EVERYTHING YOU EVER WANTED TO KNOW ABOUT HUMIDIFICATION

By Jeff Boldt







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Jeff Boldt

Engineering nerd watches 1,772 hours of ASHRAE ...



www.youtube.com/watch?v=woWi792Vw6l Jan 20, 2014 - Uploaded by KJWW In a fantastic display of nerdiness, Jeff Boldt, Director of Engineering for KJWW Engineering Consultants ...

(Search "Jeff Boldt nerd")





WHY HUMIDIFY?





HEALTH

- Many claims of humidification promoting health
- Many based on the 1985 Sterling Study
 - I believe the conclusions of that study are not supported by the details in the report
- Healthcare codes reduced minimum from 30% to 20% in most spaces (a few exceptions)





COMPUTERS





MATERIAL PRESERVATION

- Organic materials expand with >RH
 - Not absolute humidity
 - Expand more across grain
 - Gym floors
 - Carriage Museum
- Artwork
- Material cracking









STATIC ELECTRICITY

- Formerly a big issue in ORs
 - Ether is no longer used as an anesthetic
 - ORs now require 20-60% RH
- More problematic with carpet





HUMIDIFICATION ISSUES





WINDOW CONDENSATION

- Condensation
 - Windows
 - Inside walls









CONDENSATION PREDICTION

• Windows have a Condensation Resistance Factor (CRF)

	А	В
1	-10	Minimum Outdoor Temperature
2	72	Maximum Indoor Temperature (65 to 80F)
		Indoor Temperature Near Window (Use manual input if there are drapes or blinds. If
3	72	not, the default is room temperature.)
4	30%	Maximum Indoor RH at the Temperature in Cell A2
5	0.00509	Indoor Humidity Ratio (#H2O/#dry air)
6	36	Indoor Grains
7	39	Room Dew-point Temperature
		Theoretical Minimum CRF to Prevent Condensation. This assumes a perfect
8	60	installation. It is best to keep a safety factor of around 5 points.
		CRF with Saftety Factor (the maximum CRF available in aluminum framed windows is
9	65	about 70, and only very good window systems exceed 65)
10		
11		
	→ Ir	Grains H Ratio Dewpoint Dew-Point Lookup Sheet3 +





CONDENSATION PREDICTION

• Windows



PSYCHROMETRICS PSYCHOMETRICS











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HUMIDIFICATION METHODS





EVAPORATIVE (ADIABATIC)

- Pad
 - Residential, greenhouse, dr climates
 - Not legal in hospitals
- Spray
 - Commercial mostly dry climates
 - Not legal in hospitals
- Ultrasonic & Infrared
 - Computer room units mostly
 - Not legal in hospitals









K J W W HINDREE ENGINEERING ASSO







STEAM

- Boiler Steam
 - Inexpensive
 - Low maintenance
 - Less space needed
- Clean Steam



- No potential carcinogens
- Maintenance depends on feed water
- <u>http://www.esmagazine.com/articles/95728-</u>
 <u>humidification-options-amines-and-the-impacts-of-ashrae-standards-621-and-170</u>





BOILER CHEMICALS

Should they be used for humidification?

- Health Risk
- POTENTIAL carcinogens
- 62.1 = FDA <u>boiler</u> chemical limits
 - No air monitoring
 - WHEA fought hard for this

- Maintenance
- Without amines, condensate pipes rust swiftly
- Neutralizing amines protect condensate pipes
 - Cyclohexylamine
 - Morpholine
 - DEAE
- RO reduces blowdown, chemical costs, corrosion



ENERGY SOURCES





HEAT OF THE AIR (ADIABATIC)

- Pads, sprays, ultrasonic, maybe IR
- Called "adiabatic"
- Not legal for hospitals
- Common in dry climates and computer room units





ELECTRIC

- Low first cost
- High operating cost
 - Natural gas ~35% the cost of electricity
- High maintenance cost
- Difficult to control accurately except for deluxe modulating units





NATURAL GAS

- Relatively low first cost
- Maintenance depends on design
- Good option for clean steam at multiple distant locations





STEAM

- Traditional
- Jacketed
- Smaller tubes
- Need summer shutoff

- Short Dispersion
- Large diameter tubes
- No automatic shutoff needed





HOW MUCH HUMIDITY DO YOU NEED?





WISCONSIN CODE

- ASHRAE Standard 170-2008 Addendum d
 - 20% for most healthcare areas
 - Surgery
 - Delivery
 - Procedure
 - Endoscopy
 - 30% for a few areas
 - Intensive Care
 - NICU
 - Newborn Nursery





WHAT IS THE BEST LOCATION?

- Upstream of cooling coil?
 - Eliminates water in duct risk
 - After HC so air is low RH
 - Low velocity can be an issue
 - Has anyone experienced this? Email me!
- Downstream of fan?
 - High velocity = short dispersion











MY OPINION

- Between Preheat Coil and Cooling Coil
 - Prevents water droplets going down ducts
 - Low RH normally for good absorption





STEAM HUMIDIFIER TYPES





JACKETED BAYONET HUMIDIFIER





SHORT DISPERSION HUMIDIFIER











DESCRIPTION

- Bayonet tubes are ~212°F
- They cause unwanted air heating
- Short absorption manifolds have large surface area and intensify the problem
- Up to 5°F of heat added





INSULATED BAYONETS







ADVANTAGES OF INSULATED BAYONETS

- Energy efficiency
- Less water waste

Treated water waste

- Better control of discharge air temperature
- Complies with energy codes
 - 90.1-2010
 - IECC-2012





DISADVANTAGES OF INSULATING BAYONETS

- Higher first cost
- Can be more difficult to clean
- Must be rated for use in the airstream
- Potential wear and tear of insulation





STAINLESS STEEL SHELL WITH AIR GAP



Stainless Steel Shell with Air Gap







ELASTOMERIC INSULATION

Elastomeric

- R = 0.74
- Flame Spread 25
- Smoke Spread 45
- Thickness 0.5 in
- 70% condensate reduction







PVDF INSULATION

<u>PVDF</u>

- R = 0.56
- 1/8 inch thick
- 75% reduction in condensate
- 0/0 flame/smoke rating

Steam exits through tubelet orifice Stainless steel dispersion tube Heat-welded insulation seam 1/8"-thick PVDF insulation Tubelet shoulder secures insulation to tube







THERMAL INSULATING COATING

- Ceramic spray-on coating
- Approximately 0.03" thick
- R-Value of 0.045
- Durable and easy to clean





DISPERSION **TUBE HEAT** LOSS

Heat loss vs. air speed at 50 °F for a 3" o.c. tube bank, 1½" dia. stainless steel tubes with 212 °F internal wall temperature



Btu/hr/linear foot of tube



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R-VALUE

 ASHRAE 90.1 6.5.2.4.3 Humidification system dispersion tube hot surfaces in the airstream of ducts or air handling units shall be insulated with a product with an insulating value of at least R-0.5.





KJWW PERSPECTIVE

- Worth the added cost for new construction
- Will save energy if implemented and maintained
- Should be considered for all projects
- Required for 90.1-2010 or later and LEED v4
- Insulation type should be evaluated for each project for cost, longevity, and R-value



CONTROL OPTIONS

- Return Air
 - Slow response
 - Need limits on supply RH
- Supply Air with Return RH Reset
 - My favorite option
 - Fast response
 - No wet filters





MAINTENANCE HEADACHES





WATCH FOR IMPROPER PITCH







WATER TREATMENT

- RO reduces TDS
 - 90-95% reduction in TDS (including hardness)
 - Surface water vs. well water
 - Madison = 18-20 grains of hardness
 - TDS = hardness + other minerals (sodium)





WATER TREATMENT

- Softening
 - One 2+ (calcium) replaced by two 1+ (sodium)
 - "Naturally" soft water is not like softened water







WATER TREATMENT

- Legionella and Infection
 - No issue for steam humidifiers
 - No recorded Legionnaires from swamp coolers





Q&A

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