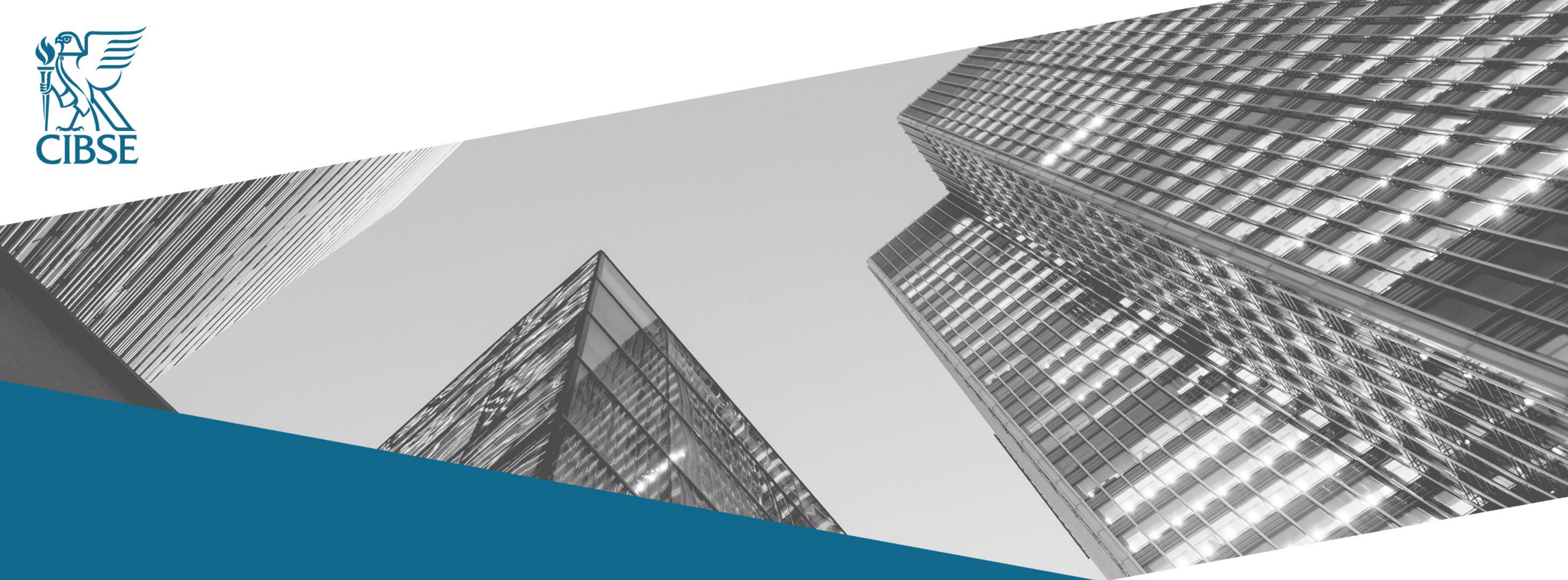


HUMIDITY CONTROL






















OUR TEAM

CIBSE

OUR MISSION

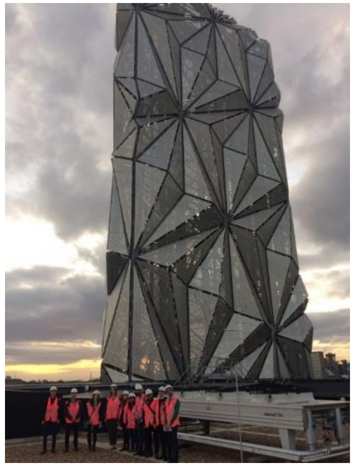
- To improve the energy performance of buildings and reduce their carbon footprint.

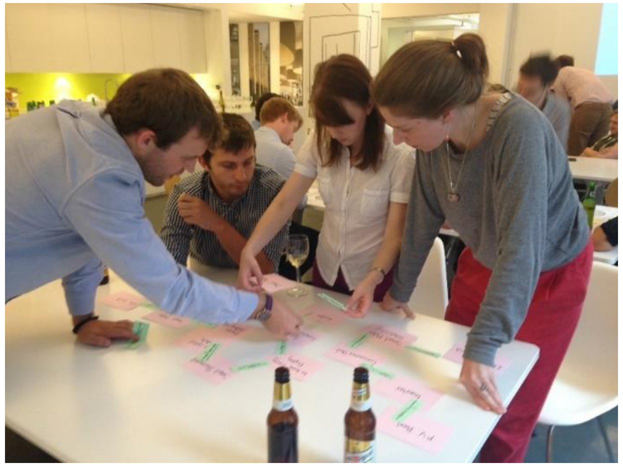
- To reach out to young professionals and those aspiring to join the industry, supporting them in their professional development.

- To provide a forum for discussion, enabling networking opportunities and promoting collaboration amongst members.

OUR EVENTS


Waste or resource
Habitats
Pollution
Meeting the CO2 challenge

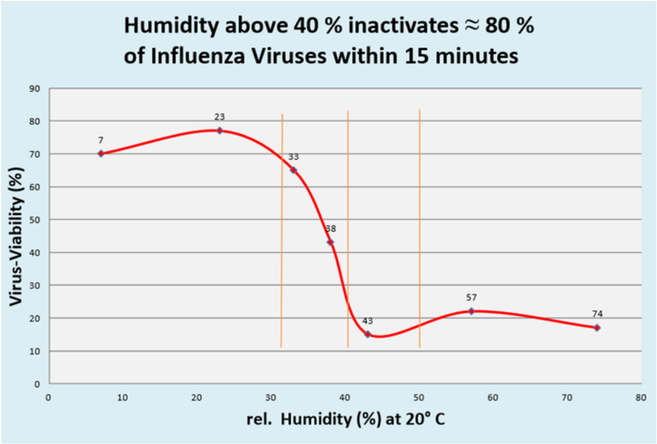


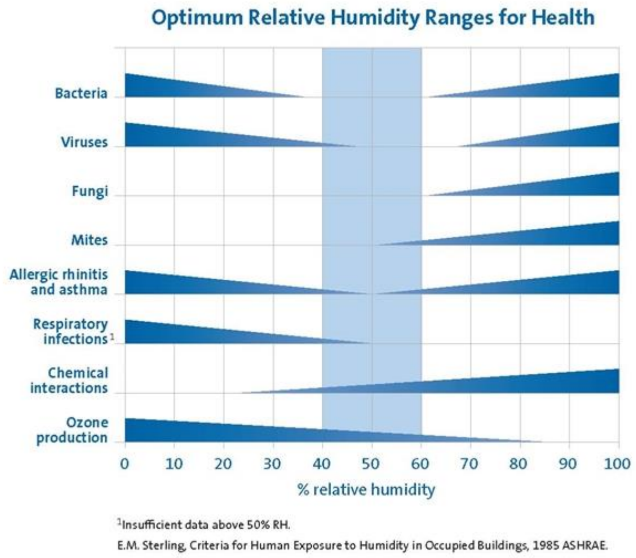



See
Hear
VISUAL COMFORT

Why?

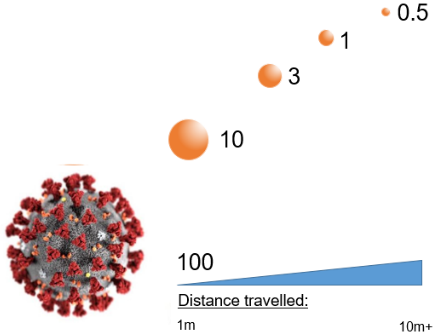
- Human Comfort (40-60%)
- COVID-19
- Valued Engineered out!
- Myths





Droplet diameter in microns (um)

Float time

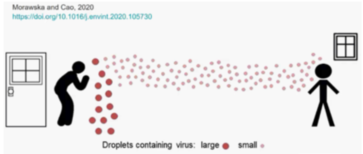


41 hours

1.5 hours

6 seconds

Dry air shrinks aerosolized droplets, promoting greater pathogen spread

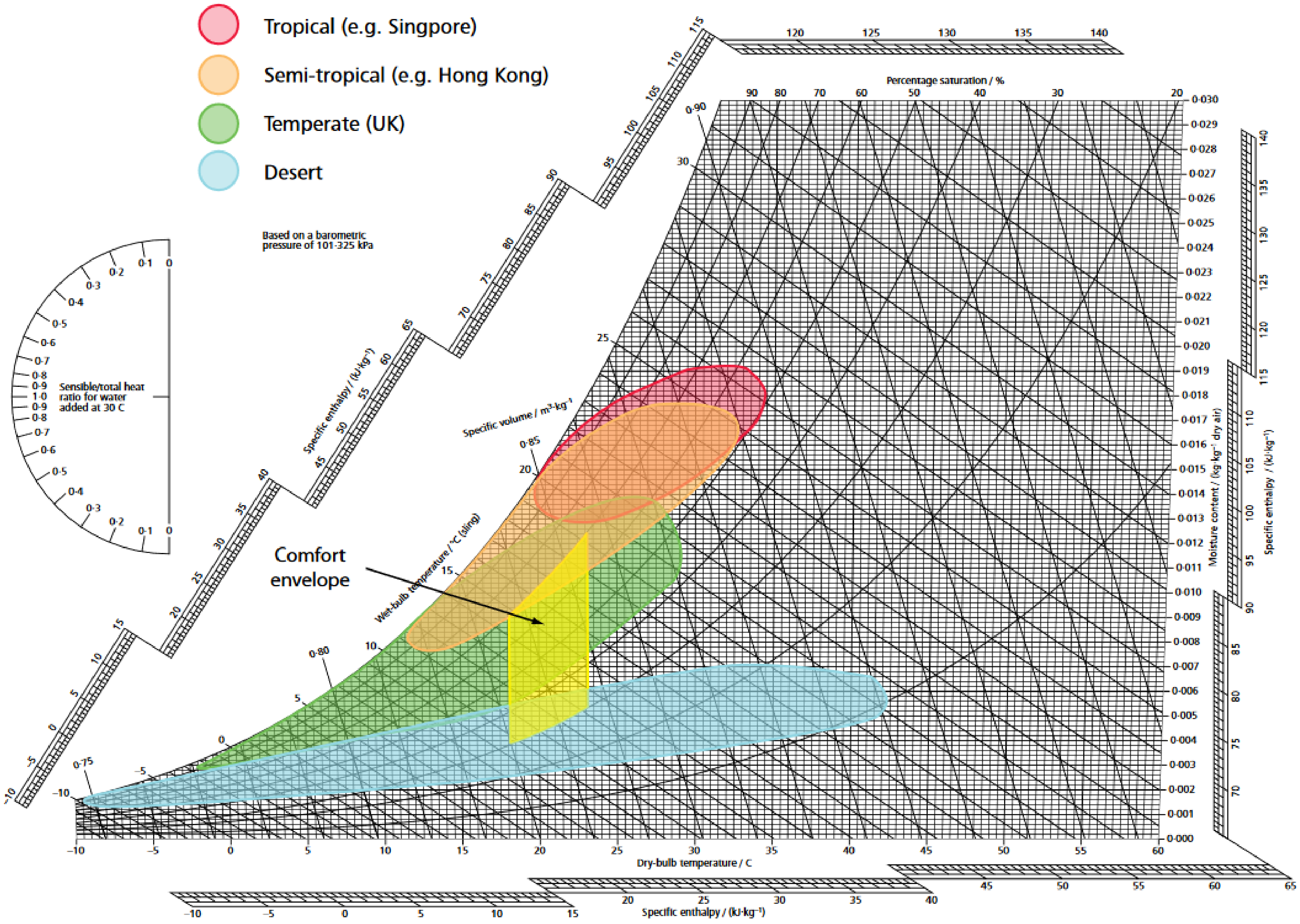


Moist air causes Droplets to settle quickly

Climates

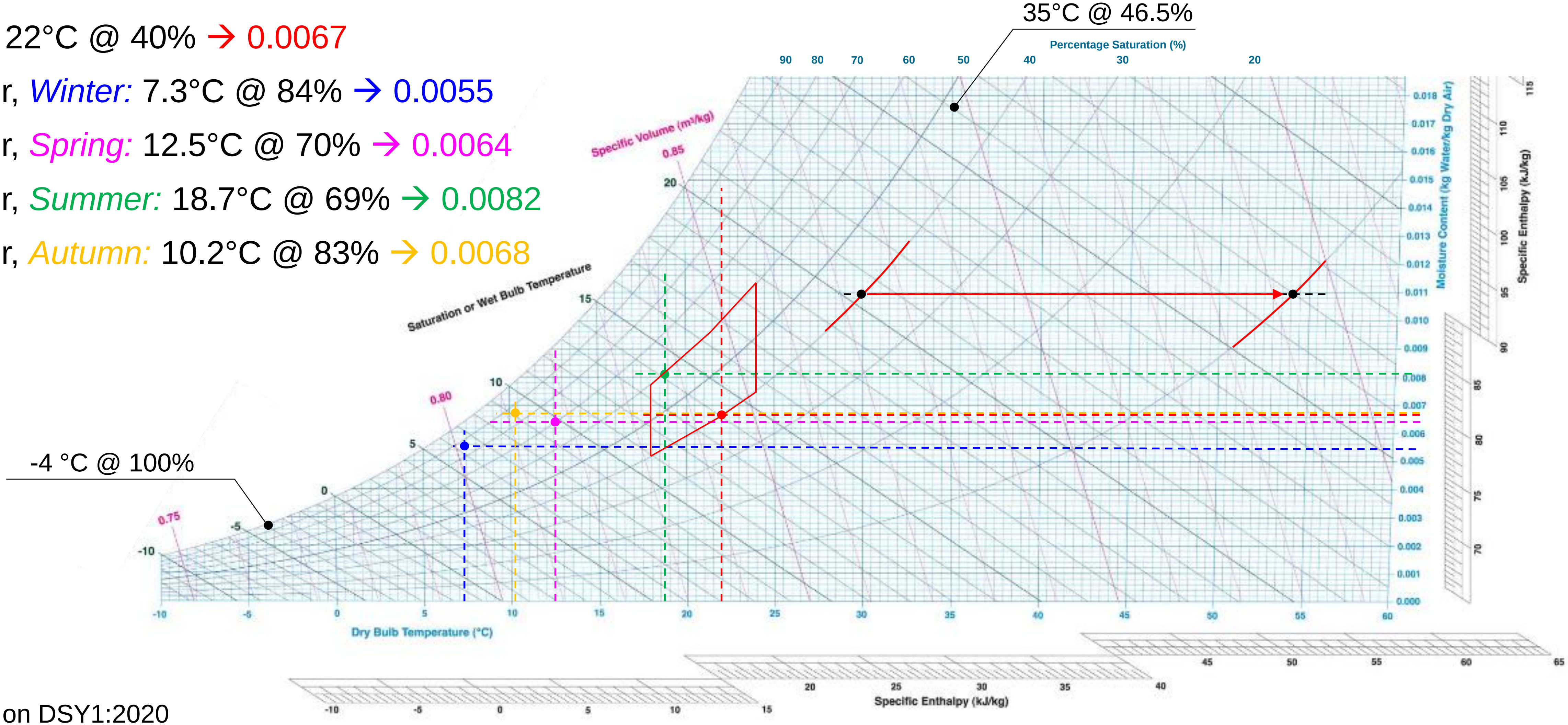
Source: *CIBSE KS20*

“Practical psychrometry“



The basics

- Indoor: 22°C @ 40% → 0.0067
- Outdoor, *Winter:* 7.3°C @ 84% → 0.0055
- Outdoor, *Spring:* 12.5°C @ 70% → 0.0064
- Outdoor, *Summer:* 18.7°C @ 69% → 0.0082
- Outdoor, *Autumn:* 10.2°C @ 83% → 0.0068



Data based on DSY1:2020

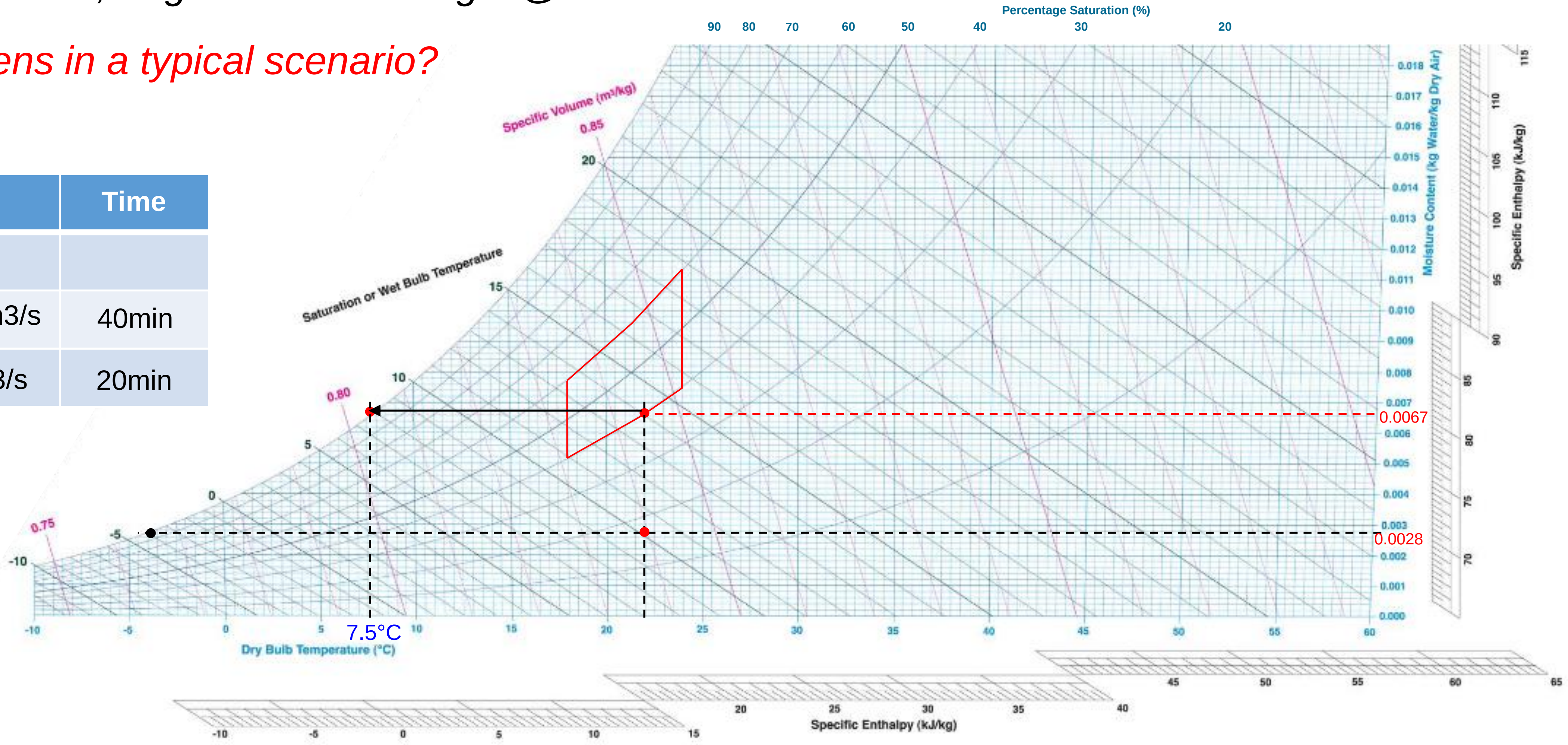
Example

Office: 1000m^2, 3m H, target Winter: 22degC @ 40% RH

Q1: What happens in a typical scenario?

	1:8	Time
No. of people	125	
10 l/s/p	1.25m3/s	40min
20 l/s/p	2.5m3/s	20min

24% of the year



Example

Office: 1000m², 3m H, target Winter: 22degC @ 40% RH

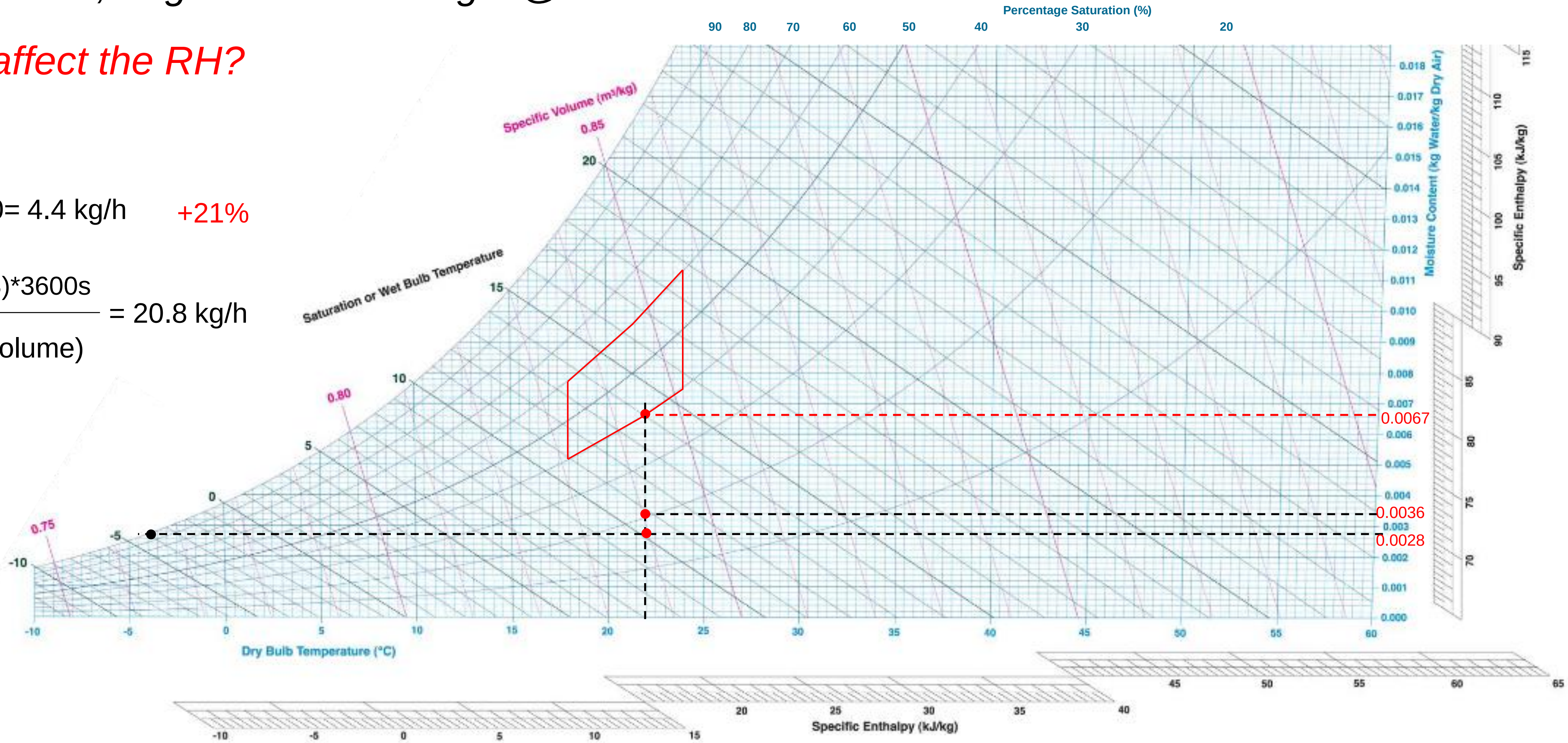
Q2: Do people affect the RH?

35 g/p/h * 125ppl /1000= 4.4 kg/h

+21%

$$\frac{1.25\text{m3/s}*(0.0067-0.0028)*3600\text{s}}{0.845\text{m3/kg (specific volume)}} = 20.8\text{ kg/h}$$

MINOR IMPACT



Considerations

- COVID: Higher flow rates → Higher energy demand
- Climate change → Drier lands
- Refurbishments → Cold Bridges, Ventilation
- Centralised vs Decentralised → RH = f (T)

Agenda

- Passive Humidity Control Measures: David Black

  (Global Product Marketing Manager FlaktGroup, CIBSE HVAC Group)

- Active Humidity Control Measures: *Dave Marshall-George*

  (UK and Ireland Sales Director, Condair)

- Q&A

CIBSE FläktGroup

Passive Moisture Exchange in AHUs

FLÄKTGROUP – KEY FACTS

€630M	FLÄKTGROUP TURNOVER *
3600	EMPLOYEES
170	DEDICATED R&D EXPERTS
65	COUNTRIES SERVED WORLDWIDE
16	MANUFACTURING SITES
9	CENTRES OF EXCELLENCE

*BASED ON TURNOVER 2018

David Black - Global Product Marketing Manager for Modular Air Handling Units

I’ve worked in the HVAC sector since 1986 for English, German and Swedish AHU manufacturers.

I am a CIBSE HVAC Group committee member and contributed material for the CIBSE Covid 19 ventilation guidance.

CIBSE

Passive Moisture Control – Summer Benefits

There are three types of Thermal Wheels

Condensation wheel – better known in the UK as a sensible only thermal wheel

- Consists of smooth, untreated aluminium.
- Humidity efficiency is very low in UK design conditions.
- The use of these wheels is recommended primarily for ventilation systems without mechanical cooling.

Enthalpy wheel – better known in the UK as a hygroscopic wheel

- Consists of a material treated to form a capillary surface structure which captures moisture.
- The humidity is transmitted by sorption and condensation, with the sorption component being very low.
- Moisture transfer efficiency typically 50% in UK design conditions. Recommended for systems with mechanical cooling.

Sorption wheel – often (incorrectly) described as dessicant

- Consists of a surface that has pores which allow the capture of water vapour molecules but very little else.
- Moisture transfer efficiency >80%. In summer conditions de-humidifies the fresh air supply.
- Particularly recommended for systems with mechanical cooling as the demand load is significantly reduced. Has health benefits in recovering moisture in winter

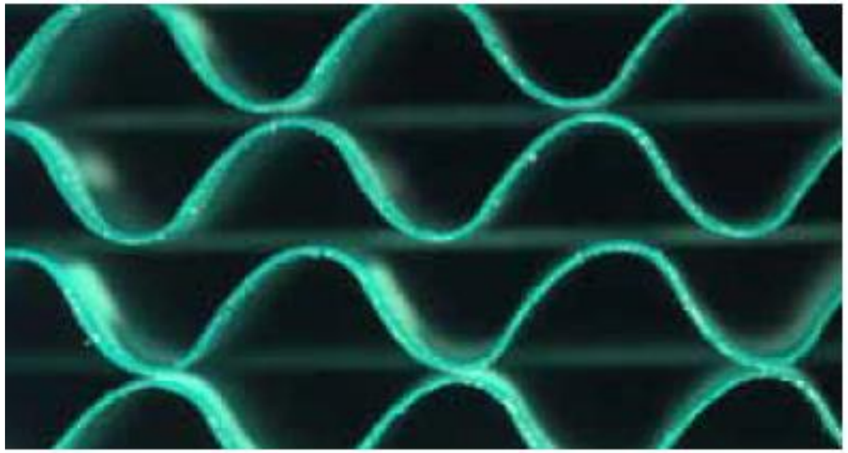
Source: Hoval guide to rotors

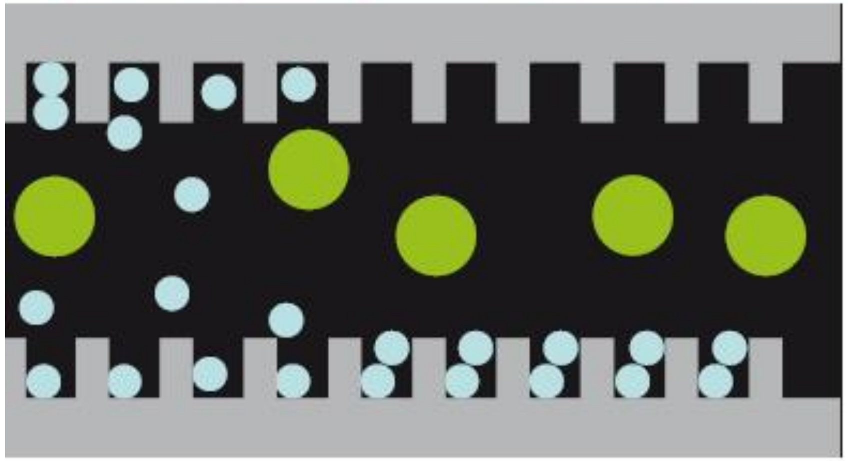
How Sorption rotors recover moisture

- **Hygiene**

A 4Å molecular sieve has the unique ability to limit adsorption to particles that are smaller than around 4 Angstrom.

Because water vapour has a kinetic diameter of 2.65 Angstrom it is strongly attracted to a 4Å transfer media.





Practically all substances that are regarded as contaminants in the air handling context are larger than 4 Angstrom, which means that they pass through the heat exchanger and are carried away with the exhaust air.

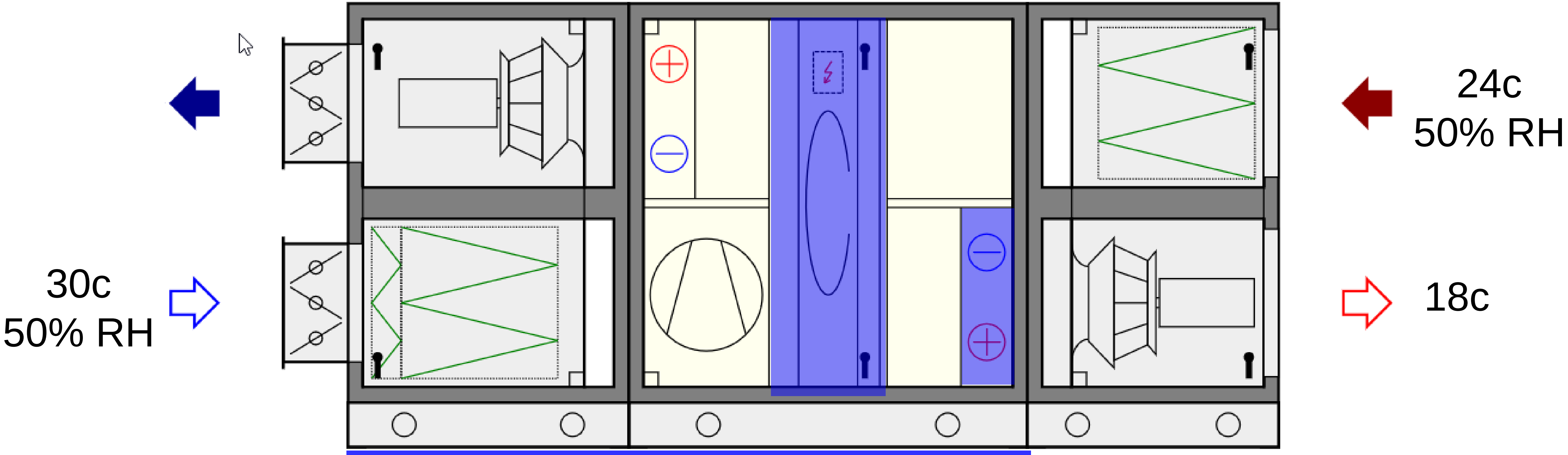
ENERGY EFFICIENCY GUARANTEED

The energy performance data is taken from a EUROVENT certified AHU selection program.

The following are guaranteed;

- Temperature efficiency and pressure drop of the heat recovery
- Air velocity in the internal cross section
- Absorbed electric power of the fan motors

Summer coil demand load: Fan Coil System per m3/s



No cooling recovery 23.7 kW

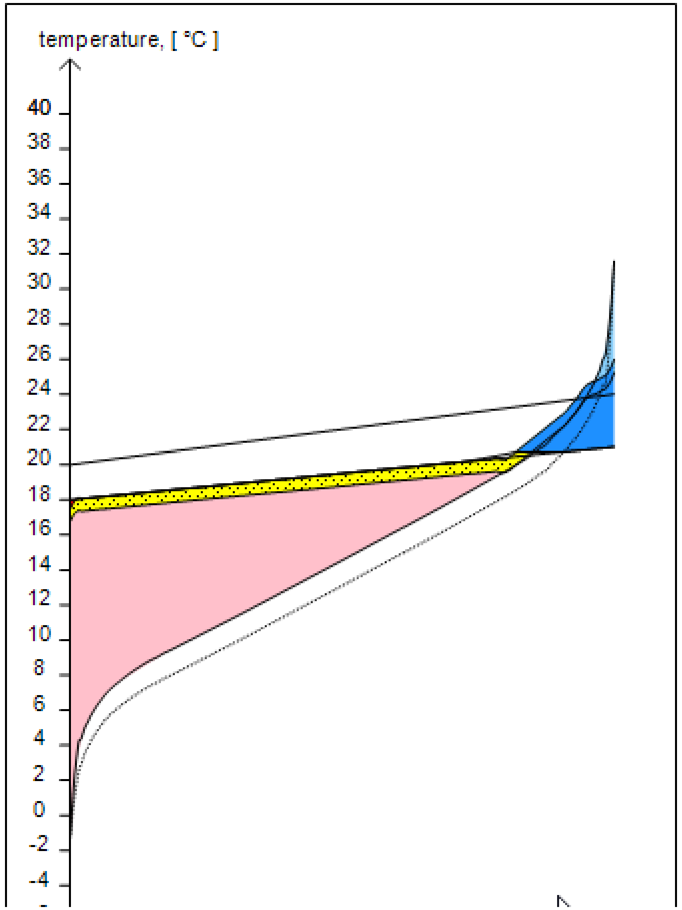
Sensible cooling recovery 16.8 kW air on to coil 25 -29%

With Latent cooling recovery 12.6 kW air on to coil 25 -47%

Sorption cooling recovery 10.3 kW air on to coil 25 -57%

What is optimal efficiency? Energy diagram-London 84.8%

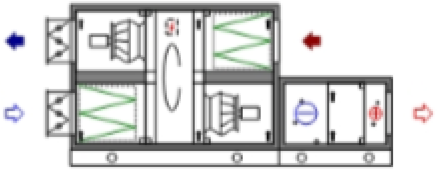
Annual energy efficiency		
Annual energy efficiency	99.9	%
Annual energy recovery		
Heat recovery	17364	kWh
Cooling recovery	360	kWh
Temp. rise in supply air fan	2192	kWh
Annual additional energy		
Heating	11	kWh
Cooling	1645	kWh
Supply air fan	2742	kWh
Exhaust air fan	2802	kWh
Other Equipment	142	kWh



ENERGY CALCULATION

Air handling unit

Dimensioning data	
Unit type & Size	eQ Prime - 011
Supply air	1.00 m³/sec
Exhaust air	1.00 m³/sec
Heat recovery	RHE, Semco
SFPv	1.62 kW/(m³/s)
Efficiency, EN308	84.8 %
Heating	7.28 kW
Cooling	7.39 kW
Supply air fan	0.914 kW
Exhaust air fan	0.958 kW



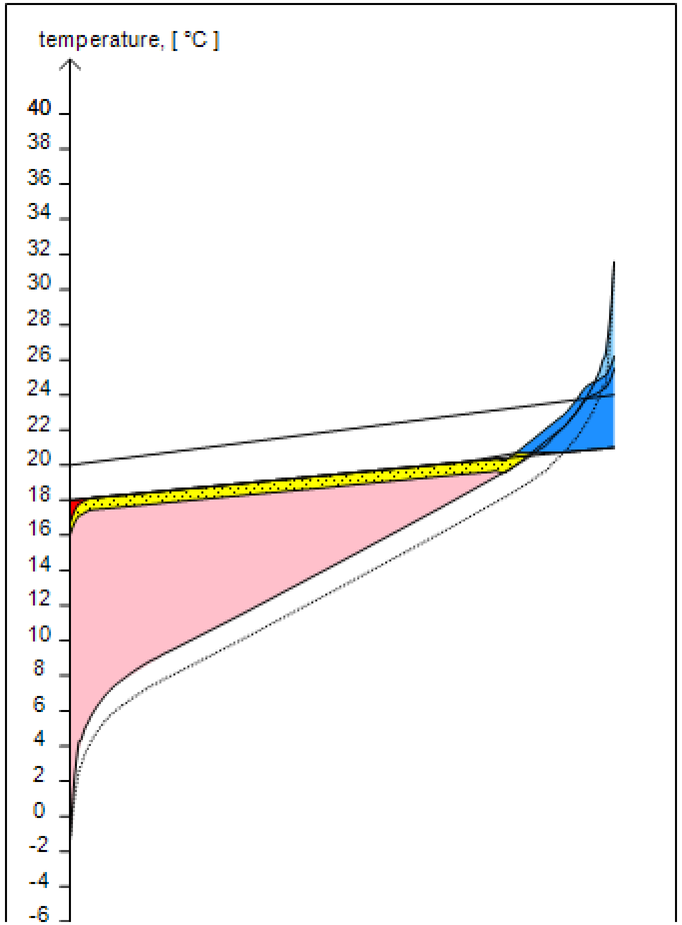
Result

Annual energy recovery	**Energy recovery**
Annual energy efficiency	100 %
Heat recovery	17364 kWh
Temp. rise in supply air fan	2192 kWh
Cooling recovery	360 kWh
Total	19916 kWh

Annual additional energy	**Energy demand**
Heating	11 kWh
Cooling	1645 kWh
Supply air fan	2742 kWh
Exhaust air fan	2802 kWh
Other Equipment	142 kWh
Total	7342 kWh

What is optimal efficiency? Energy diagram-London 81.3%

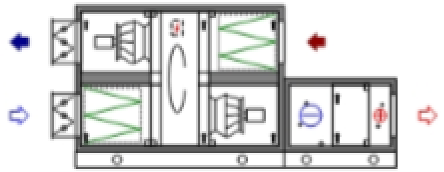
Annual energy efficiency		
Annual energy efficiency	99.7	%
Annual energy recovery		
Heat recovery	17407	kWh
Cooling recovery	348	kWh
Temp. rise in supply air fan	2102	kWh
Annual additional energy		
Heating	55	kWh
Cooling	1642	kWh
Supply air fan	2627	kWh
Exhaust air fan	2673	kWh
Other Equipment	142	kWh



ENERGY CALCULATION

Air handling unit

Dimensioning data	
Unit type & Size	eQ Prime - 011
Supply air	1.00 m³/sec
Exhaust air	1.00 m³/sec
Heat recovery	RHE, Semco
SFPv	1.54 kW/(m³/s)
Efficiency, EN308	81.3 %
Heating	7.28 kW
Cooling	7.39 kW
Supply air fan	0.875 kW
Exhaust air fan	0.907 kW



Result

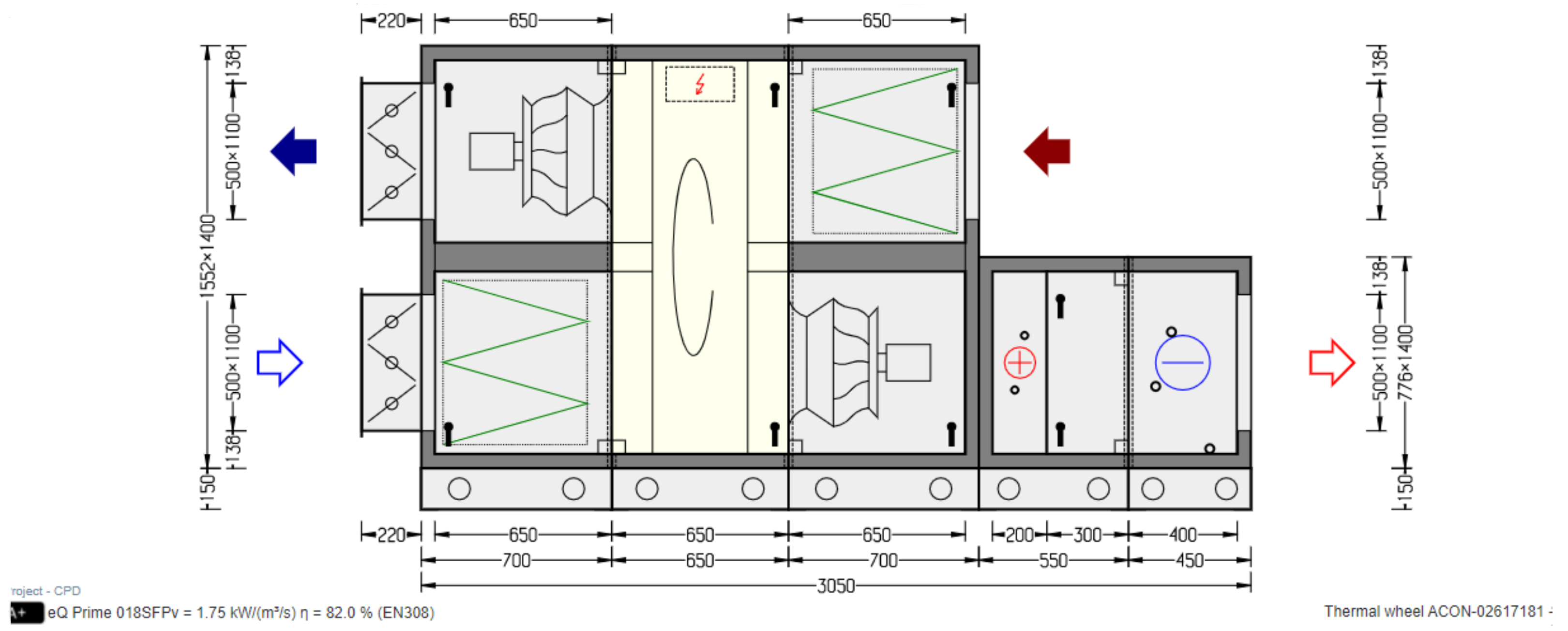
Annual energy recovery	**Energy recovery**
Annual energy efficiency	100 %
Heat recovery	17407 kWh
Temp. rise in supply air fan	2102 kWh
Cooling recovery	348 kWh
Total	19857 kWh

Annual additional energy	**Energy demand**
Heating	55 kWh
Cooling	1642 kWh
Supply air fan	2627 kWh
Exhaust air fan	2673 kWh
Other Equipment	142 kWh
Total	7139 kWh

What is optimal efficiency? Comparison summary

Efficiency	81.3%	84.8%
Extra Heat	55 kWh	11 kWh
Extra Cooling	1642 kWh	1645 kWh
Supply Fan	2627 kWh	2742 kWh
Exhaust Fan	2673 kWh	2802 kWh
Total	**6997 kWh**	**7200 kWh**

What is optimal configuration?



SFPv	Price Index	Description
1.62	100	ErP compliant plate
1.63	114	Counterflow plate
1.57	115	IE4 fan & motor
1.53	105	IE5 fan & motor
1.64	77	Thermal wheel unit
1.60	73	Omit frost coil
1.54	72	Omit pre filter
1.52	71	Heater for demand load
1.54	71	Change to Sorption rotor
1.53	69	Cooler for demand load
1.48	70	Optimal fan selection
1.75	61	Smaller unit

All units are the same height & width

Latent plate

Polybloc are a swiss based manufacturer

Transfers heat and humidity - tight against germs and smells

During the winter months we spend about 90% of our time inside buildings. Dry throats, stinging eyes and dry skin are often the uncomfortable results of arid, heated winter air.

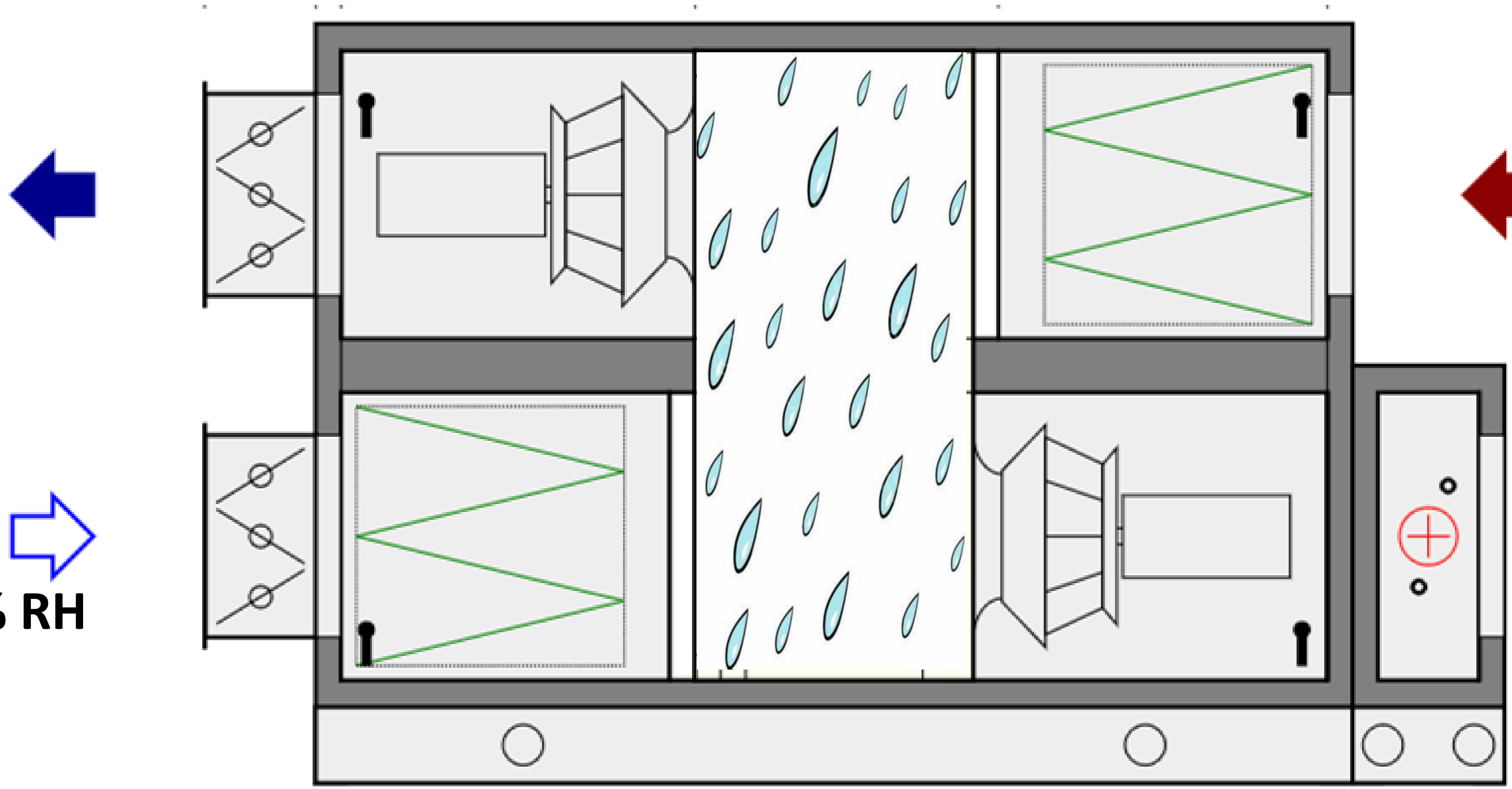
These symptoms can be eliminated by using the Vapobloc from POLYBLOC as cross- and counter-flow pleat heat exchanger. This specially designed energy exchanger transfers the heat and humidity from the return air to the supply air but leaves out smells, spores and bacteria. Vapobloc is ideal for sensitive areas such as hospitals, schools, residential homes and apartment houses.

Polybloc sensible & latent efficiency

	Low efficiency - greater airflow *								
Model	Airflow		Max width without bypass (mm)	Dry effeiciency (supply side) Winter	Dry effeiciency (supply side) Summer	Dry effeiciency (Exhaust side)	Pressure drop (std conditions)	Latent efficiency (%) Winter	Latent efficiency (%) Summer
eQ-005	0.45	1620 m3/h	540	74.00%	74.50%		207Pa	61.20%	54.50%
eQ-008	0.78	2790 m3/h	790	74.50%	75.00%		206 Pa	62.10%	55.20%
eQ-011	1.20	3500 m3/h	890	75.10%	75.50%		200 Pa	63.30%	56.30%
eQ-014	1.30	3400 m3/h	790	74.60%	75.00%		199 Pa	61.70%	56.60%
eQ-018	1.75	4100 m3/h	1040	74.40%	74.80%		199Pa	61.70%	56.60%
eQ-023	2.20	6700 m3/h	1340	75.20%	75.70%		203 Pa	62.80%	56.10%
eQ-032	3.10	8000 m3/h	1390	75.80%	76.20%		203 Pa	63.90%	57.20%
eQ-041	3.90	9300 m3/h	1590	75.90%	76.30%		201 Pa	64.10%	57.40%
eQ-050	4.80	11600 m3/h	1840	76.30%	76.60%		201 Pa	64.70%	58.10%
eQ-063	6.10	12700 m3/h	2000	76.20%	76.60%		200 Pa	67.80%	58.10%
eQ-072	7.00	14300 m3/h	2230	76.10%	76.50%		200.00	64.80%	58.10%

Health benefits of moisture transfer in Winter

Sorption rotor moisture recovery



20c
40% RH

-5c
99% RH

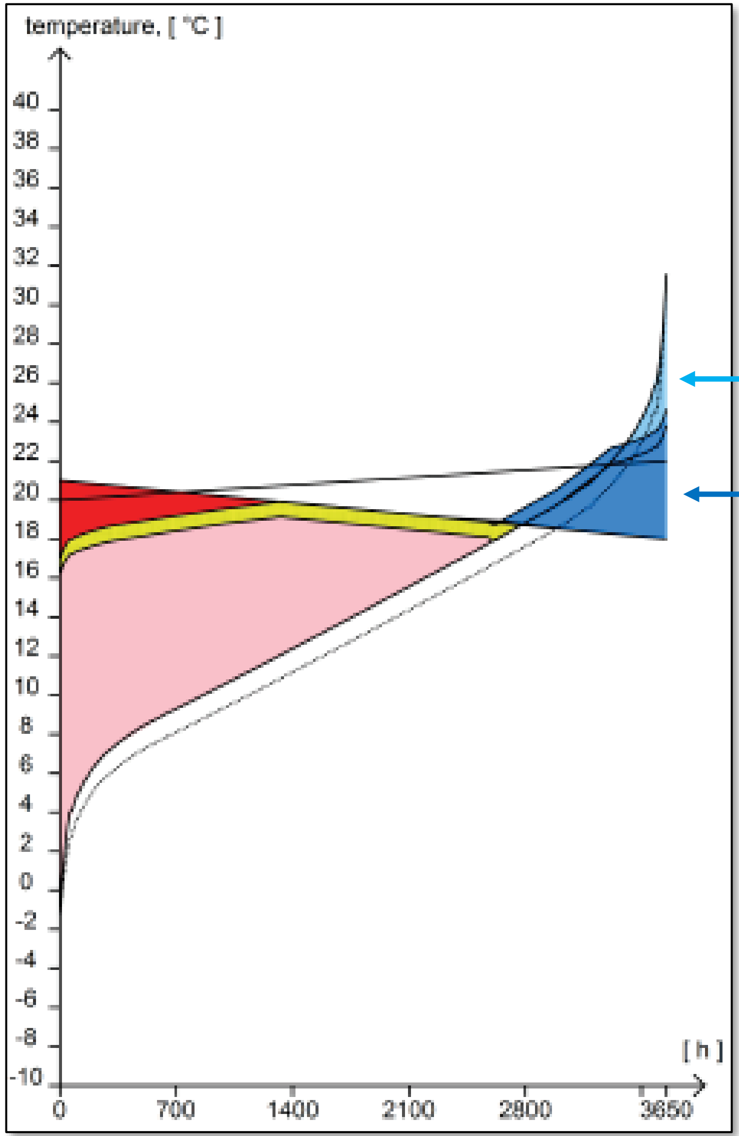
Moisture recovery
19c, 39.3% RH

The risk of influenza incidence was significantly increased with low (30%–40%) relative humidity. RH > 40% greatly reduces the infectivity of virus

Source: Effects of temperature, humidity, and diurnal temperature range on influenza incidence in a temperate region.Ji-Eun Park et al. 13th September 2019

Enthalpy Control for Sorption rotors

Cooling Recover- Typical chart for London



Cooling recovery

Cooling Load

Coil load effect with cooling Recovery – Supply air 18c

	Off rotor	Coil load	Coil cost	Annual Cooling recovered
No Cooling recovery	30c / 50%	23.7 kW	846 €	0
Sensible cooling recovery	23.5 / 73.2%	12.6 kW	682 €	906 kWh
Sorption cooling recovery	23.5 /53.9%	10.3 kW	624 €	1887 kWh

1 m3/s
30/50% External, 24/50% return
Supply temperature 18c

rotor – 82.3%
Operating 5 days a week, 14 hours a day

Enthalpy control

We have a function that optimises additional cooling recovery based on enthalpy.

We can run the rotor even if the **external temperature** is **lower** than the **extract** temperature.

If the **external *humidity* is high** – as it often is in summer – removing moisture from the fresh air in can reduce the **load on the cooling coil**.

Our controller regulates the rotor based on when there is a cooling demand and the extract air enthalpy is 2kJ/kg lower than the outdoor air enthalpy, the rotor is started at maximum capacity for cooling recovery

Sample calculation based on 1 m3/s – AHU has to deliver air @ 18c

External Temp	Relative humidity	Enthalpy kJ/kg	Off rotor condition	Cooling recovery	Enthalpy recovery	Coil load 18c supply	Off coil humidity
23.5	75	58.3	23.5/75%	No	-	14.1 kW	89.1%

Internal Temp	Relative humidity	Enthalpy kJ/kg	Off rotor condition	Cooling recovery	Enthalpy recovery	Coil load 18c supply	Off coil humidity
24.5	40	44.1	24.3/48.6%	No	Yes	8.04 kW	70.9%

Internal Temp	Relative humidity	Enthalpy kJ/kg	Off rotor condition	Cooling recovery	Enthalpy recovery	Coil load 18c supply	Off coil humidity
26.0	40	47.5	25.6/47.9%	No	Yes	10.1 kW	74.4%

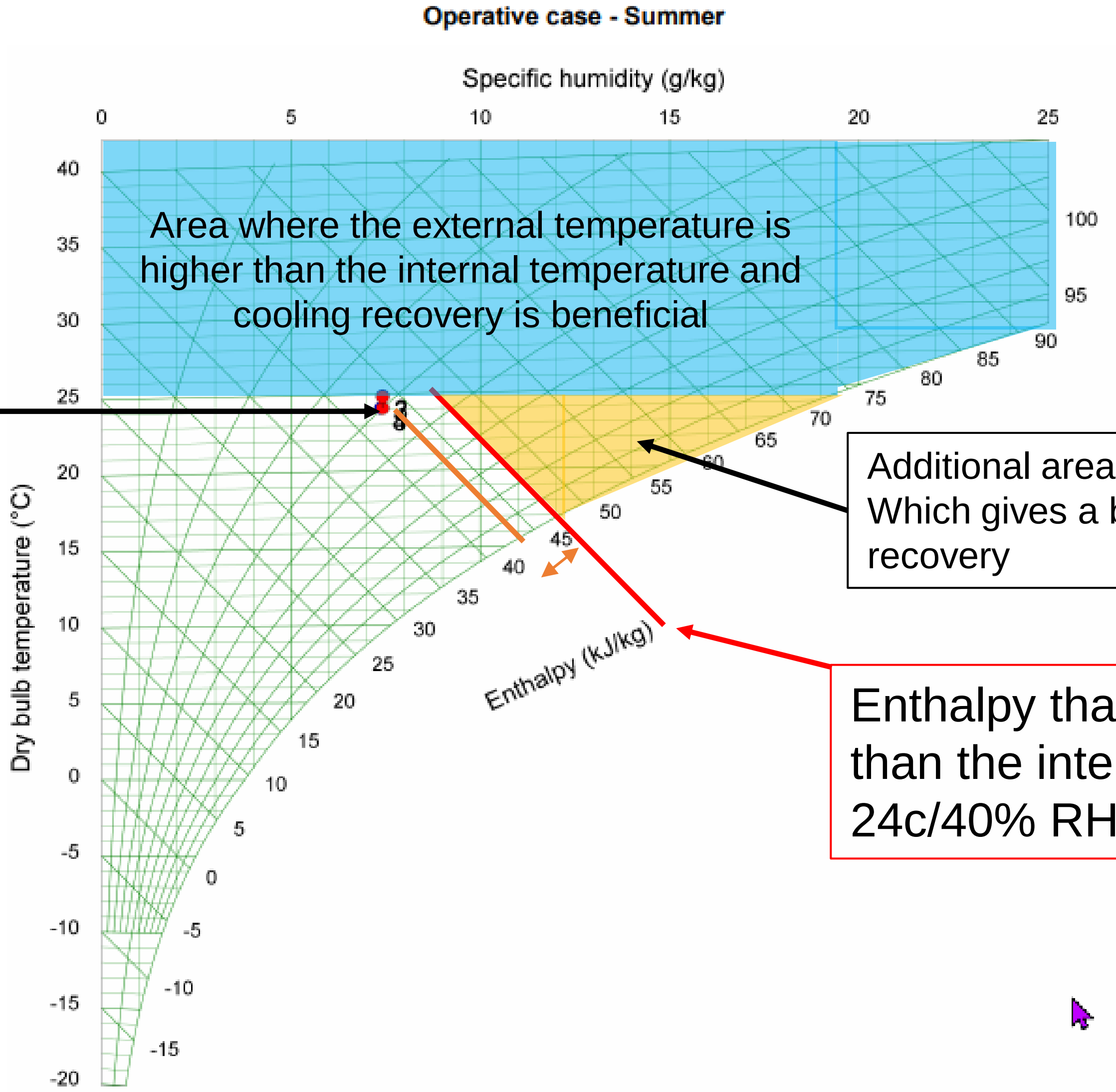
Internal Temp	Relative humidity	Enthalpy kJ/kg	Off rotor condition	Cooling recovery	Enthalpy recovery	Coil load 18c supply	Off coil humidity
27.0	40	51.5	26.5/42.7%	No	Yes	12.3 kW	72.4%

External Temp	Relative humidity	Enthalpy kJ/kg
24.0	65	55.0

External Temp	Relative humidity	Enthalpy kJ/kg
24.5	60	54.0

Consider an internal condition of 24c/40% RH

Exhaust air volume flow rate Number		Dry bulb temperature (°C)	Relative humidity (%)	Specific humidity (g/kg)
1	Exhaust air	24.0	40.0	7.4



Additional area of external conditions Which gives a benefit for enthalpy recovery

Enthalpy that is 2 kJ/kg more than the internal condition of 24c/40% RH

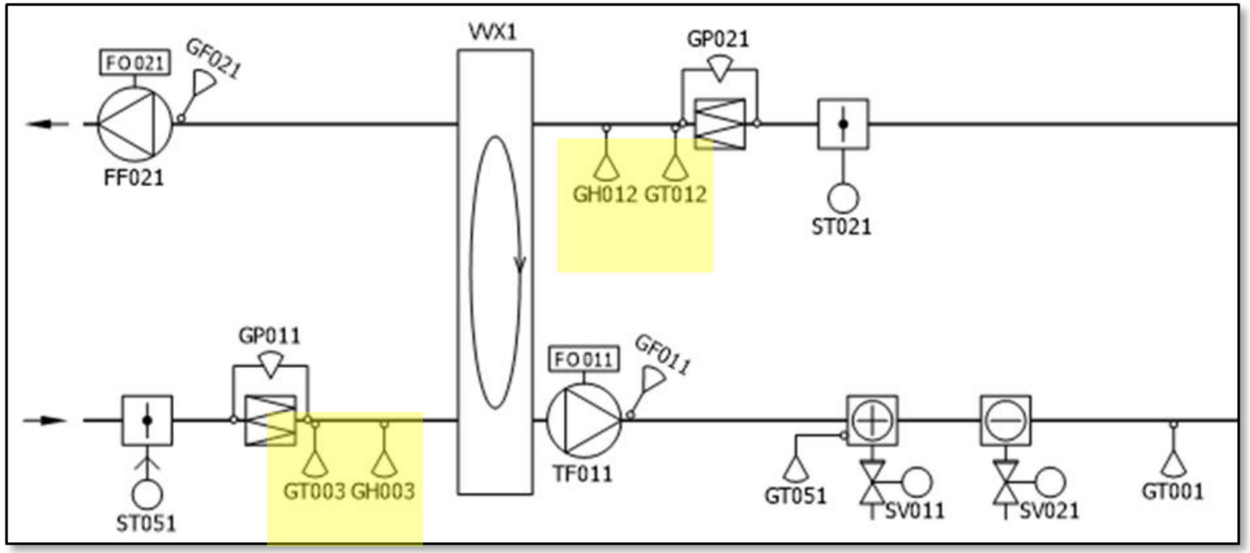
Enthalpy control – How to select

To select this function you need to select a RegAsorp wheel and select cooling recovery.

ACON then adds the necessary temperature and humidity sensors.

Modbus Humidity/Temperature sensor, outdoor air	GH003/GT003	FTK140 MODBUS	MoF
Modbus differential pressure sensor, filter exhaust air	GP021	SE2:QBM70.7000TNFW	MoF
Modbus Humidity/Temperature sensor, exhaust air main zone	GH012/GT012	FTK140 MODBUS	MoF

MoF = Factory installed and connected

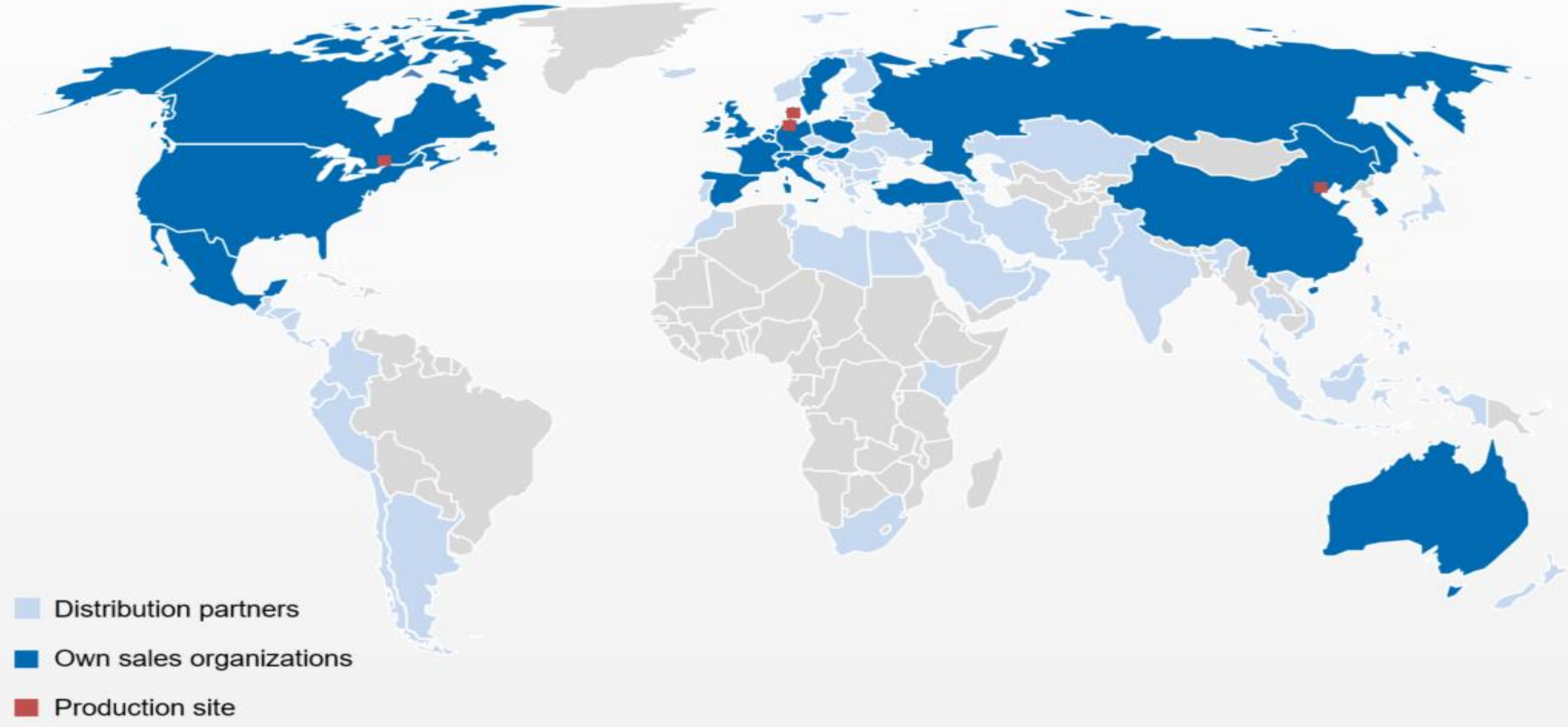


Summary

- Sorption rotors have benefits in both summer and winter
- Use sorption rotors to reduce cooling coil load
- Ensure that the rotor efficiency is optimised
- Consider sizing the cooling coil based on demand load
- Latent recovery plates are available on the market
- Enthalpy control extends the envelope of reduced cooling coil load

HUMIDIFICATION ACTIVE MEASURES

Condair Limited
Presenter Dave Marshall-George



condair

CIBSE

Humidifier active measures

Benefits
Low capital costs
High steam outputs
Simple and quick to maintain

Considerations
High energy consumption
High maintenance commitment
High spares consumption
Potential use of renewable energy

Typical control
±10%RH

Electrode boiler humidifiers

CIBSE

Resistive humidifiers

Benefits

Close control
Low spares commitment
Any water quality compatible

Considerations

High steam outputs
High energy consumption
Regular maintenance commitment
Potential use of renewable energy

Typical control

±2 to 5%RH depending on application

Benefits
High steam outputs
Low energy cost
Very low spares commitment
Any water quality compatible

Considerations
Install costs
Regular maintenance
Flue

Typical control
±10%RH

Gas-fired humidifiers

Benefits

Low energy use
High steam outputs
Low spares commitment
Any water quality

Considerations

Install costs
Footprint

Typical control

±5 to 10%RH

Steam-to-steam humidifiers

Benefits

Low energy use
High steam outputs
Minimal maintenance and spares

Considerations

Valve body material
Externally mounting protection required

Typical control

±5%RH

Live steam humidifiers

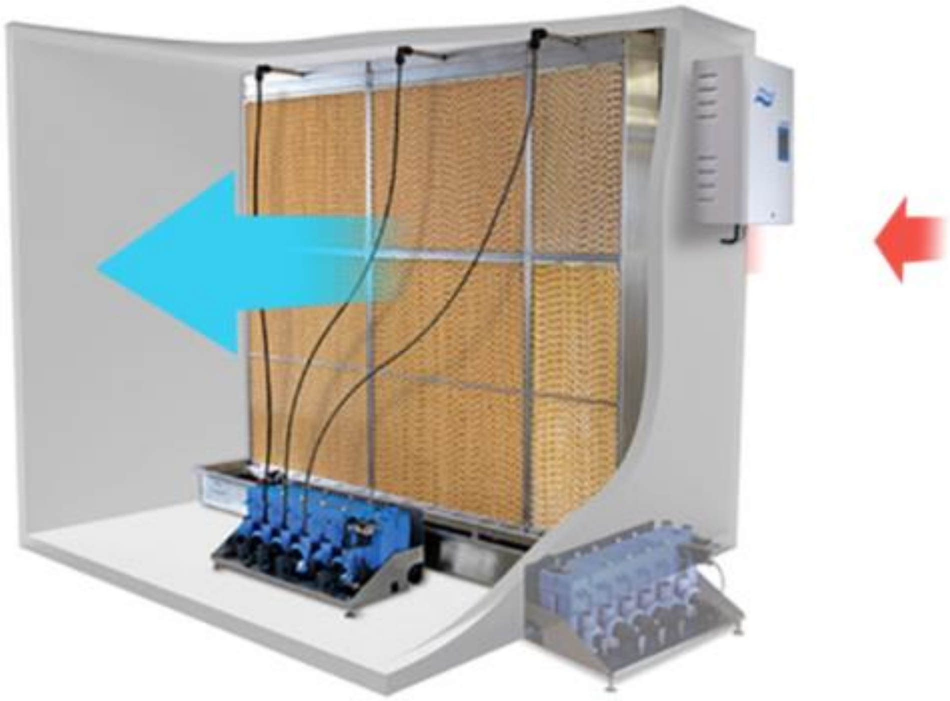
Steam distribution

Distributor pipe
for in duct humidification
Bn = 1000mm

OptiSorp manifold system
for shortest humidification distance
Bn = 250mm

Fan unit
for direct room applications

Note: Bn = absorption distance (dependent on humidification load and temperature of airstream)

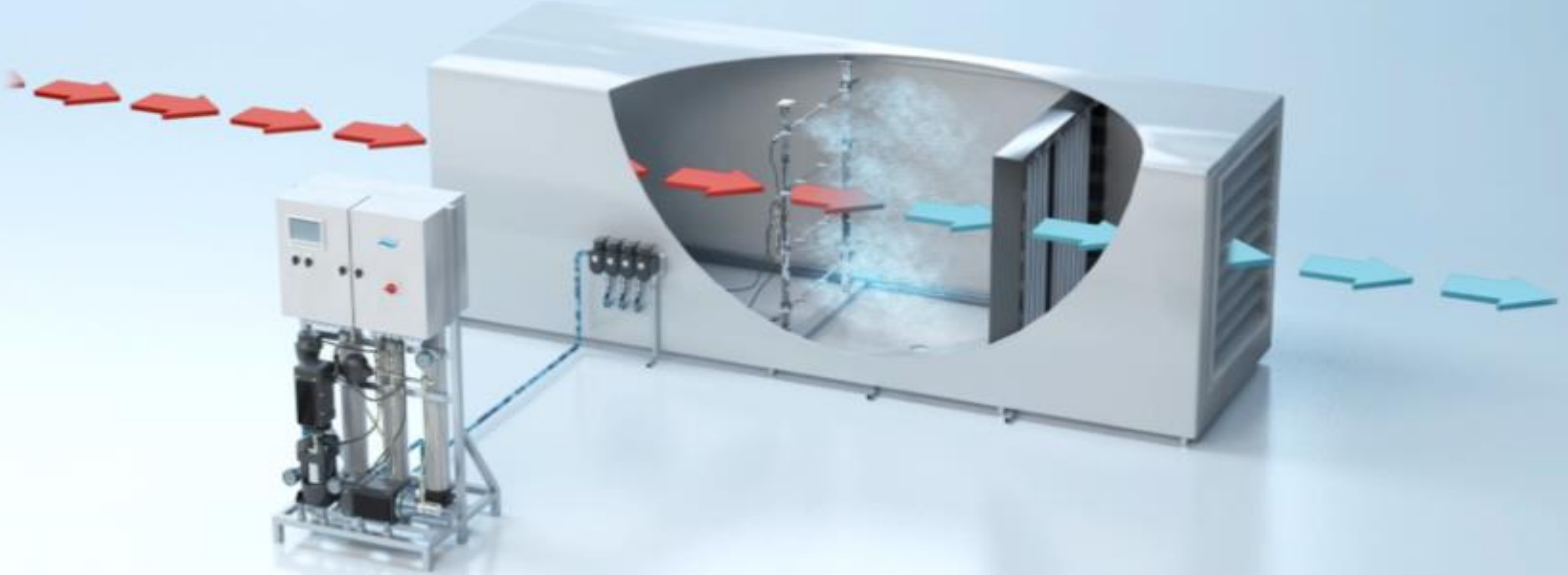


Benefits
High humidity outputs
Low energy
Low maintenance
No evaporation distance
Adiabatic cooling
Potential use of renewable energy

Considerations
Consider pre-heating requirements
Space in duct

Typical control
±10%RH

Evaporative media humidifiers

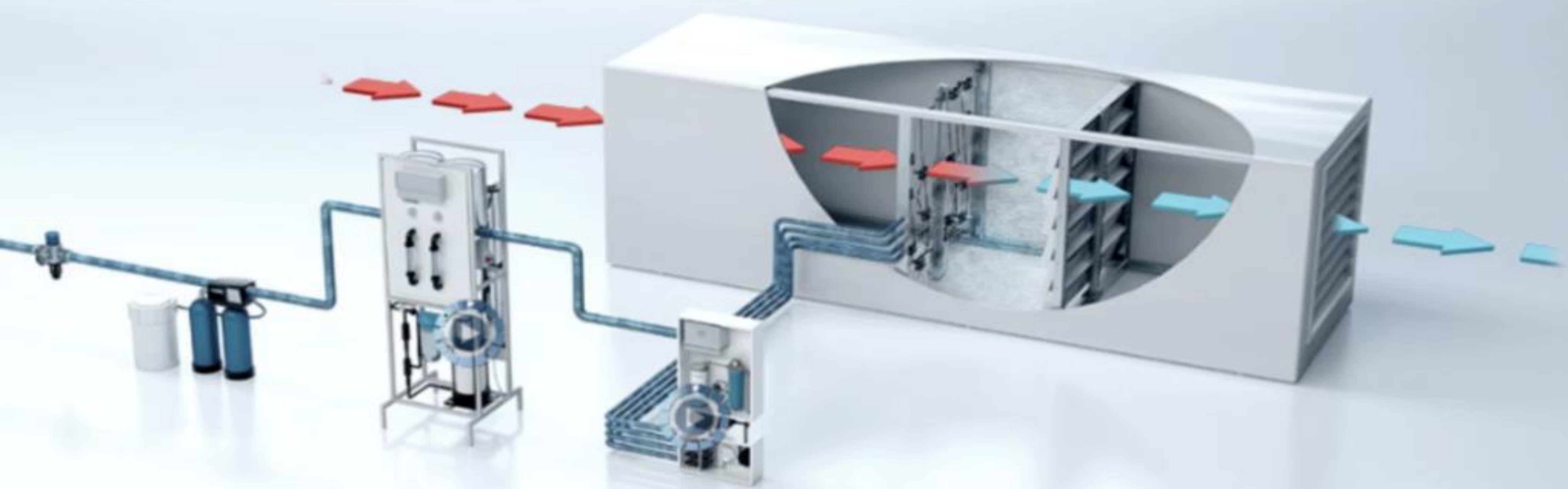


Benefits
High outputs
Multiple AHUs from a single pump station
Evaporative cooling effect

Considerations
RO water
Stainless steel wet section
Need for pre-heating

Typical control
±5%RH

High pressure spray – in-duct



Benefits
Stage and pressure modulation
= close control
Short section length (from 600mm)
Very low maintenance
Evaporative cooling effect

Considerations
RO water
Stainless steel wet section
Need for pre-heating

Typical control
±2%RH

Hybrid spray and evaporative humidifiers

Load calculation

Outside air volume	1m3/s
External ambient	-6degC 100%rh
Internal design	21degC 50%rh
Moisture differential	0.0078 – 0.0022 = 0.0056
Specific volume	0.84m3/kg

Load calculation

Calculation=

$$\frac{1m3/s \ \ x \ \ 0.0056 \ x \ 3600sec}{.84m3/kg}$$

= Kg/hr or lt/hr

Thank you

Any further questions?

Please ask about the complete series of Condair CPDs

www.condair.co.uk

Tel: 01903 850200

Today's presenter:

Dave Marshall-George, UK and IRE Sales Director

Q & A