Adiabatic Humidification

Condair Ltd.
www.Condair.com

Humidity for a better life

Agenda

Adiabatic Humidification

1. Introduction to Humidity
2. Product Overview
   - Isothermal
   - Adiabatic
   - Water
3. Adiabatic Opportunities
4. Key Takeaways + Q&A

1

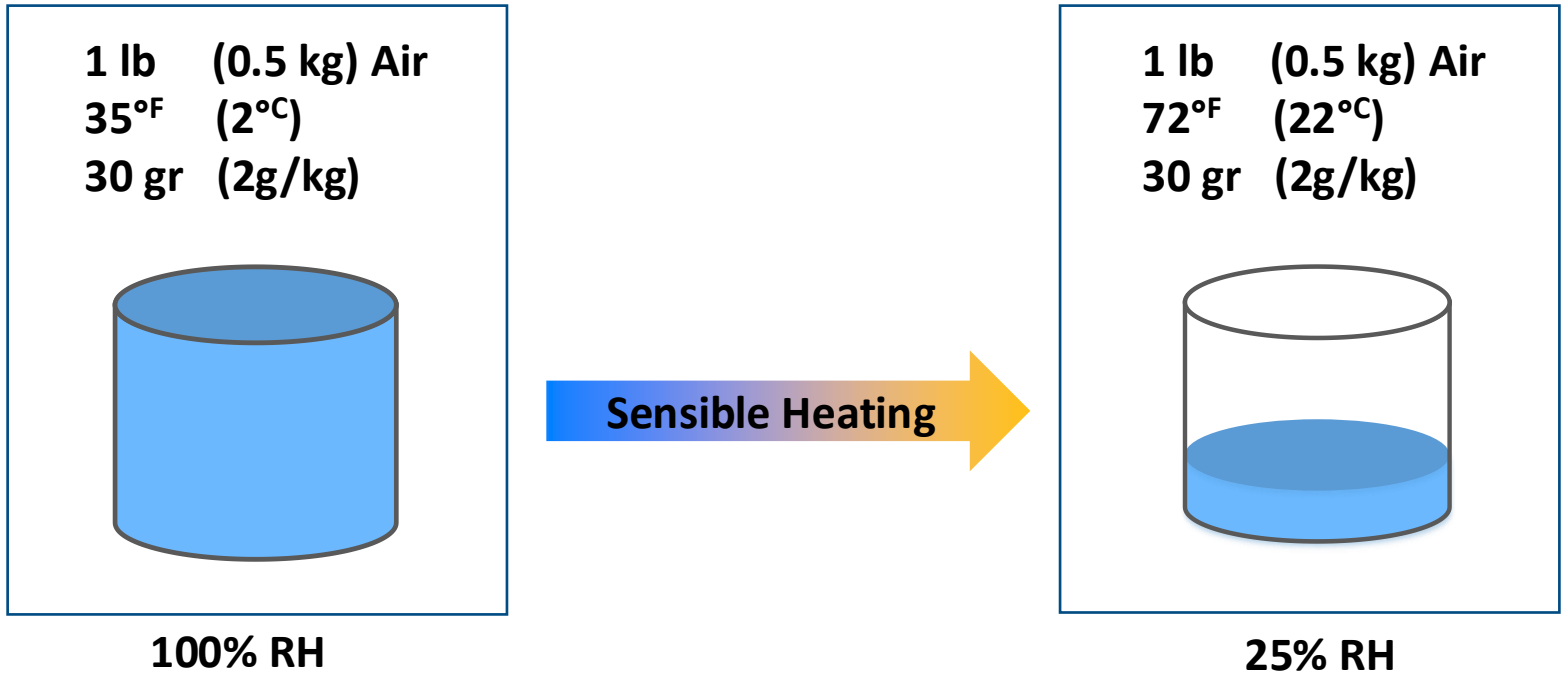
Introduction to Humidity

Introduction to Humidity

Humidity vs. Temperature

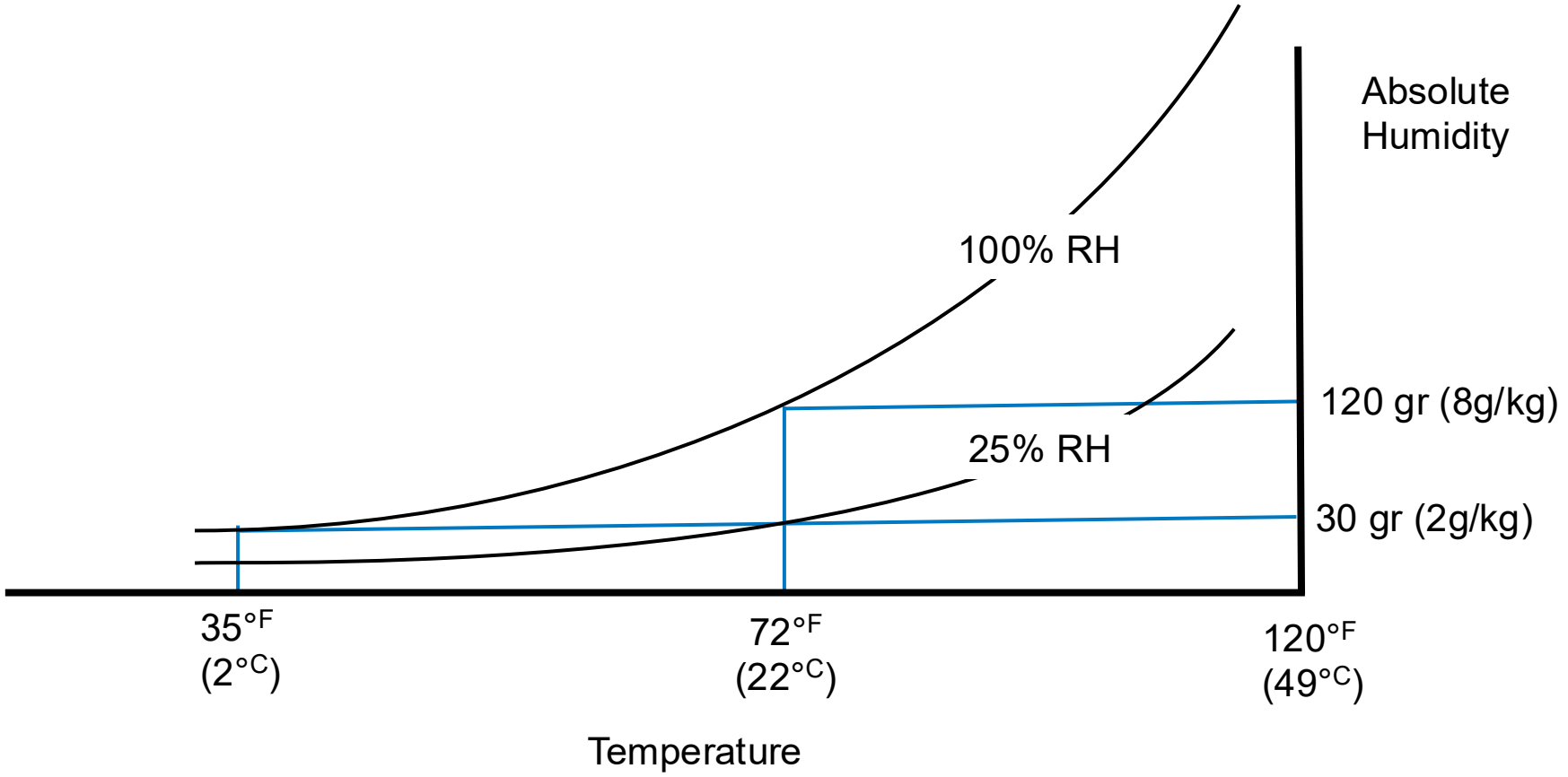
Absolute Humidity is measured by mass (gr/lb, g/kg)

Relative Humidity is relative to temperature (%)



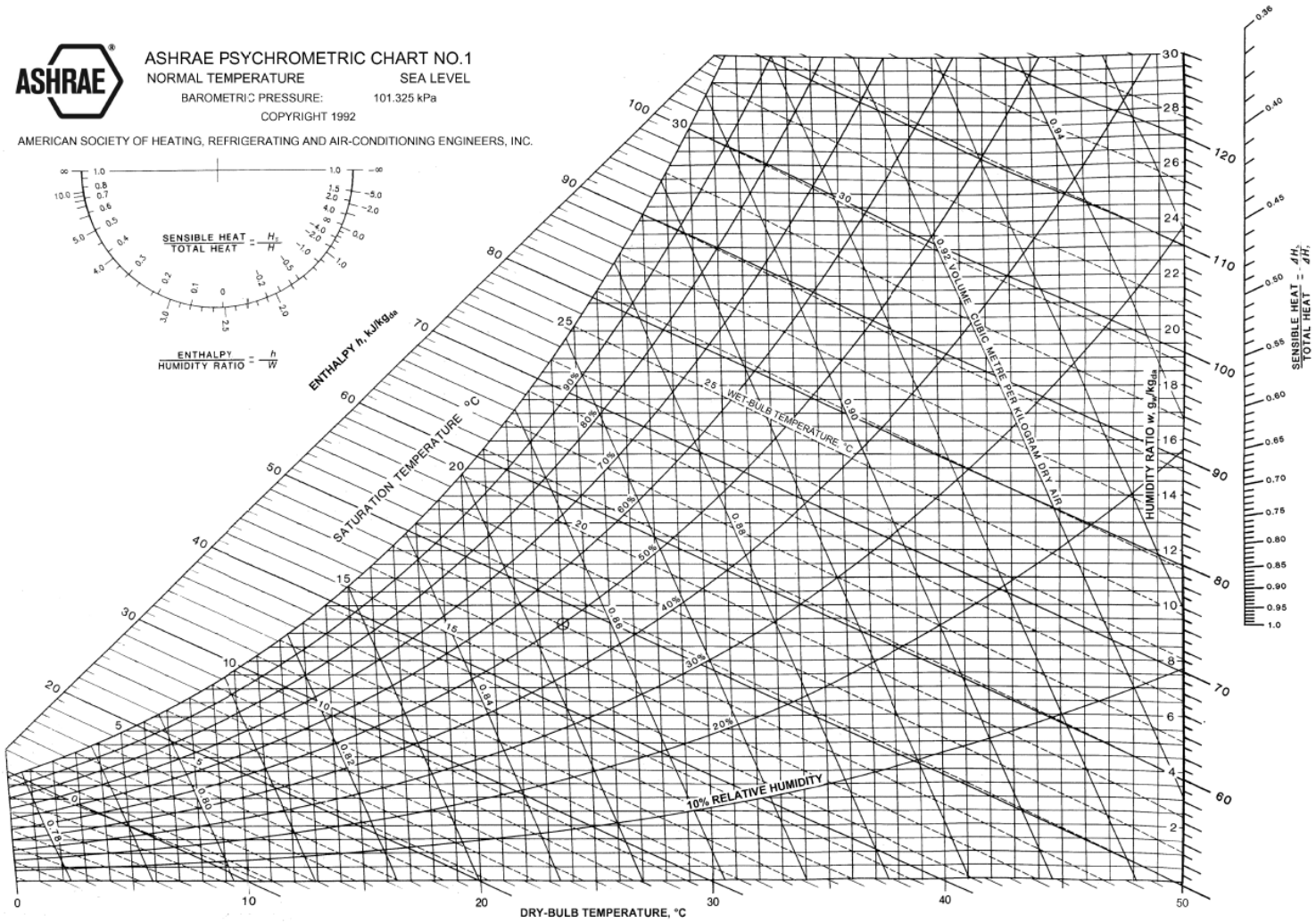
Introduction to Humidity

Humidity vs. Temperature



Introduction to Humidity

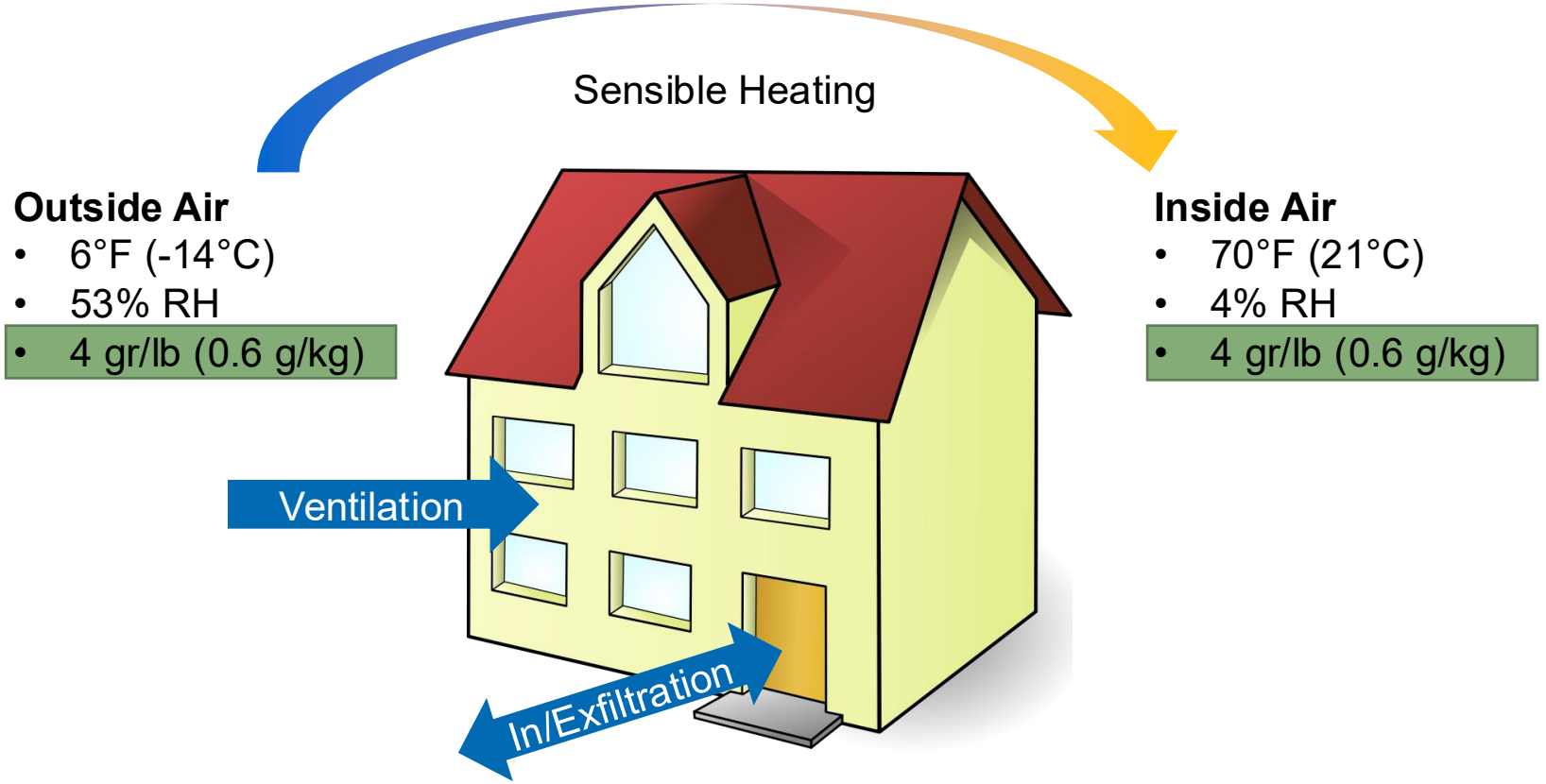
Psychrometric Chart



Introduction to Humidity

Why Buildings get Dry

Outside air with low absolute humidity dries building



Introduction to Humidity

Is Dryness a Problem?

Manufacturing and Processes

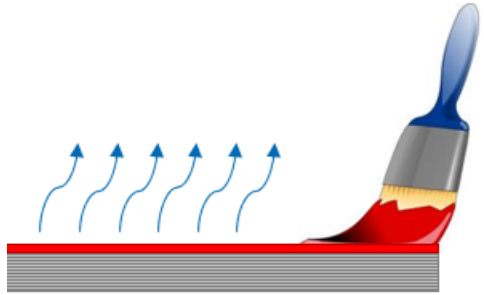
iStock: 000030384618X

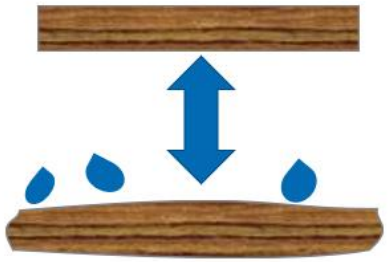
Human Health and Wellness

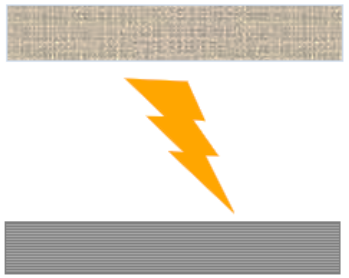
Licensed from www.peopleimages.com

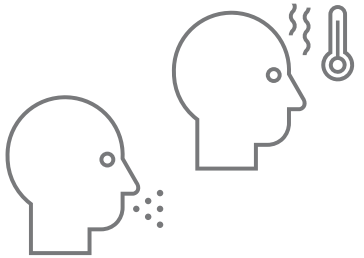
Introduction to Humidity

Is Dryness a Problem?







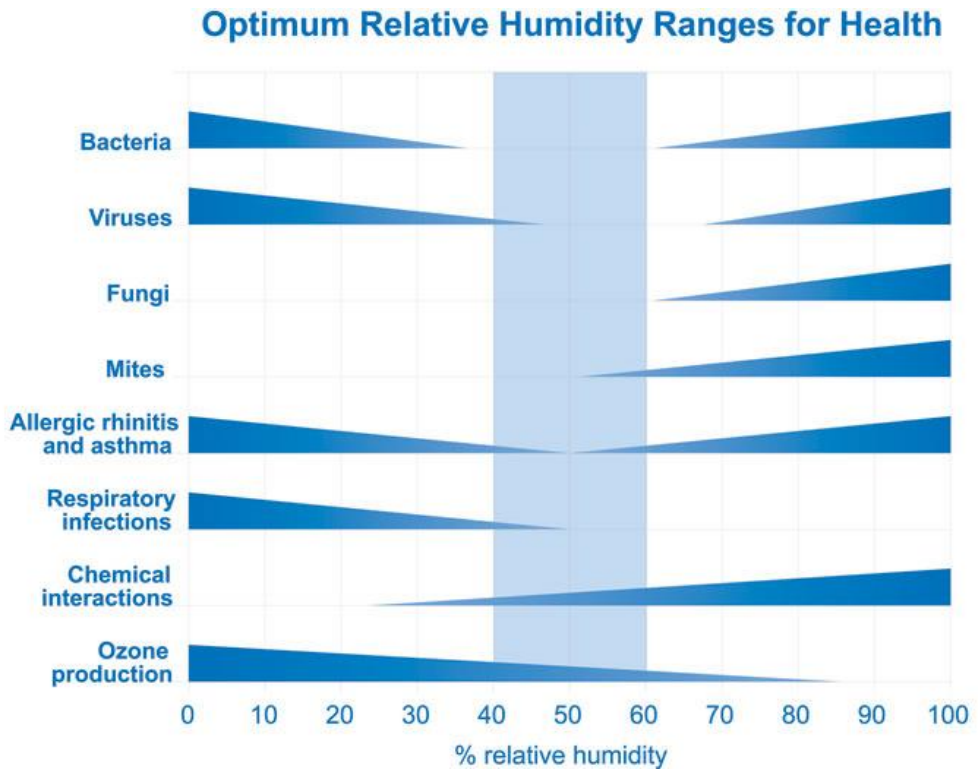


	Evaporation Rates	Hygroscopic Materials	Static Charges	Human Health and Wellness
Effects of low rh	• Water based sprays / paint • Shrinkage • Adhesion • Runs / Drips	• Dimensional instability • Cracking / deterioration • Coating delamination	• Component damage • Static cling • Unpredictable spray pattern • Paint Defects • Ignition of volatile compounds	• Eye discomfort • Thermal discomfort • Vocal cord irritation • Decreased cognitive function • Decreased immune function • Increased transmission of cold/ flu

Does anyone know the ideal range for indoor rh% for human health/wellness?

Introduction to Humidity

What Does ASHRAE Say?



The Sterling Chart

- Common design reference
- Optimal mid-range 40 - 60%

ASHRAE Standard 55

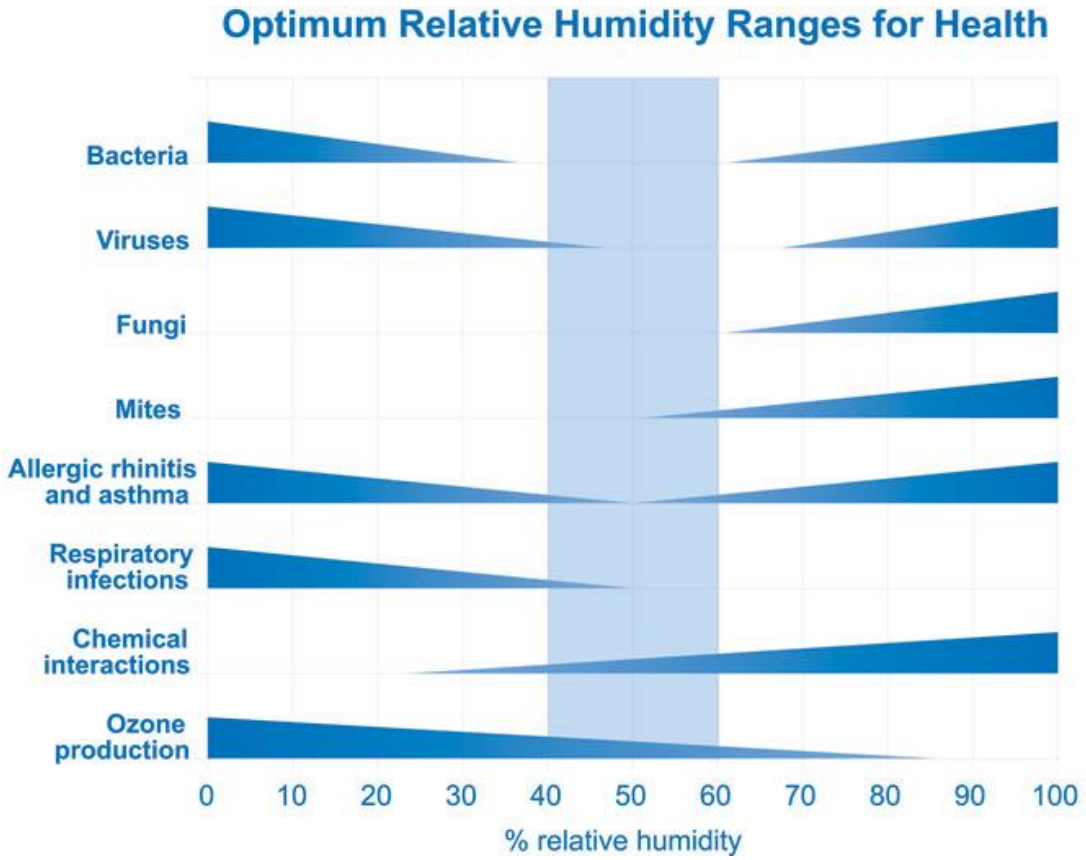
"There are no established lower-level humidity limits for thermal comfort, consequently, this standard does not specify a minimum humidity level.

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

Introduction to Humidity

Summary

1. Buildings dry out when outside is colder than target levels
2. Humidity affects processes
3. Humidity affects occupant health
4. Optimum indoor range for occupants: 40 – 60% RH (and 20°C – 23°C, <1000 ppm)
5. Planning for humidity helps achieve great results



2

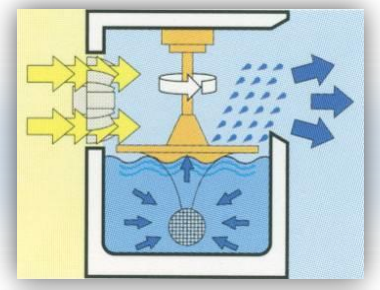
Product Overview

Product Overview

Types of Humidification

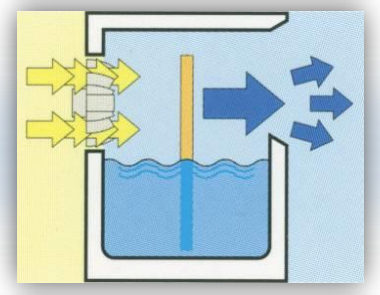
Adiabatic

Atomization



High Pressure
Nozzles
Ultrasonic

Evaporation

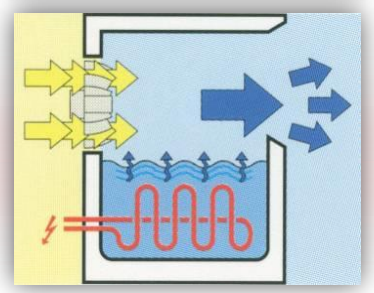


Hybrid

Evaporative Media

Isothermal

Vaporization



Gas Steam
Electric Steam
Resistive Element
Live Steam

Product Overview

Condair Products Portfolio

Isothermal

EL

RS

GAS

Distribution

SAM-e

Central steam

Live Steam

Steam-to-steam

Adiabatic

ME/ MC

US

DL

HP

ML/ DRS

Dehumidification

DA

Water Treatment

RO-H

RO-A

MLRO

B500

JetSpray

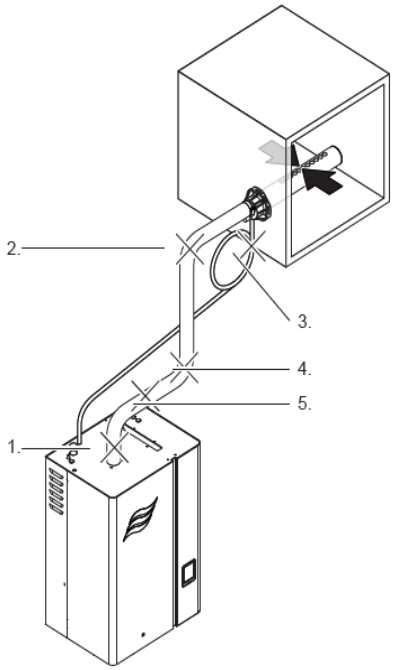
Product Overview

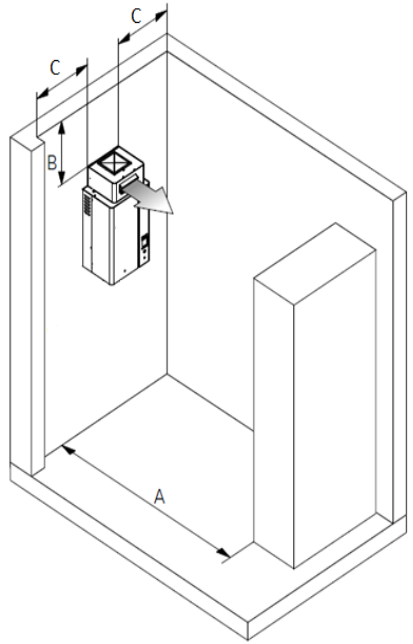
Isothermal Technologies

Overview

Steam humidity source

- Clean, atmospheric* steam (*excluding LS which is pressure steam with LS tubes)
- Highly specified and reliable technology





Complete packaged products

- Easy installation
- Simple to order
- Complete enclosure/ cabinet, plug and play
- Exception: LS which requires some assembly on site

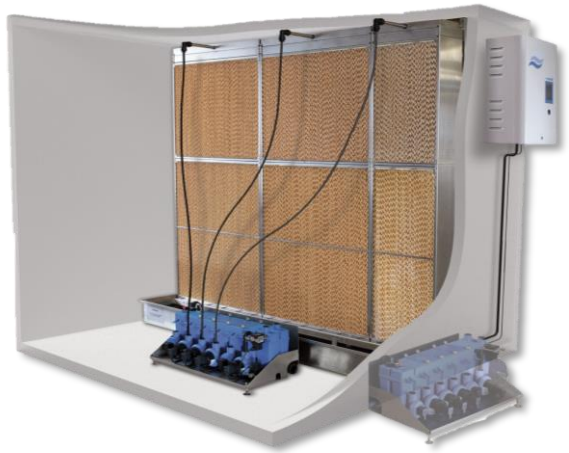
Product Overview

Isothermal Summary

		In Space	In Duct	Benefits	Considerations
Isothermal	EL Series (Electrode)	X	X	• Easy maintenance (replaceable cylinder) • Highest electrical efficiency (~98%) • Patented auto-adaptive cycle • Low first cost	• Specific water quality requirements • Only up to 200 lb/hr on a single unit
	RS Series (Resistive Element)	X	X	• Can use potable, RO or DI water • Patented Scale Management option • High-Precision Option • Maintenance features	• Only up to 180 lb/hr on a single unit
	GS Series (Gas-Fired)	X	X	• High Efficiency, low-cost Gas • SCAQMD low NOx • Large capacities (50-600 lb/hr) • Can use potable, RO or DI water	• Gas Regulations • Requires gas/ supply air connections
	SE Series (Steam Exchange)	X	X	• Economical operation by leveraging existing on-site energy source • Boiler chemicals are contained and • returned to boiler • Large capacities (50-1050 lb/hr)	• Easy maintenance (replaceable cylinder)
	LS Series (Livesteam)		X	• Lowest first cost and economical operation • High accuracy • Large capacities (0.5-3250 lb/hr) • Minimal maintenance	• Potential carryover of any boiler steam chemicals/ contaminants

Product Overview

Adiabatic Technologies



Overview

Cold Water Humidification

- Evaporative Cooling
- Low operating costs

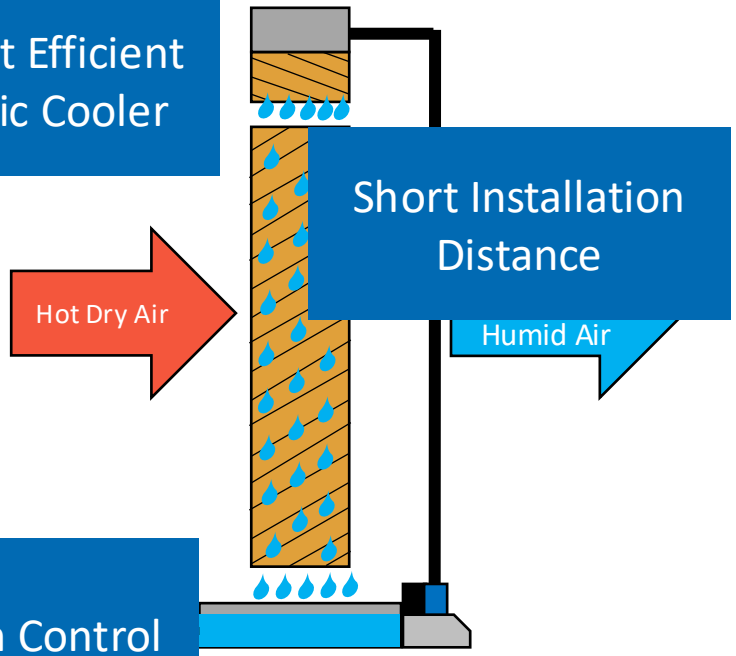
Hygiene Features

- Condair Products are equipped with many hygiene features to ensure clean operation. These include:
  - Silver ion dosing
  - UV light
  - Water Treatment

Product Overview

Evaporative vs. Atomization

The Most Efficient Adiabatic Cooler

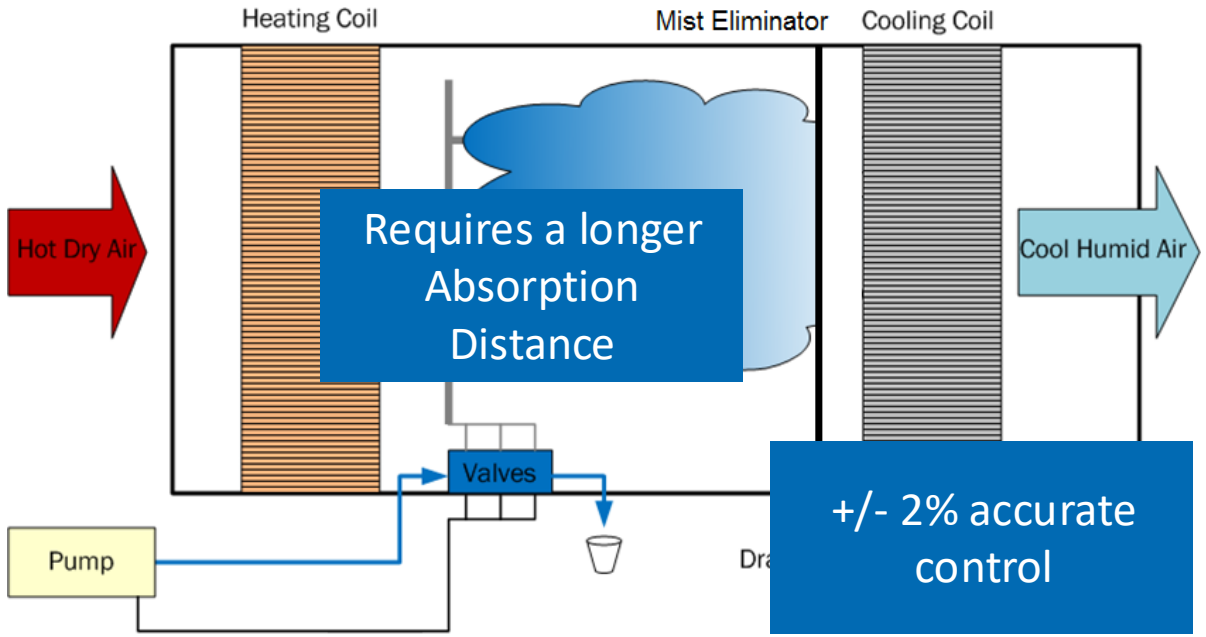


Short Installation Distance

+/- 10%rh Control

ME Series

Media Evaporative



Requires a longer Absorption Distance

+/- 2% accurate control

HP Series

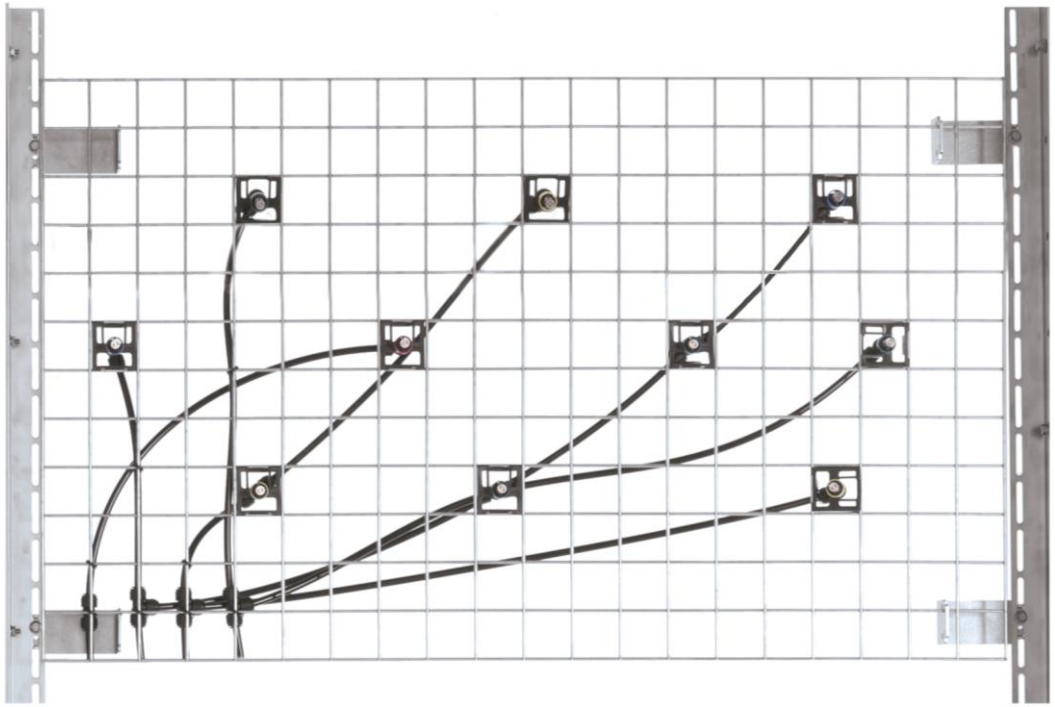
High Pressure Atomization

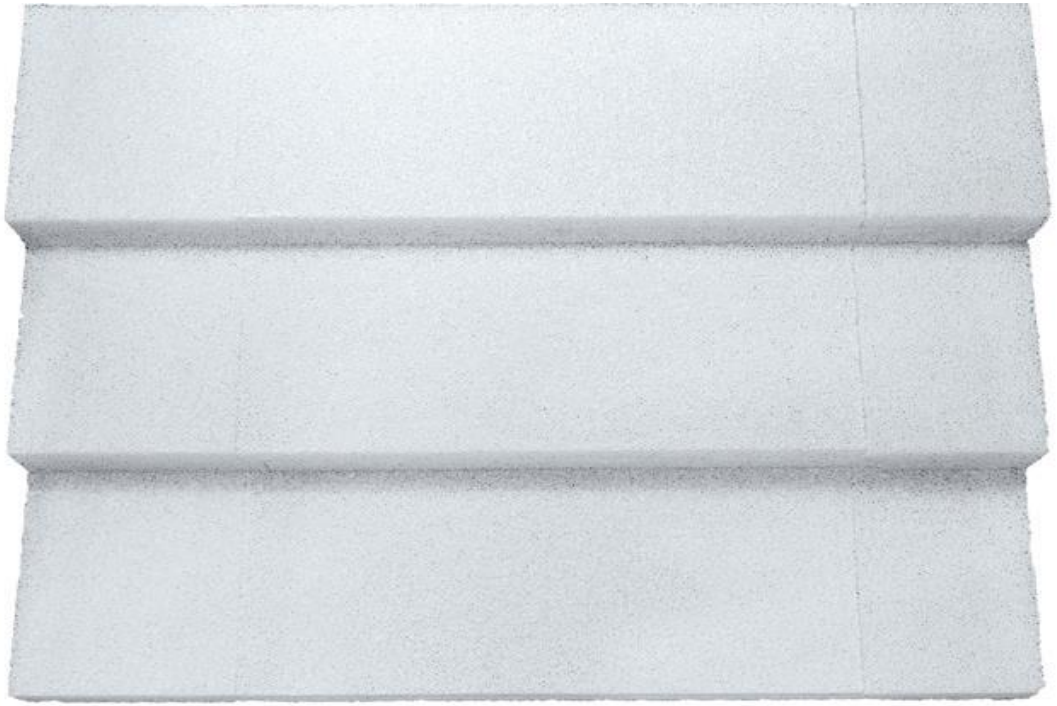
Product Overview

Hybrid Technology

DUAL Technology Humidifier:

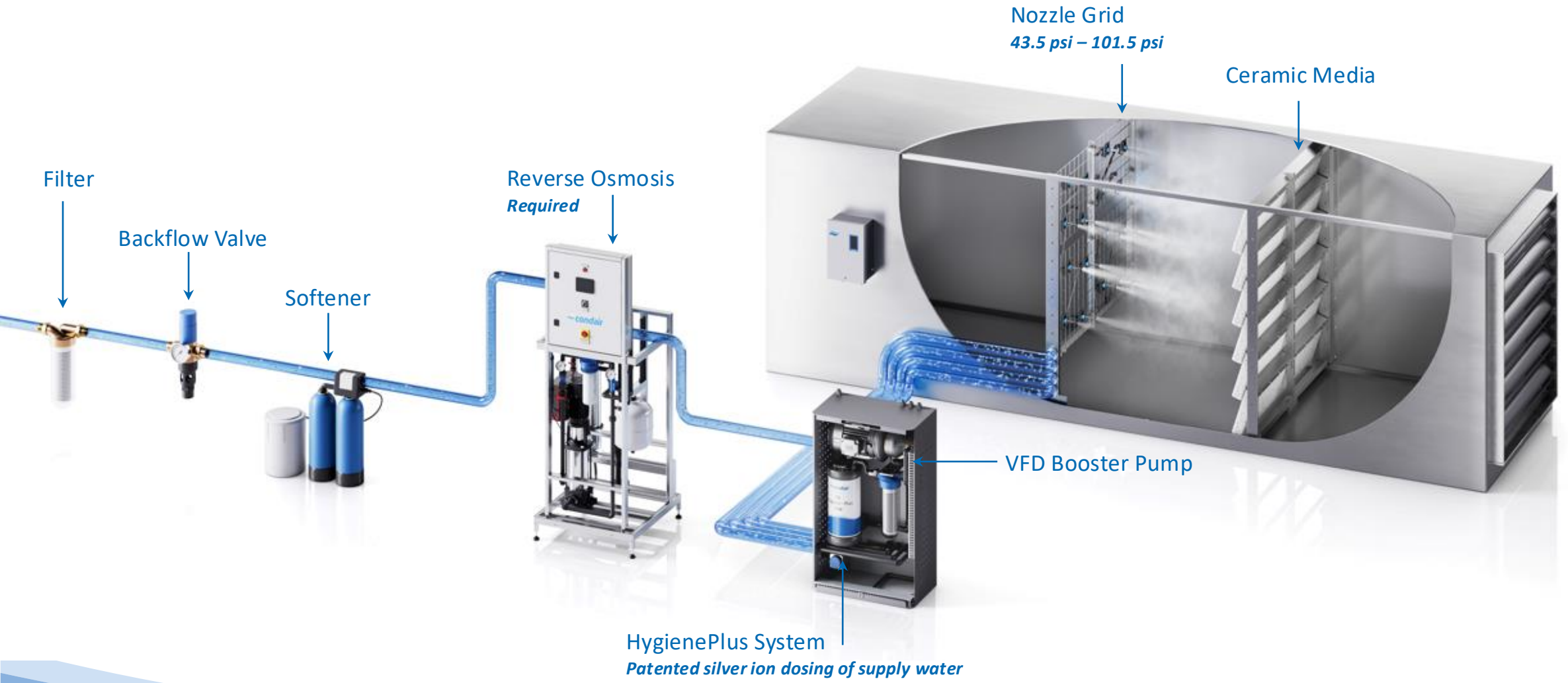
Atomization + Evaporation





Product Overview

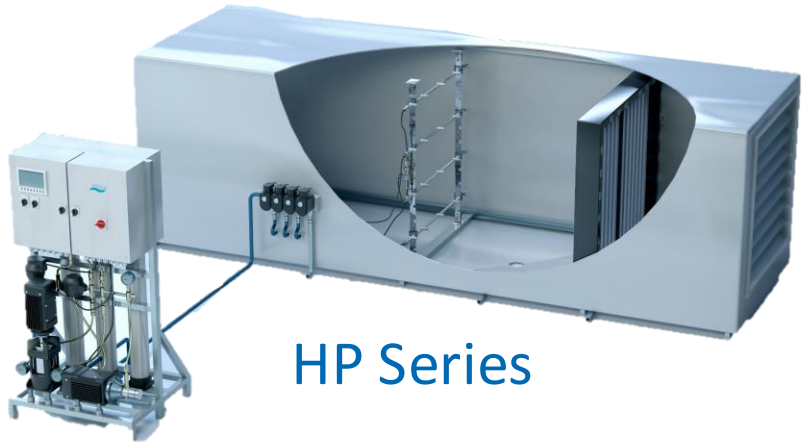
Condair DL Series



Product Overview

Condair DL Series

DL Series



HP Series

<u>The DL improved the existing High-Pressure technologies:</u>

HP systems have been around for 50+ years.

HP systems one of the most common adiabatic technologies but has many design limitations.

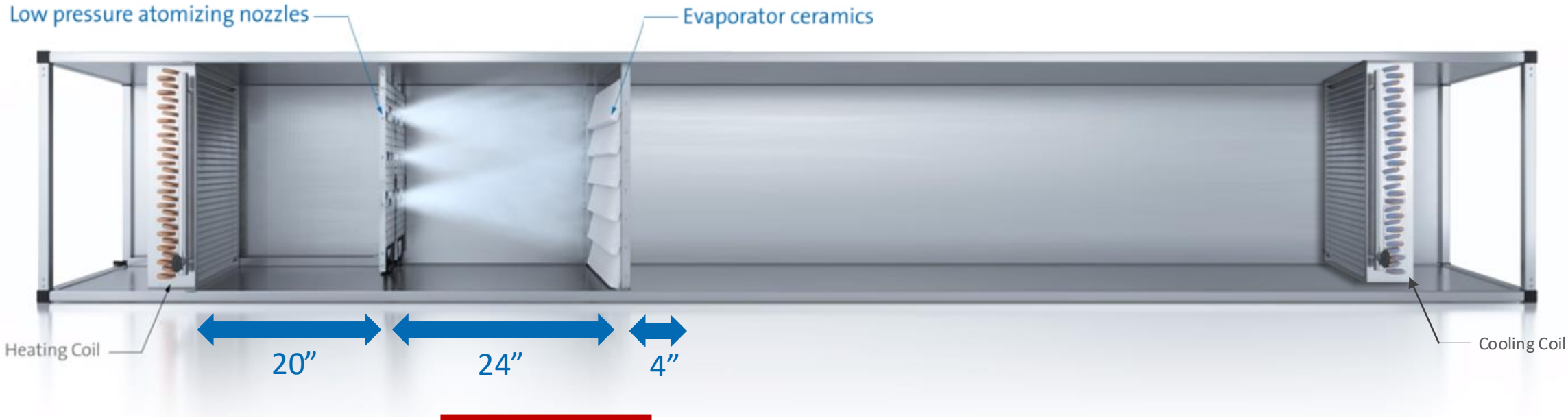
The DL was designed to improve these limitations:

- Install Length
- Energy Efficiency
- Water Waste
- Hygienic Function
- Maintenance

While still offering the same high control accuracy (up to ±2%) as the HP.

Product Overview

Installation Requirements



EVAPORATIVE

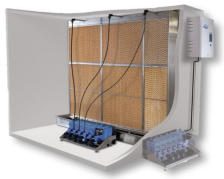
24”

UNIT

20-30”

24”*

*Recommended for service access



HIGH PRESSURE

20”

NOZZLES

60-96”

MIST ELIM

20”

Product Overview

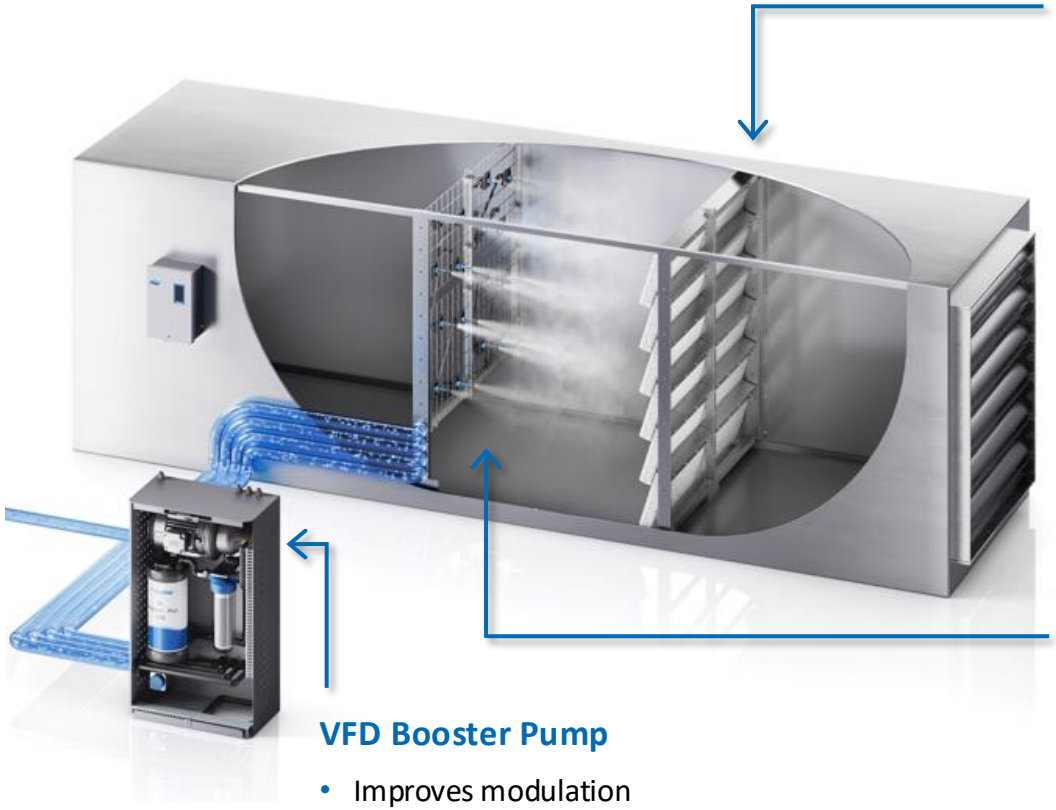
Condair DL Series

DL Series

- The most hygienic adiabatic humidifier
- Single unit can provide up to 2200 lbs/hr
- Low energy costs: consumption as low as 55W
- Flexible sizing to fit any duct (great for retrofits!)
- Offset mechanical cooling costs with free cooling effect
- UL Approved

Hygiene

- Patented HygienePlus System
- Independently certified (Fresenius Institute) for hygienic operation
- No recirculation of water
- Continuous conductivity monitoring of inlet water
- Automatic drain and flush cycles



Ceramic Plates

- Patented hygienic ceramic material
- No risk of aerosols
- Very low pressure drop (<0.20 WC @500 fpm velocity)
- Maintenance-free & replacement-free
- Extremely high surface area = maximum evaporation efficiency
- Optional droplet separator available (>600 fpm)
- Reduce total unit footprint to just 24”

VFD Booster Pump

- Improves modulation
- Maintenance-free
- Intelligent operation

Nozzle Grid

- Stainless steel nozzles
- Pressurized water operation (43-101 psi) features low energy consumption and wear
- Custom nozzle layout maximizes efficiency
- Little to no maintenance

Product Overview

Adiabatic Summary

		In Space	In Duct	Benefits	Considerations
Adiabatic	ME Series (evaporative)		X	• Evaporative Cooling • Low energy consumption: highest cooling performance • Potable Water • No evaporation distance	• Media is consumable • High pressure drop • Lower control accuracy • slower response times • Not suitable for healthcare
	DL Series (hybrid)		X	• Evaporative Cooling • Low energy consumption • Extremely hygienic • Low maintenance requirements • Short installation length requirement	• Requires RO water • Wet section with drain required
	HP/ML Series (atomizing)	X	X	• Evaporative Cooling • Low energy consumption • High reliability and low maintenance • Instant output/ shut off	• Requires RO water (same skid for <1000l/h) • Longer installation length requirement • Pumps, valves, nozzles
	AF Series (atomizing)	X		• Scalable performance for large loads • High-reliability, low maintenance • Instant output / shutoff	• Treated water may be required • Louder nozzles than high-pressure • Air compression cost
	US Series (atomizing)	X		• Evaporative Cooling • Low energy consumption	• Requires RO/ DI water • Up to 40 lb/hr on a single unit • Not suitable for healthcare

Product Overview

Water and Humidification

1 Steam Generation (Isothermal)

Scaling!

2 Atomization / Evaporation (Adiabatic)

Scaling, **Dust** and **Hygiene**!

Product Overview

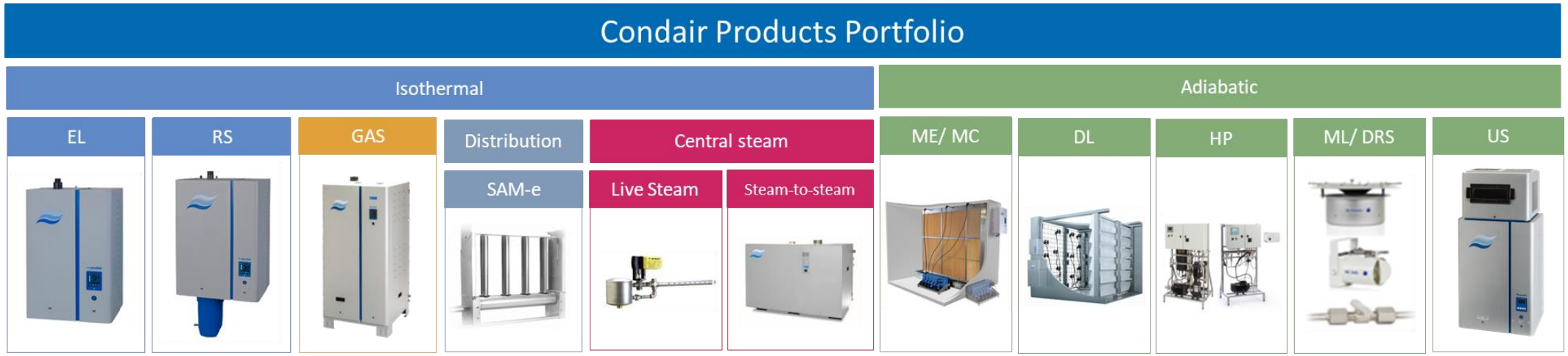
Water and Humidification

Product	EL Series		RS Series	GS Series		SE Series	
Water Type	Potable		Potable/DI/RO	Potable	RO/DI	Potable	RO/DI
Temperature	34-104°F (1-40°C)		34-77°F (1-25°C)	34-59 °F (1-15 °C)		34-77°F (1-25°C)	
Conductivity	150-1200 µS/cm		1-1500 µS/cm	1-1500 µS/cm	1-100 µS/cm	1-1500 µS/cm	1-100 µS/cm
pH	7 - 7.5		6.5-7.5	6.5-7.5	7-7.5	6.5 - 7.5	7 - 7.5
Hardness	0-3 gpg	0-12 gpg	0-12 gpg	0-15 gpg	0-1 gpg	0 - 12 gpg	0 - 1 gpg
Silica (SiO2)	4-14 ppm	0-4 ppm	0-12 ppm	0-14	0-1	0 - 14 ppm	0 -1 ppm
Chloride			0-50 ppm	0 - 40 ppm	0 - 40 ppm	0 - 25 ppm	0 - 25 ppm

Check out our Water Treatment Guide!

Product Overview

Summary



In duct?										
In Space?										
> 200 lb/hr single system										
Water Treatment needed?										

3

Adiabatic Opportunities

Adiabatic Opportunities

Why Adiabatic?

Energy savings

Steam humidifiers use electricity or gas **($$$)**

Adiabatic humidifiers draw energy from air **(¢)**

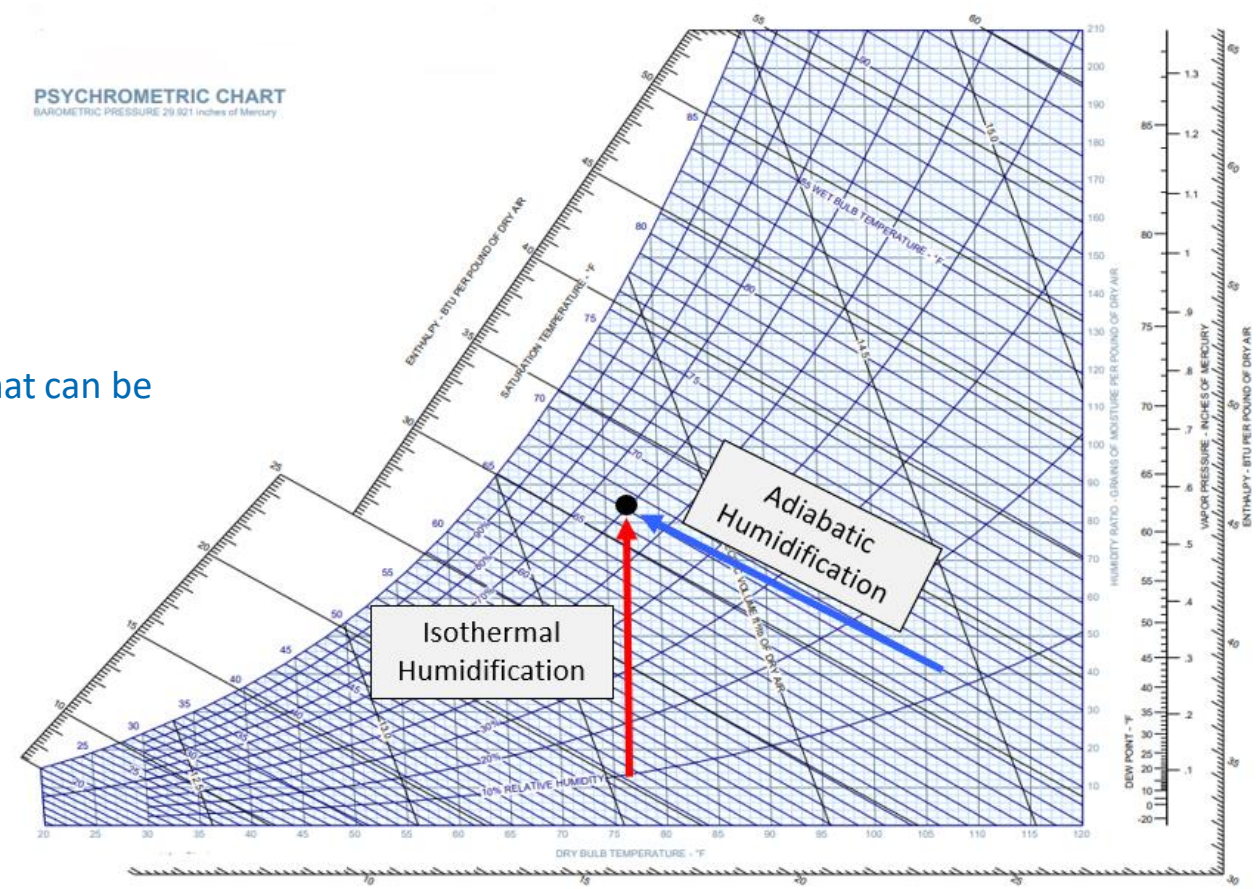
Free cooling

Drawing energy from air results in sensible cooling that can be used to offset mechanical cooling requirements

Flexible humidification

Custom setups & redundancy options
Large single-system capacities (2,200 lbs/hr+!)

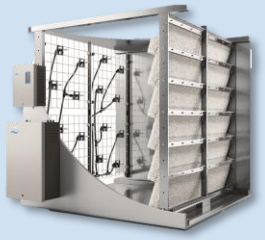
Low maintenance



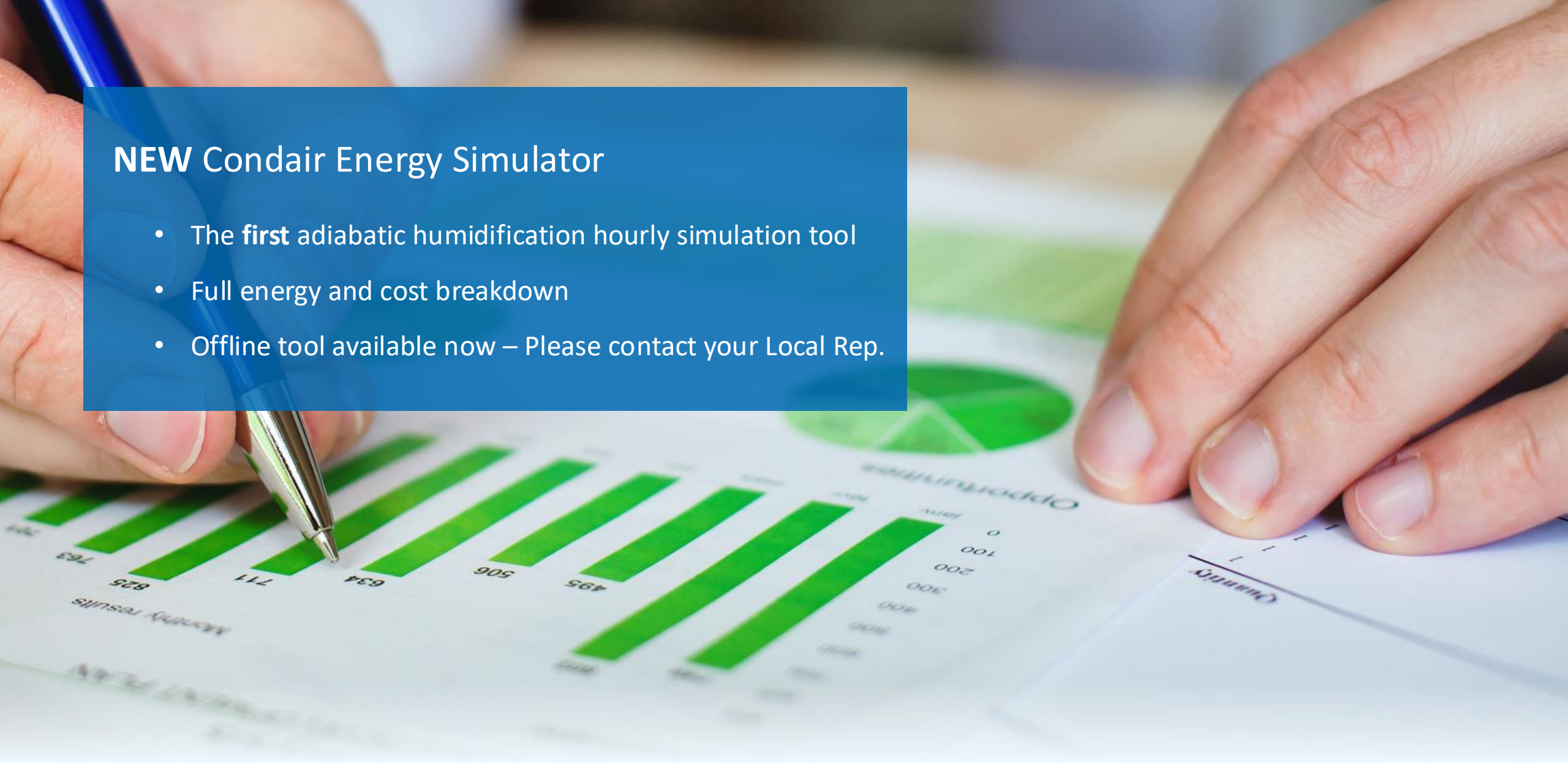
Adiabatic Opportunities

Why Adiabatic?

Application: Hospital
Load: 2200 lbs/hr

		Power Consumption (kW)	2000 hours @ $0.08/kW
Adiabatic DL Series		2.6	$416*
Resistive RS Series		780	$124,800
Electrode EL Series		737	$117,920

**With beneficial evaporative cooling*



NEW Condair Energy Simulator

- The **first** adiabatic humidification hourly simulation tool
- Full energy and cost breakdown
- Offline tool available now – Please contact your Local Rep.

Adiabatic Opportunities

Case Study – Hospital in Toronto (retrofit)

Condair Energy Analysis Tool

Opportunity Name	Toronto Hospital
Currency	CAD
Units of Measure	Metric (SI units)

Project Location

Toronto Lester B. Pearson Int, ON	Canada

Building Basic

Project Location WMO	716,280	
Climate Zone	6	
Building Type	Hospital	
Total Building Floor Area	148,144	m2
Building height	54	m
Number of Floors	9	
Ceiling Height	3	m
Window to Wall Ratio	25	%
Envelope Performance	ASHRAE 90.1-2019	
Infiltration	Airtight building	

Building Density

	Peak	Off-Peak	
Lighting	11.3	5.65	W/m2
Sensible Equipment	5.1	2.8	W/m2
Latent Equipment	5.41	1.78	W/m2
Average Occupancy	21	212	m2/person

Operational Schedule - Peak Hours

	SUNDAY	*MONDAY*	*TUESDAY*	*WEDNESDAY*	*THURSDAY*
Peak Begins	6:00:00 AM	6:00:00 AM	6:00:00 AM	6:00:00 AM	6:00:00 AM
Peak Ends	7:00:00 PM	7:00:00 PM	7:00:00 PM	7:00:00 PM	7:00:00 PM

Air System

HVAC Air Side Type	CV	
HVAC Cooling Type	Water-cooled chiller	
HVAC Heating Type	Gas Boiler	
Total Air Volume	1,764,904	m3/h
Outside Air %	70	%
Fan Efficiency	75	%
Preheat Energy Source	Natural Gas	
Preheat System COP	1	
Include Free Cooling?	TRUE	
Cooling System COP	3.3	

Building Setpoints

	Setpoint	Setback	
Cooling	22.22	27	C
Heating	22.22	18	C
Humidification	35	30	%
Dehumification	60	90	%

Adiabatic Opportunities

Case Study – Hospital in Toronto (retrofit)

Product Selection

Selection Type	Humidification

	Product 1	*Product 2*	*Product 3*
System Type	In-Duct	In-Duct	In-Duct
Technology	DL	GS	RS
Bypass Dampers	NO	NO	NO
Water Type	Reverse Osmosis	Potable	Potable
Water Efficiency	95	85	85
Initial Purchase			
Installation Cost			
One Time Cost			
Recurring Costs			
RO System	MLRO		
RO System Efficiency	70		
RO System Purchase			

Utility Rates

Electricity Rate	0.13	$/kWh
Electricity Demand Charge	5	$/kWh/month
Natural Gas Rate	0.034	$/kWh
Propane Rate	0.04	$/kWh
Central Steam Rate	0.017	$/kg
District Heating Rate	0.08	$/kWh
Water Rate	0.002	$/L
Sewer Rate	0.0018	$/L

Adiabatic Opportunities

Case Study – Hospital in Toronto (retrofit)

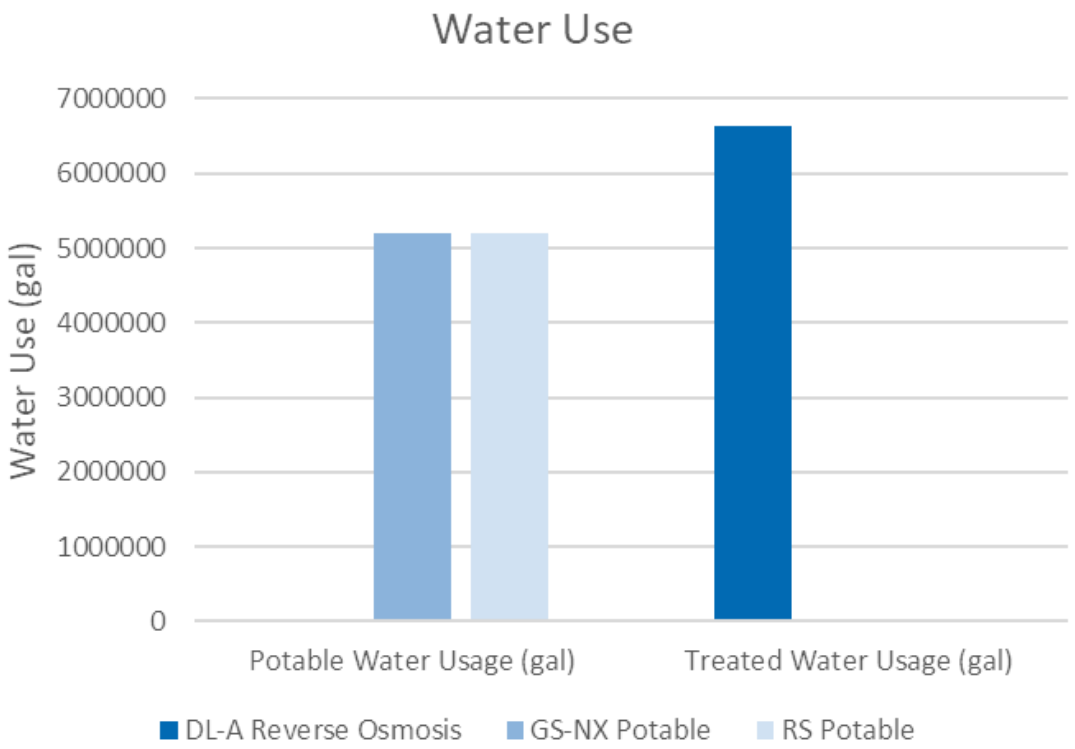
Annual Costs

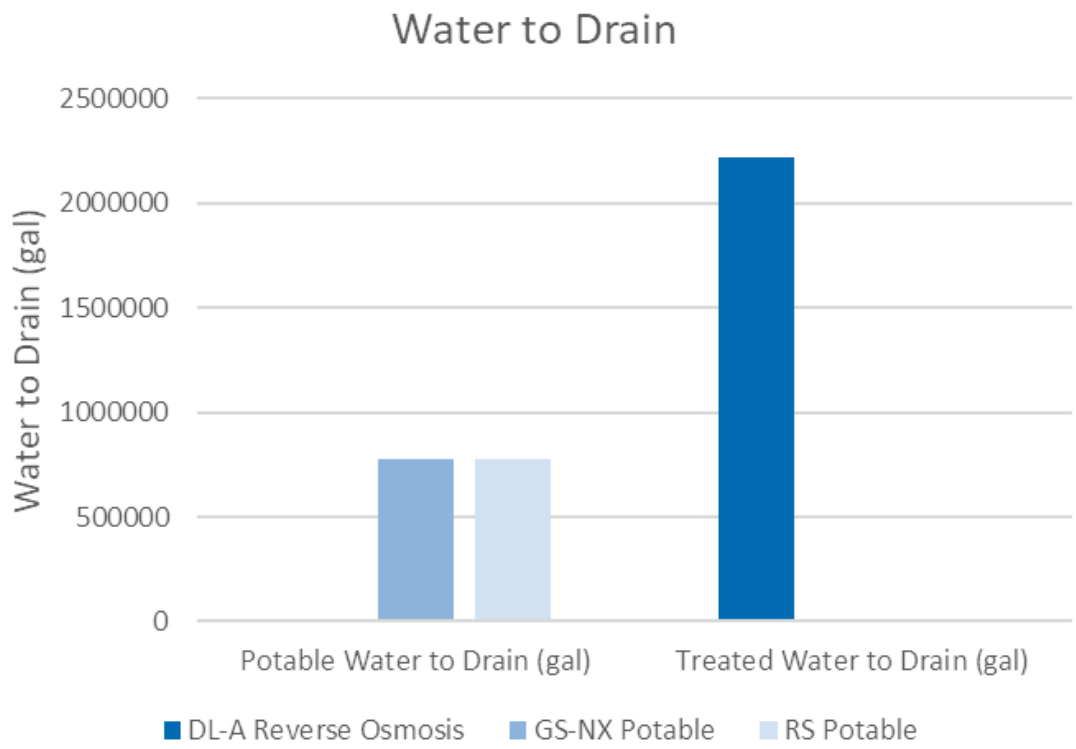
Cost Differences	vs. GS-NX	vs. RS
First Cost	$ -	$ -
Recuring Costs	$ -	$ -
Utility Costs	-$ 494,450	-$ 1,939,804
Estimated EOL Replacement	$ -	$ -

Energy Cost Analysis Summary			
Condair Model	DL-A	GS-NX	RS
Water Type	Reverse Osmosis	Potable	Potable
Equipment	$ -	$ -	$ -
Water Treatment	$ -	$ -	$ -
Installation Cost	$ -	$ -	$ -
First Cost	**$ -**	**$ -**	**$ -**
Recurring Costs	**$ -**	**$ -**	**$ -**
Total Electricity (kWH)	226,025	35,677	1,4751,231
Fan Energy due to ΔP (kWH)	183,182	18,318	18,318
Preheat Energy (kWH)		0	0
Electricity Cost ($)	**$ 30,611.71**	**$ 5,000.25**	**$ 1,991,052.47**
Beneficial cooling (KWH)	60,260		
Cooling Energy Savings ($)	**$ 2,374**		
Gas Usage (kWH)	150,300	15,902,879	0
Gas Preheat Energy (kWh)	150,300		
Natural Gas Cost ($)	**$ 5,110.21**	**$ 540,697.88**	**$ -**
Potable Water Usage (gal)	0	5,192,006	5,192,006
Treated Water Usage (gal)	6,636,399	0	0
Potable Water to Drain (gal)	0	778,801	778,801
Treated Water to Drain (gal)	2,223,194	0	0
Water Cost ($)	**$ 67,996.51**	**$ 52,470.16**	**$ 52,470.16**
Total Utility Cost	**$ 101,348.72**	**$ 598,168.29**	**$ 2,043,522.63**
Max. Humidification Load (lbs/hr)		8,374	
Annual Humidification Hours (h)		4,822	

Adiabatic Opportunities

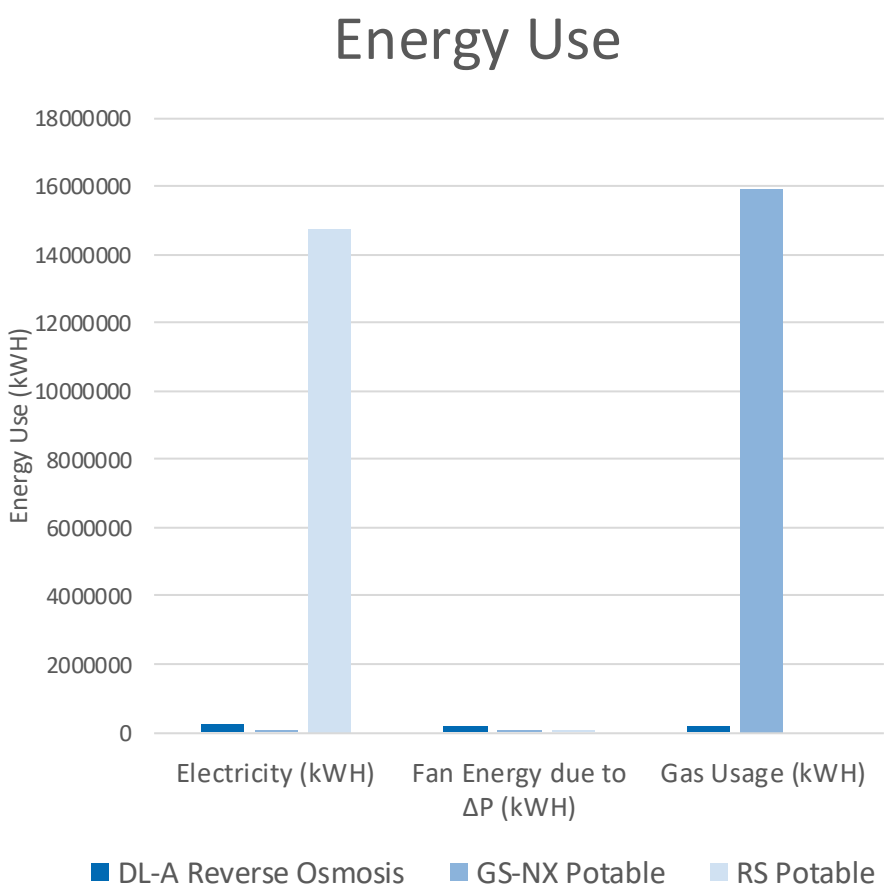
Case Study – Hospital in Toronto (retrofit)

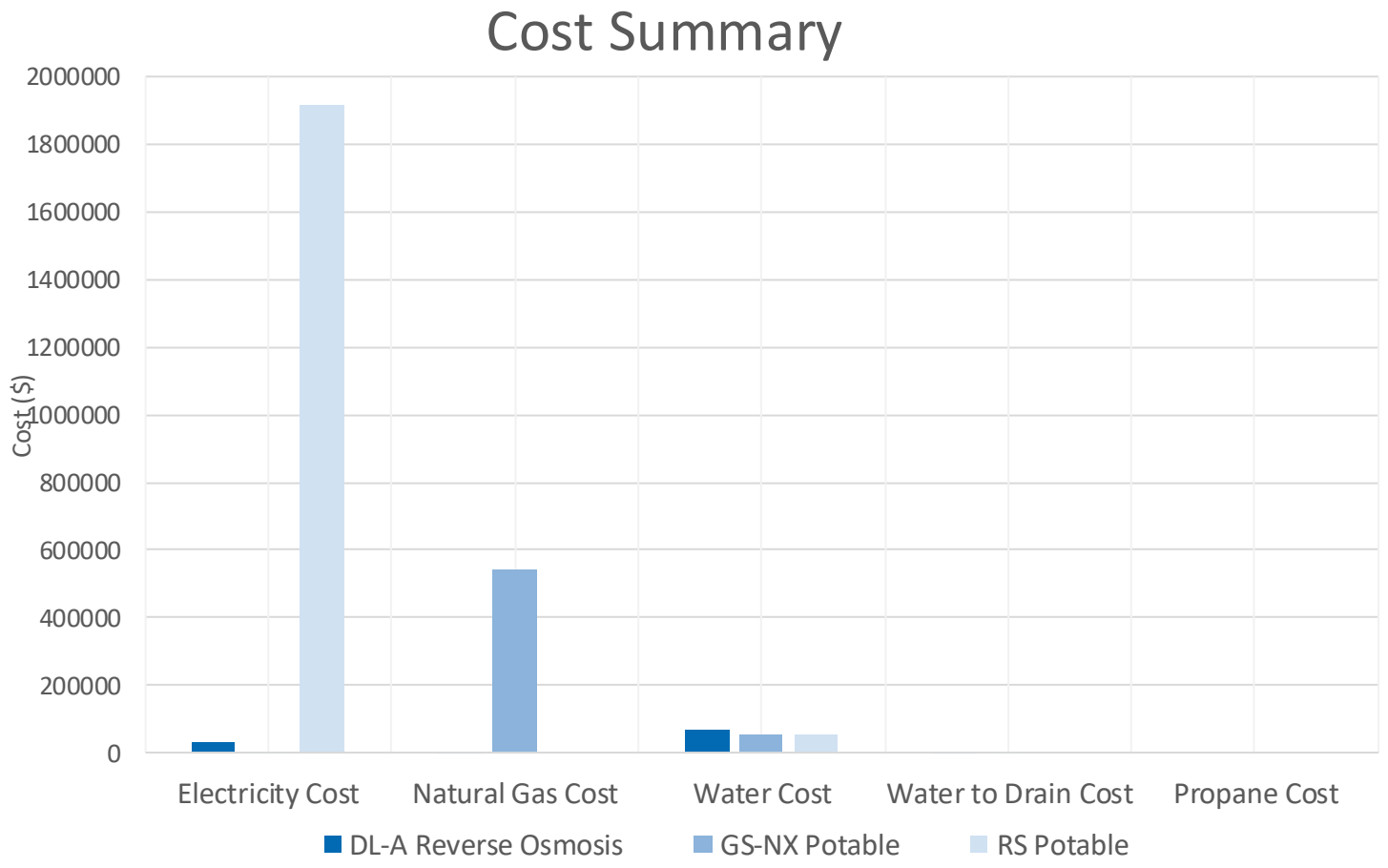




Adiabatic Opportunities

Case Study – Hospital in Toronto (retrofit)





Adiabatic Opportunities

Choosing the Right Product

Step 1: Application

Step 2: Load Sizing

Step 3: Water Quality

Step 4: Customer Requirements

Applications	Considerations
Healthcare (ex: Hospital, LTC)	• CSA • Hygiene • Maintenance • Energy Savings
Close-control (ex .Labs)	• High-accuracy controls/ operation • Sequencing • Water Treatment • Turndown • Temperature control
Reliability (ex. Manufacturing)	• Maintenance (less downtime) • Redundancy (ex. n+1)
Dust Suppression (ex. Woodworking)	• Dusting is fine • Ceiling Height
Occupant Health (ex. Schools, Offices)	• 40-60% • Accuracy is less critical • Pandemic: better understanding of science and healthy buildings

Adiabatic Opportunities

Adiabatic Retrofits: What to Consider

Load Sizing: ~250 lb/hr and up

Application: In duct or In Space, requirements

Water Quality: Issues and Availability

Energy Analysis: Adiabatic Cooling

Adiabatic Opportunities

Applications

				ISOTHERMAL (VAPORIZATION)					ADIABATIC & EVAPORATIVE				
APPLICATION	°C	°F	%RH	ELECTRODE STEAM	RESISTIVE STEAM	GAS FIRED STEAM	PRESURIZED STEAM	STEAM EXCHANGE	SURFACE EVAPORATIVE	ULTRASONIC	HYBRID	HIGH-PRESSURE NOZZLES	COMPRESSED AIR NOZZLES
Abrasive	26	79	50	■	■	■	■	■	■	■	■	■	■
Aerospace Manufacturing	21	70	50-55	■	■	■	■	■	■	■	■	■	■
Automotive Manufacturing	21	70	50-55	■	■	■	■	■	■	■	■	■	■
Bread	27	81	75	■	■					■	■	■	■
Call Centres	21	70	40-60	■	■	■	■	■	■	■	■	■	■
Ceramics	27	81	60-70	■	■	■	■	■	■	■	■	■	■
Cheese Curing	16-18	61-64	90							■	■	■	■
Clean Rooms	22-23	72-73	43-47	■	■	■			■	■	■	■	■
Data Centers (Class 1 and 2)	15-32	59-90	20-80	■	■				■	■	■		
Electrical (Instruments)	21	70	50-55	■	■	■	■	■	■	■	■	■	■
Electrical (X-ray)	20	68	40-50	■	■	■	■		■	■	■		
Electrical (Switch gear)	23	73	50	■	■				■	■	■		
Fruit Storage	4-7	39-45	85-90							■	■	■	■
Fur Storage	4-10	39-50	55-65	■	■	■		■		■	■	■	■
Greenhouses										■			
Hospitals (Admin.)	21-27	70-81	40-50	■	■	■	■	■	■	■	■		
Hospitals (ICU)	21-24	70-75	40-60	■	■	■	■	■		■	■		
Hospitals (Operating Rooms)	20-24	68-75	40-60	■	■	■	■	■		■	■		
Leather (Drying)	20-52	68-126	75	■	■	■	■	■		■	■	■	■
Leather (Storage)	10-16	50-61	40-60	■	■	■	■	■		■	■	■	■

Condair Product Catalog (p.8)

Adiabatic Opportunities

Applications

	Institutions			
	 Healthcare	 Educational	 Concert Halls	 Museums / Libraries
Benefits of Humidification	• Human Health/ Comfort • Static Protection	• Human Health/ Comfort • Static Protection	• Human Health/ Comfort • Preservation	• Human Health/ Comfort • Preservation
Load Sizing	• High	• High	• High	• High • Low (specialty items)
Control Accuracy*	• Mid (Patient/ general areas) • High (OR)	• Low (General Areas) • High (Lab)	• Low (General Areas) • Mid (Instrument storage)	• Low (General Areas) • High (specialty items)
Common Products	• DL (pending CSA Z317.2 update)	• DL, HP, ML, US, ME	• DL, HP	• DL, ML, HP, US, (RS)

Load Sizing: High (>1000lb/hr), Mid (250-1000lb/hr), Low (<250lb/hr) *Control Accuracy: High (±2%), Mid (±5%), Low (±10%)*

Adiabatic Opportunities

Applications

	Process/ Manufacturing			
	Pharmaceutical	Electronics	Laboratories	Clean Rooms
Benefits of Humidification	• Product Quality • Static Protection	• Product Quality • Static Protection	• Process Accuracy • Static Protection	• Process Accuracy
Load Sizing	• Mid/ High	• Mid/ High	• Mid/ High	• Low
Control Accuracy	• Mid	• Mid	• High	• High
Common Products	• DL, HP, ML, US	• DL, HP, ML, US	• DL, HP	• DL, US

Load Sizing: High (>1000lb/hr), Mid (250-1000lb/hr), Low (<250lb/hr) *Control Accuracy: High (±2%), Mid (±5%), Low (±10%)*

Adiabatic Opportunities

Applications

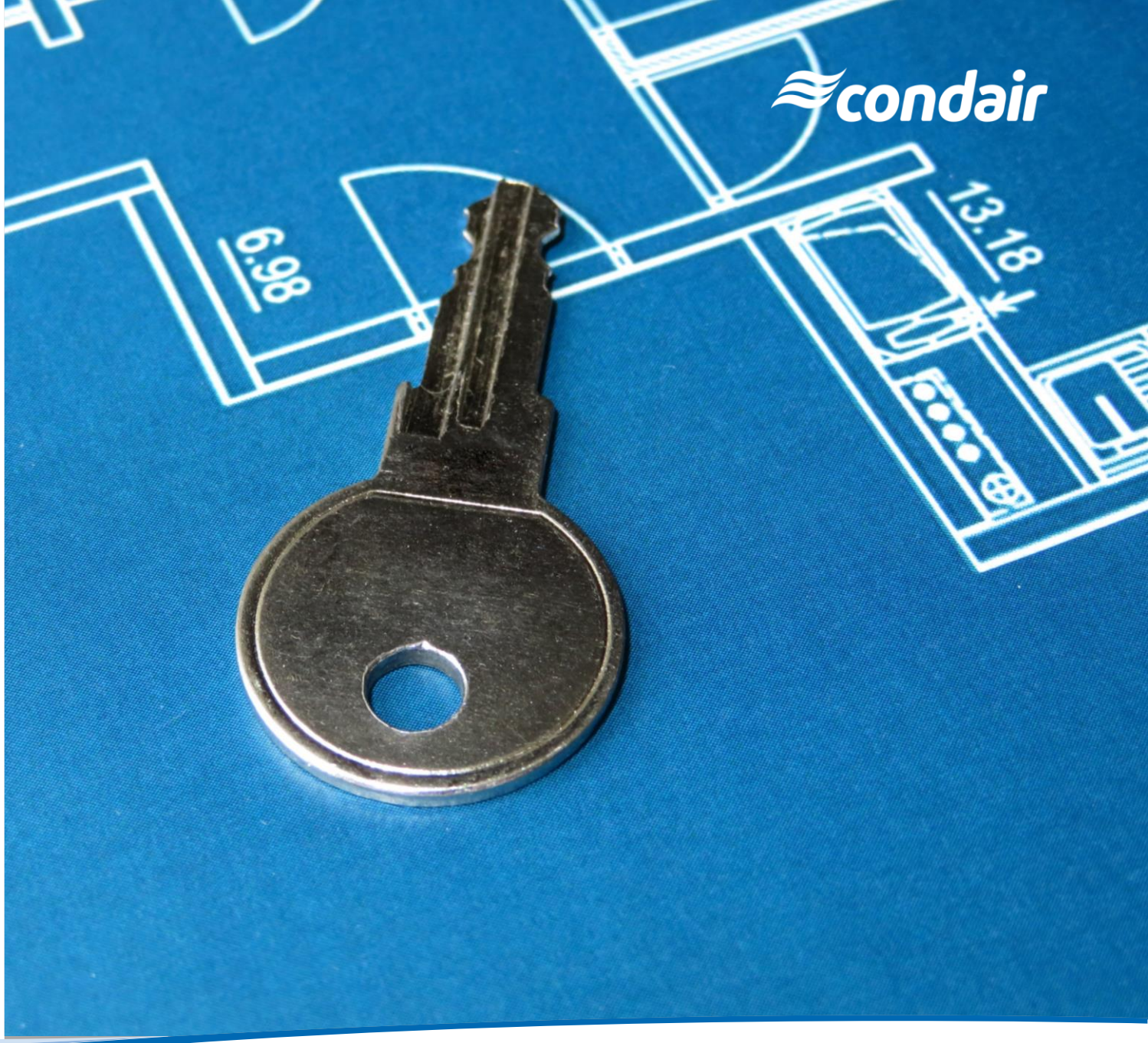
	Process/ Manufacturing			
	 Woodworking	 Paint Booth	 Printing	 Data Centers
Benefits of Humidification	• Dust Suppression	• Process Quality	• Process Quality • Static Protection	• Cooling • Static Protection
Load Sizing	• Mid	• Low/ Mid	• Mid/ High	• All
Control Accuracy	• Low	• Mid	• Mid	• Low
Common Products	• JS, ML	• HP, ML, JS	• HP, ML	• ME, US

Load Sizing: High (>1000lb/hr), Mid (250-1000lb/hr), Low (<250lb/hr) *Control Accuracy: High (±2%), Mid (±5%), Low (±10%)*

4

Key Takeaways

Q&A



Key Takeaways

Summary

Condair has a complete product portfolio

Adiabatic humidification provides energy efficient humidification and free cooling, reducing operational costs

Resources are available (Condair Help, Longhill, Condair.com, etc.)

Questions?

Humidity for a better life