, consequently, this standard does not specify a minimum humidity level.

    NOTE: Non-thermal comfort factors such as skin drying, irritation of mucus membranes, dryness of the eyes, and static electricity generation may place limits of the acceptability of very low humidity environments."

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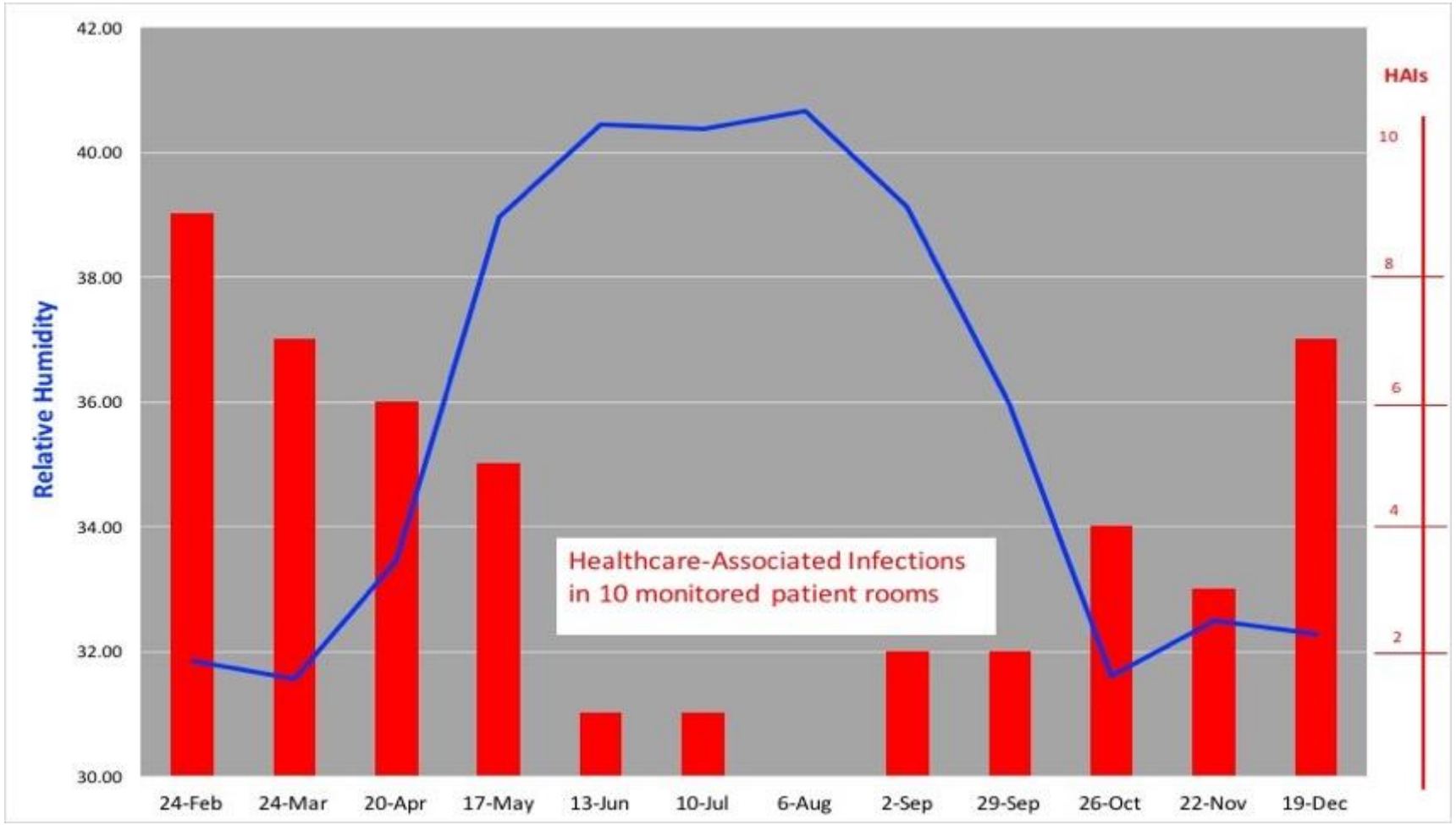
[2] Rief S and Juric M, Air Humidity in the Office Workplace, Fraunhofer IAO, 2014

Hospital Research: Infection Rates vs. % RH



Source: Colonization and Succession of Hospital-Associated Microbiota, in Press 2016

Simon Lax, Daniel Smith, Naseer Sangwan, Kim Handley, Peter Larsen, Miles Richardson, Stephanie Taylor, Emily Landon, John Alverdy, Jeffrey Siegel, Brent Stephens, Rob Knight, Jack A Gilbert

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Applications: Humidity in Healthcare

Photo: iStock

- Conditions: 68-72°F (20–22°C), 40–60% RH
- Reduce hospital acquired infection rates
  - Improve patient outcome
  - Reduce lost bed cost
  - Reduce penalty costs
- ASHRAE 170-2017
  - Now permits use of adiabatic fogging systems
  - Reduce cooling costs

6.6.3 Adiabatic Atomizing Humidifier Requirements

a. Humidifier water shall be treated with a reverse osmosis process, a UV-C sterilization light source, and a submi-

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Applications: Humidity in the Workplace

- Conditions: 68-72°F (20–22°C), 40–60% RH

- IBI Study 2012[3]
  - Poor health costs US Economy $576 Billion
  - 39% due to lost productivity
- Improve employee health and well being
  - Reduce spread of flu and respiratory illness
  - Reduce eye and vocal stress
  - Reduce skin dryness

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[3] https://ibiweb.org/research-resources/detail/poor-health-costs-u.s.-economy-576-billion-infographic

Applications: Humidity in Education

Photo: iStock

- Conditions: 68-72°F (20–22°C), 40–60% RH
- Attendance Based Funding Methods
  - Funding proportional to daily attendance
  - Common in California, New York, Texas
  - Partially used in Illinois
- Reduce rates of flu and respiratory illness
  - Reduce absenteeism
  - Increase opportunities for learning

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Now You Know!

- Humidity control for process and industry
  - **Stabilizes** hygroscopic materials
  - **Controls** drying rates
  - **Dissipates** Static Electricity

- Humidity control for your health
  - **Reduces** infectious particle travel
  - **Supports** body defenses
  - **Maintains** body well-being

How can humidity control benefit your next application?

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Summary

- Target a midrange humidity between 40 – 60%
- Two ways to humidify: adiabatic and isothermal
- Many types of equipment options to fit your needs
- Residential humidification preserves health, homes, and possessions
- Energy for humidification is conserved in the home
- Control humidity to control static, drying, and materials
- Maintain mid-range humidity for occupant health

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Questions?
Presentation online here:
www.ahrinet.org/humidifiers

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