Applying Adiabatic and Steam Humidification Systems

Greg Drensky – Jacco & Associates

Who is Jacco

- Established 1968
  - Hudson, Ohio
  - Columbus, Ohio
  - Toledo, Ohio

- Focused on the Engineered Environment

- Systems Knowledgeable
  - HVAC Systems
  - Service & Maintenance
  - Parts

JACCO

Purpose Statement

The purpose of our Company is to solve our customers problems, in the most economical way, at all times optimizing the owning experience.

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Who is Jacco

- Operations
  - –Brenda Homjak
  - –Mike Spangler
  - –Chad Russell
  - –Mike Mueller
  - –Hana Lee
- Contractor Owning Experience
  - –Dan Duignan
  - –Rick Baker
- Engineering Owning Experience
  - –Greg Drensky
  - –Jerry Cohen
- Owning Experience
  - –Beth Plazak
  - –Jeff Watson

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Who is Jacco

- 30 Minute Pledge
  - Design
  - Questions
  - Problems
  - Answers

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Upcoming Seminars & Events:

- December 12th: Applying Low Dewpoint OA Systems Using DX and Desiccant Technology

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WE HUMIDIFY THE AIR

The Science and Technology Of Humidification

Relative Humidity

The amount of water vapor present in the air expressed as a percentage of the amount needed for saturation at the same temperature.

- Higher temperature air expands and absorbs more water:
- Moisture travels 100 ft in 4.5 seconds over a high gradient.
- Moisture tries to coat things with a micro-film, which can also absorb impurities and become conductive.
- Moisture absorbed by particulates increases mass, and gravitational attraction.

°F	Grains per Cu Ft	°F	Grains per Cu Ft
0	0.475	60	5.795
5	0.609	65	6.845
10	0.776	70	8.055
15	0.984	75	9.448
20	1.242	80	11.04
25	1.558	85	12.87
30	1.946	90	14.94
35	2.376	95	17.28
40	2.863	100	19.95
45	3.436	105	22.95
50	4.106	110	26.34
55	4.889	115	30.13

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Why Humidify?
Hygroscopic Materials...

Museums - Proper humidity control is far more important than temperature control.

Contact Lenses - Dry air makes them lose moisture and curl, making them very uncomfortable.

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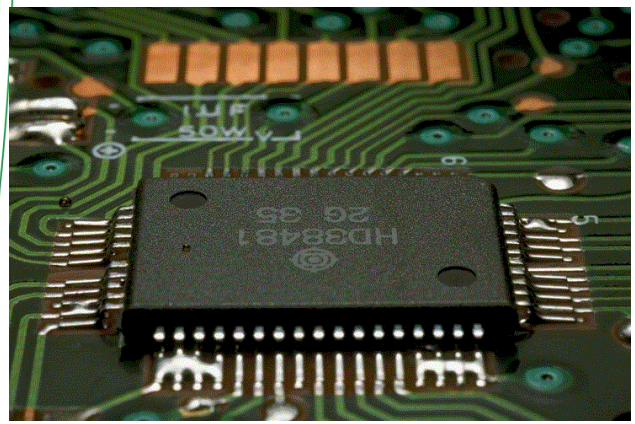
Why Humidify?

Static Electricity...



Bowling - 5 points higher pin scores in humidified alleys.

Microchips - static discharge of only 10 volts destroys chips. Avg. static discharge = 5,000 V.

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Why Humidify?
Health & Comfort...

Sick Building Syndrome
- **Outgassing**
- **Dust Count**

Hospitals & Operating Rooms
- **Plastic Surgery**
- **Organism Levels**

Comfort Level
- **Dry Skin/Membranes**
- **Contact Lenses**
- **Zoos**

Respiratory Ailments
- **Body Adjustment**
- **Asthma**

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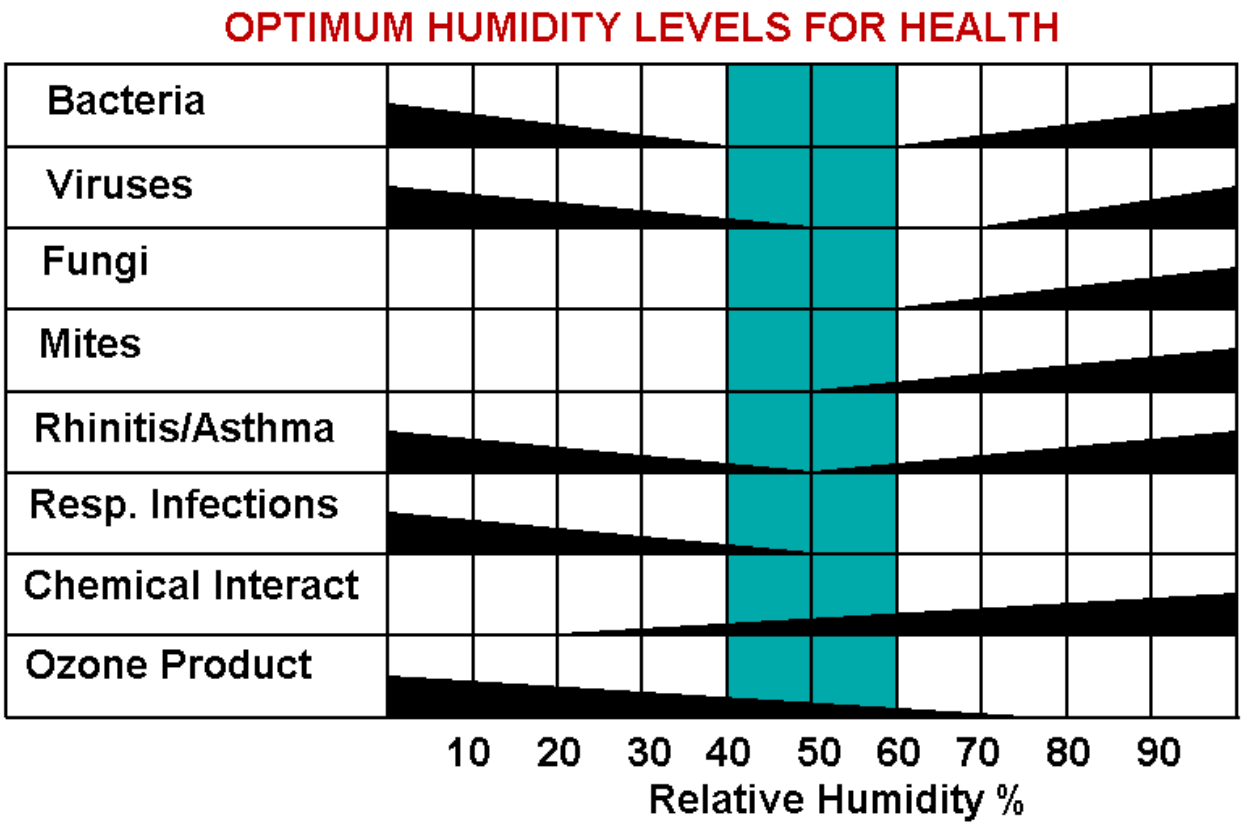
Why Humidify?

Health & Comfort...



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How Much Humidity?

Calculations:

- Determine grains of moisture/ft^3 of air at design temperature and humidity
- Determine grains of moisture/ft^3 of air at outside temperature and humidity
- Determine largest volume of outside air
- Run this formula:

$$\text{Lbs/hr} = \frac{(\text{ft}^3/\text{hr}) \times (\text{gr/ft}^3 \text{ design} - \text{gr/ft}^3 \text{ outside})}{7{,}000 \text{ gr/lb}}$$

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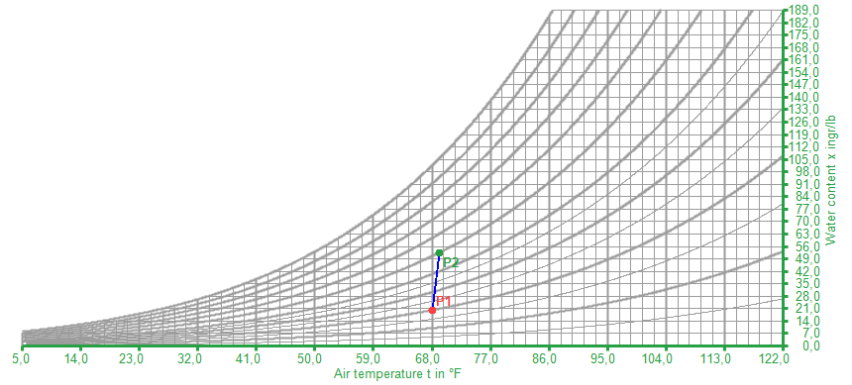
Humidification types can be divided into:

Isothermal humidification

Steam

- Energy is internally supplied
- Dry bulb increases slightly
- Wet bulb increases



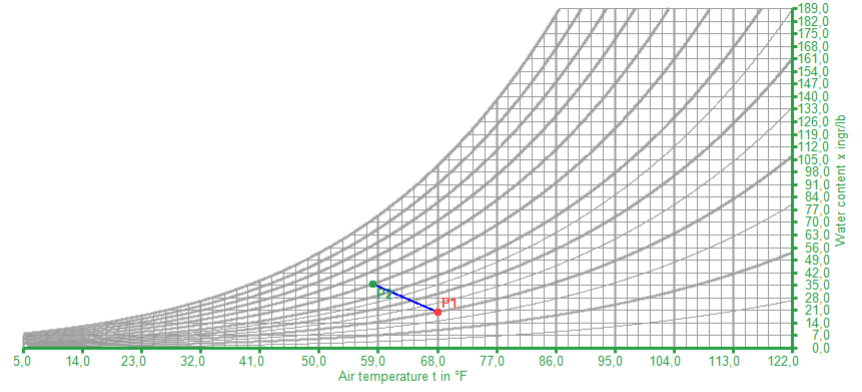
	P1: before humidification	P2: after humidification	Mouse position
Temperature	68,0 °F	69,1 °F	67,1 °F
Humidity	20,0 %	50,0 %	11,0 %
Absolute humidity	20,1 gr/lb	52,4 gr/lb	10,5 gr/lb
Enthalpy	19,45 BTU/lb	24,76 BTU/lb	17,78 BTU/lb

Barmoetric pressure: 1013 hPa, 0 m altitude

Adiabatic humidification

Evaporation / Atomization

- Energy is absorbed from the air – constant enthalpy
- Dry bulb decreases
- Wet bulb remains same



	P1: before humidification	P2: after humidification	Mouse position
Temperature	68,0 °F	58,1 °F	9,3 °F
Humidity	20,0 %	50,0 %	24,0 %
Absolute humidity	20,1 gr/lb	35,5 gr/lb	2,1 gr/lb
Enthalpy	19,45 BTU/lb	19,46 BTU/lb	2,56 BTU/lb

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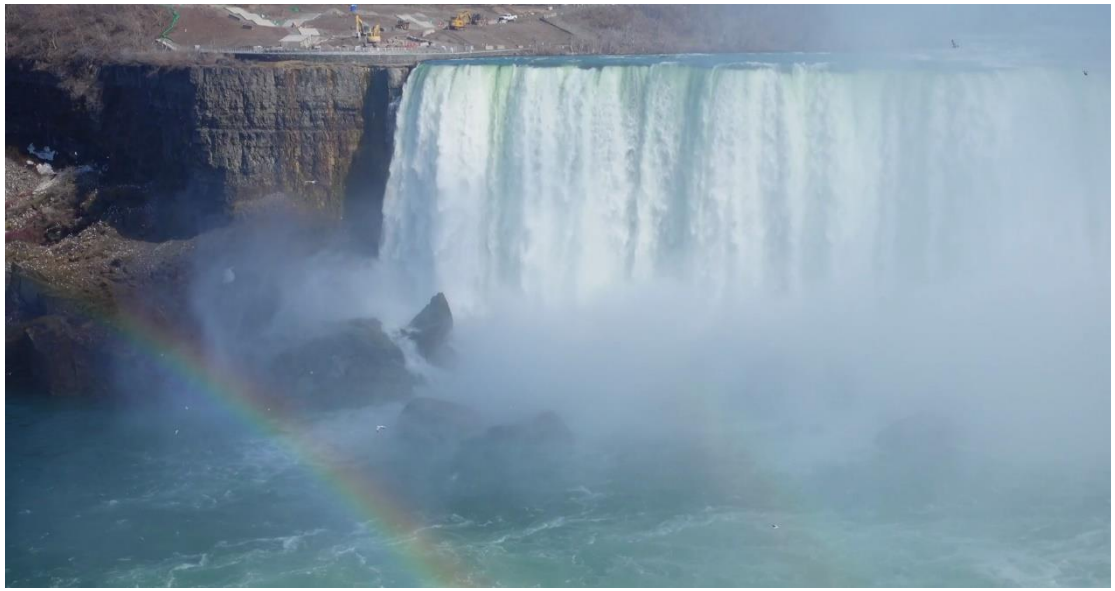
Humidification Technology

- **First Outdoor Humidifiers:**



- **First Indoor Humidifiers:**

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Humidification Technology

Isothermal - Electrode

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Humidification Technology
Isothermal - Electrode

Advantages of new technology:

- Mineral shedding rather than mineral holding
- Up to 3 times longer maintenance cycle
- Cleanable cylinder / consumable electrodes – no landfill
- No fill cup – mounting above or below steam distributor
- Bottom cool area to reabsorb mineral precipitate
- Drain pump to grind up mineral deposits
- Better diagnostics with pre-warnings
- Interlock Options: Turn on fan, lock out on cooling/dehum
- Full modulating to any sensor/controller
- Programmable capacity limits
- BacNet or ModBus communications

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Humidification Technology
Isothermal – Heating Element

Advantages of new technology:

- Precision SSR control to +-0.5%
- Works on ANY water, including R/O, hard, softened
- Mineral shedding, drain pump
- Complete programmability, including load shedding
- Fully protected heater elements
- Non-float level control

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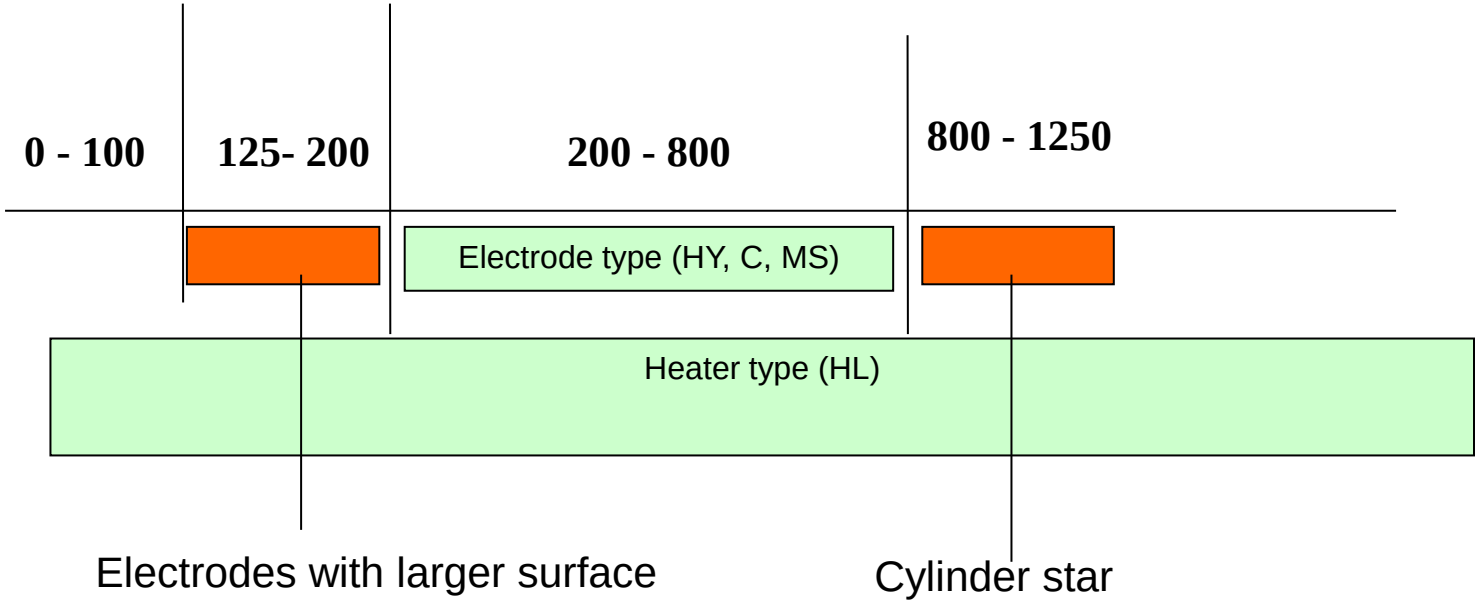
Water-qualities for electrode and heater type humidifiers

Tap water with a conductivity of 125 to1250 µS/cm (Micro Siemens/cm or µmhos/cm) at 59°F / 15 °C



HL units Conductivity: We recommend to use water higher than µmhos/cm 3µS/cm as this water is too agressive.

HL units Hardness: We recommend water treatment at > 15.64 gr/gal(US) (grain $CaCO_3$/gal(US)) >15°dH (German hardness).

Conductivity is measured in the US in micromhos per centimeter (µmhos/cm) or microsiemens per centimeter (µs/cm)
http://www.convertunits.com/from/micromhos/to/microsiemens

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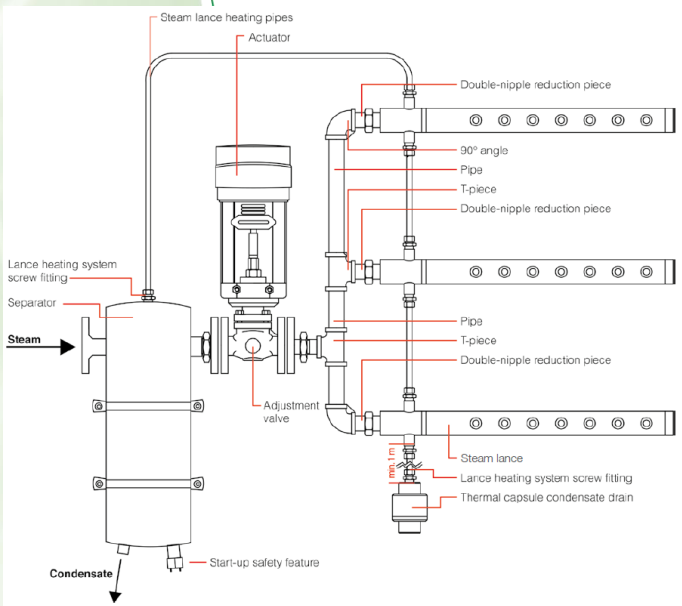
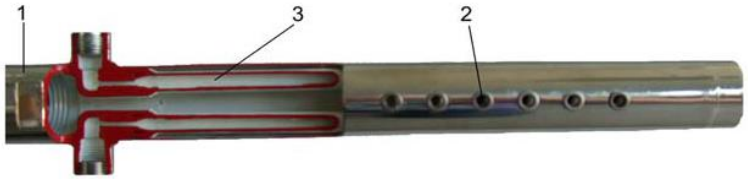
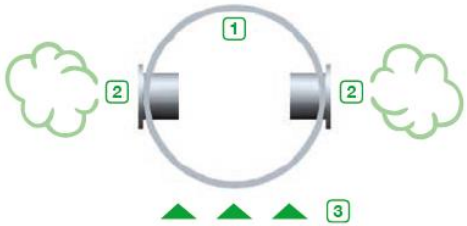
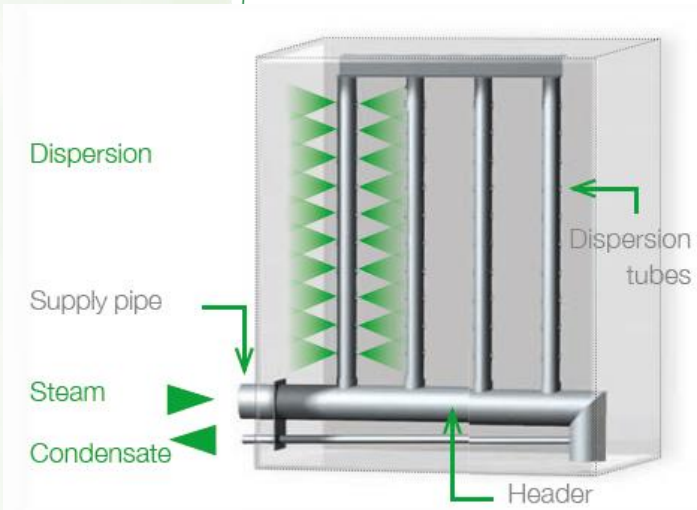
Humidification Technology
Isothermal – Direct Discharge

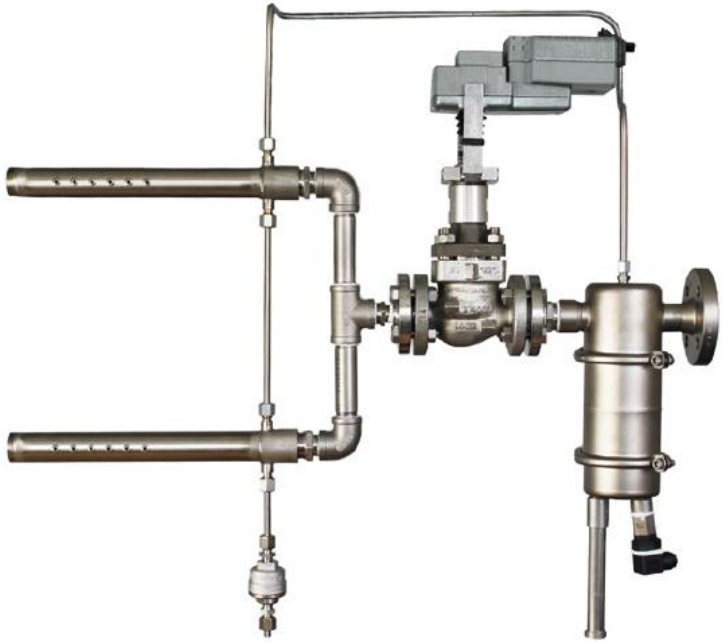








- Air gap insulating
- Steam nozzles
- Heat tracing
- Complete shutdown
- Multiple manifolds
- Reverse discharge
- 100% stainless steel
- Future: Variable orifice slot discharge



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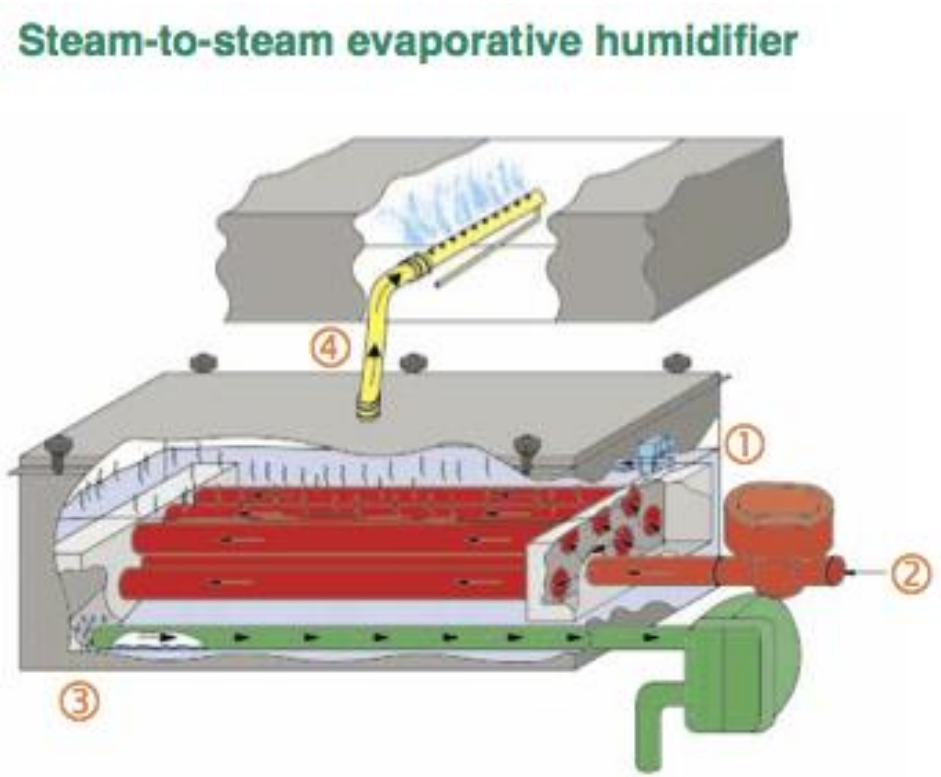
Humidification Technology
Isothermal – Steam to Steam

Boiler steam in heat exchanger boils clean water in reservoir

- Eliminates any boiler chemical carryover
- About 80% efficiency in conversion
- Uses any type of water
- Expensive technology
- Mostly used in older buildings with older steam systems
- Newer treatment chemicals evaporate less and are less carcinogenic



Humidification Technology

Adiabatic – Pressure Atomizing

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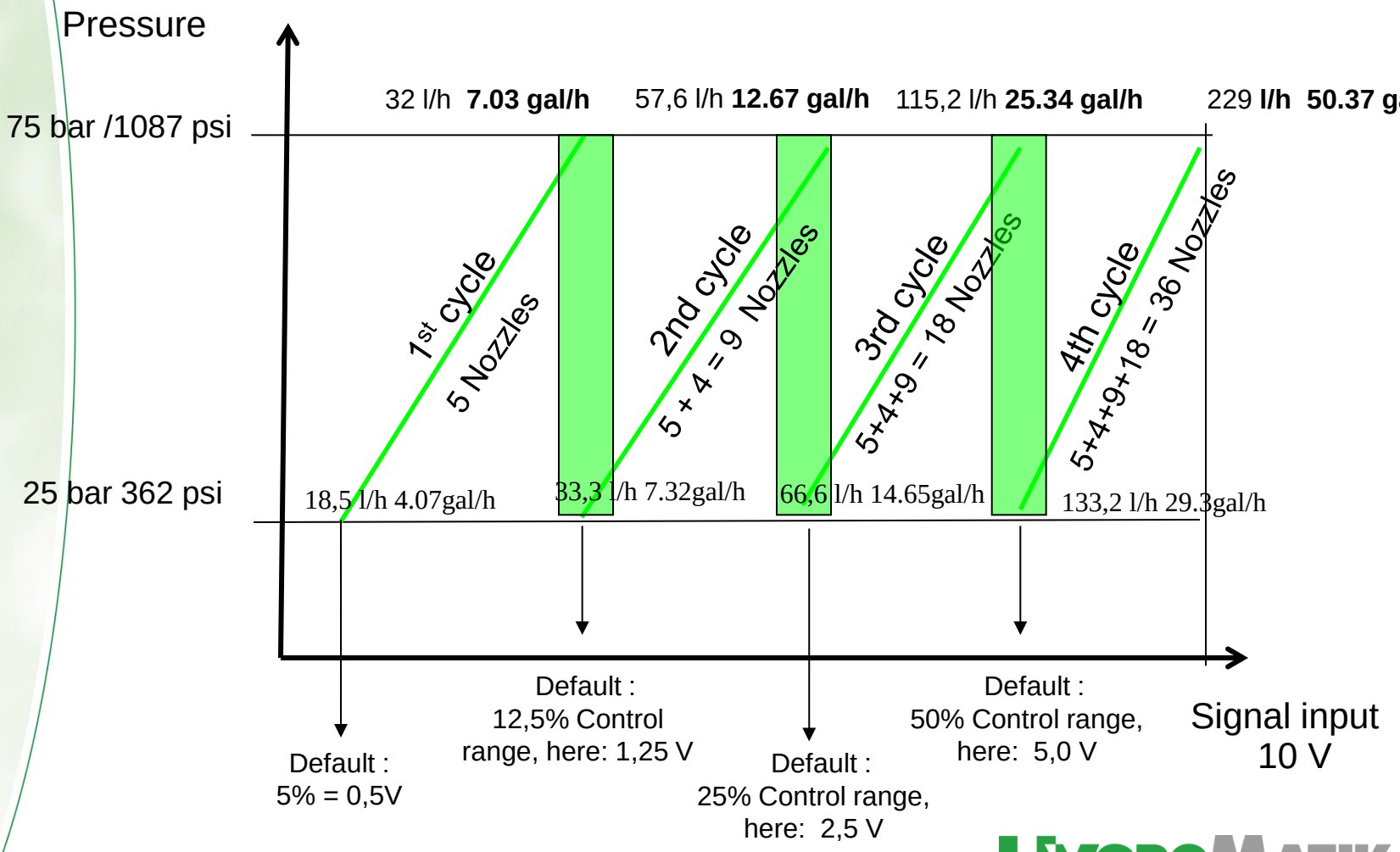
HPS 4-CYCLES (PROPORTIONAL CONTROL)

Control range
4.07gal/h to 229 l/h **50.37 gal/h** 18,5 l/h



Humidification Technology
Adiabatic – Pressure Atomizing

Advantages of technology:

- HPS: Up to 95% evaporation efficiency
- LPS: Up to 80% evaporation efficiency
- Pump fully monitored for pressure, temperature
- Only system certified by ILH - VDI 6022 for hospitals
  - No hygroscopic or hydrophilic materials, all inert
  - “Dead leg flushing” to prevent stagnant water
  - System drain down on shut-down prevents stagnation
  - Water sampling tap
- Leakage detection
- Stages + Modulation for precision control

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HPS in a blood Centre in Linz / Austria

- **8 Air handling units**, isotherm humidification
- **11 Steam humidifiers** installed

The cost effectiveness of the HPS

Operating costs for steam humidification – <u>previous state</u>:

Energy costs for isothermal air humidification:	$105,894 p.a.
Maintenance:	$8,250 p.a.

Operating costs for atomizing humidification – <u>new state</u>:

Energy costs for adiabatic air humidification:	$2,524 p.a.
Energy costs for pre-warming the air:	$14,867 p.a.
Maintenance costs:	$1,540 p.a.

Savings in operating costs by using the HygroMatik High pressure nozzle system: **$94,964 p.a.**

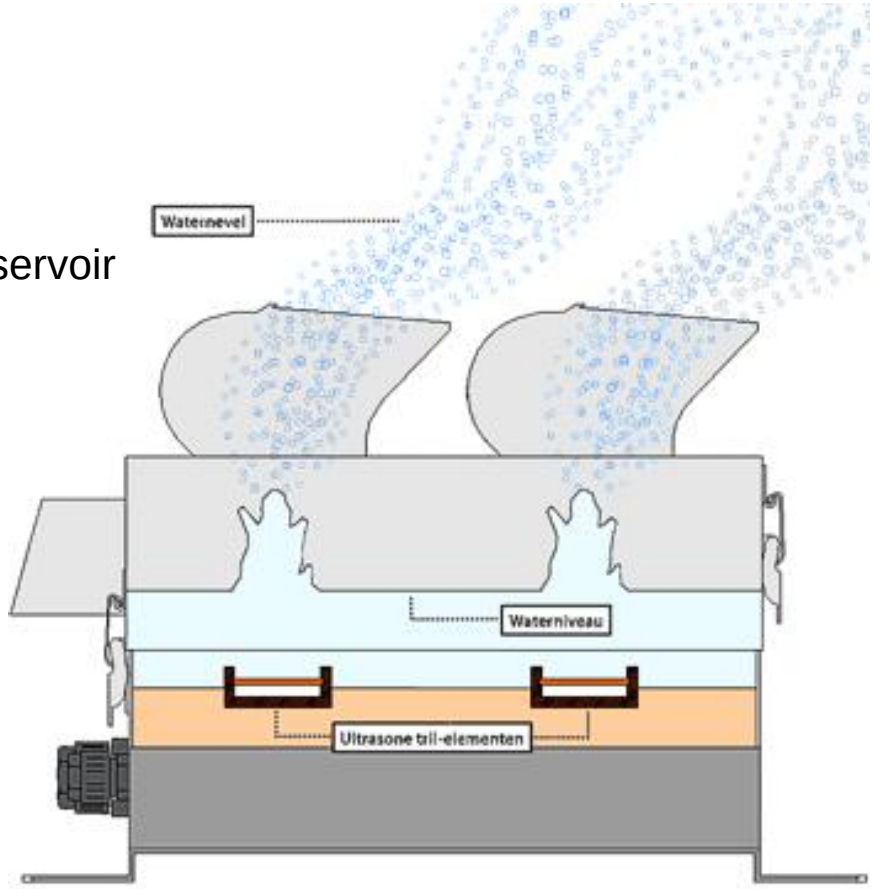
Total investment costs: **$160,600**

<u>Amortization:</u> **1.69 years**

Humidification Technology
Adiabatic – Ultrasonic Atomizing

Piezo-electric transducers induce sound waves that atomize the surface water into a fine mist

- Produces droplets of approximately 1 micron in size
- Very efficient. Instant on/off
- Needs clean atmosphere
- Uses only demineralized water
- Very expensive technology
- Unfiltered air moving through the reservoir carries the mist out
- Microbes float on the surface of the reservoir
- Atomizing the surface puts highest concentrations of any contaminates into the air



Humidification Technology
Adiabatic – Evaporative Media

Water runs through or is sprayed onto a hygroscopic media

- Pure evaporation, no droplets are produced
- Very efficient, and also cleans the air
- Uses any type of water
- Low cost technology
- Works like an air filter – air washer
- Limited to AHU applications
- Reservoir prone to contamination

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MORE THAN

45 YEARS

HUMIDIFICATION

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