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Welcome to :
COVID-19: Air Handling Units and Air Recirculation

HVACR Leadership Workshop by Eurovent Middle East

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Eurovent Middle East

Association of the **H**eating, **V**entilation, **A**ir-**C**onditioning and **R**efrigeration Industry in the Middle East

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Dr. Iyad Al-Attar Air Filtration Consultant

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KEY PERSPECTIVES ON THE REGION'S HVACR INDUSTRY

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Agenda

Part 1

1. Event introduction
2. Air borne pathogens and air filtration
3. Air filtration recommendations
4. Recirculation and energy recovery
5. Hygienic Air Handling Units
6. Certification for hygienic Air Handling Units
7. Panel Discussion, Q&A

Part 2 (16 September)

1. Fundamentals of AHUs
2. Construction features in HAHUs and UVGI
3. Energy recovery solutions based on integrated logic
4. Condition based monitoring
5. Retrofit cost savings with AFE drives
6. EC fan technology
7. Panel Discussion, Q&A

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COVID-19: Recommendations

Event Introduction

Some basics

- Possible aerosol transmission
- Virus does not replicate outside of host
- Infectivity depends on many factors
- Keep virus load in the air low

- Source of infections are infected people
- General safety recommendations:
  - ➢Distancing, masks, reduced occupancy
- Dilution!

Industry Recommendations

- Increase ventilation
- Enhance filtration
- Reduce/stop recirculation
- Observe general safety recommendations

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REHVA

Federation of European Heating, Ventilation and Air Conditioning Associations

www.ashrae.org | www.rehva.eu

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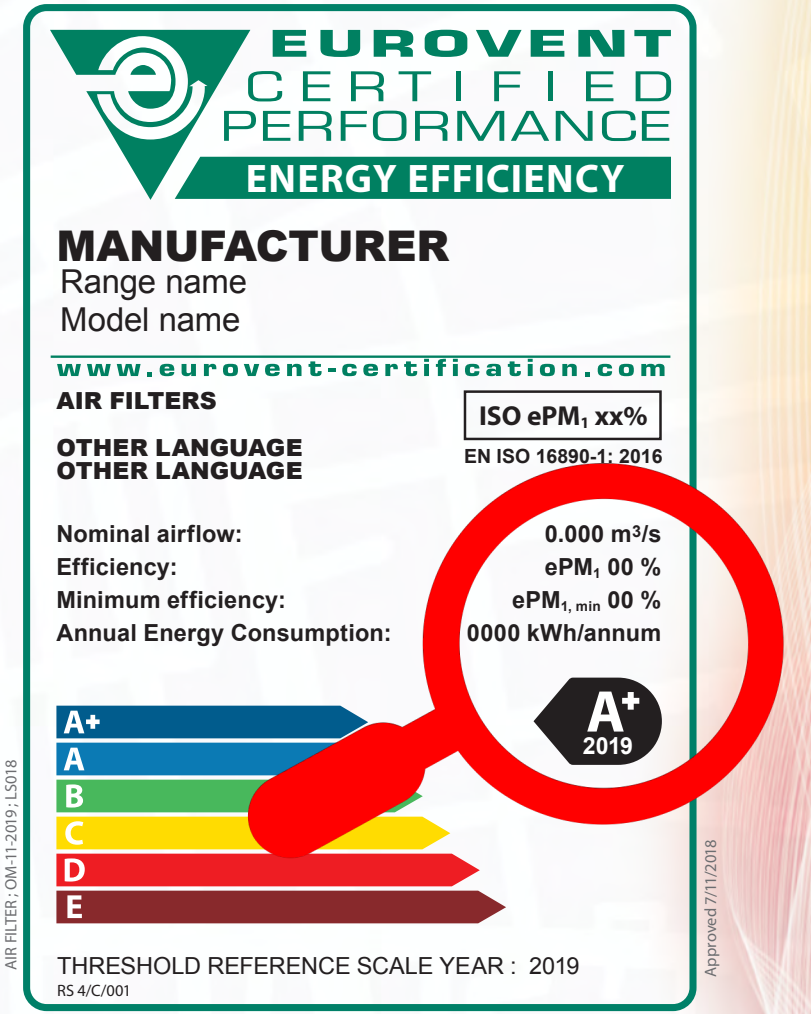
Ventilation and filtration

- Increase ventilation rates
  (air exchanges per hour)
- Extend operating hours
  (no shut down during night)
- Reduce/stop recirculation
  (max fresh air intake)
- Enhance filtration
  (switch to ePM1 80% or higher)



Every building is different

- Assess
- Consult
- Improve
- Maintain

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Airborne pathogens and air filtration

Dr. Iyad Al-Attar

IAQ and Air Filtration Consultant

ASSOCIATED CONSULTANT
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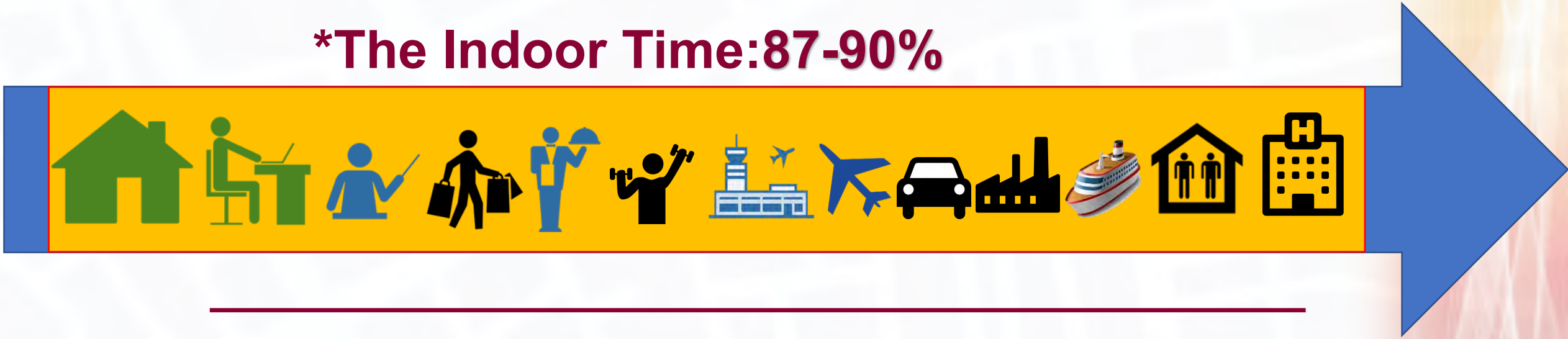
Filtration: The Common Denominator

Total Time

Time spent indoor

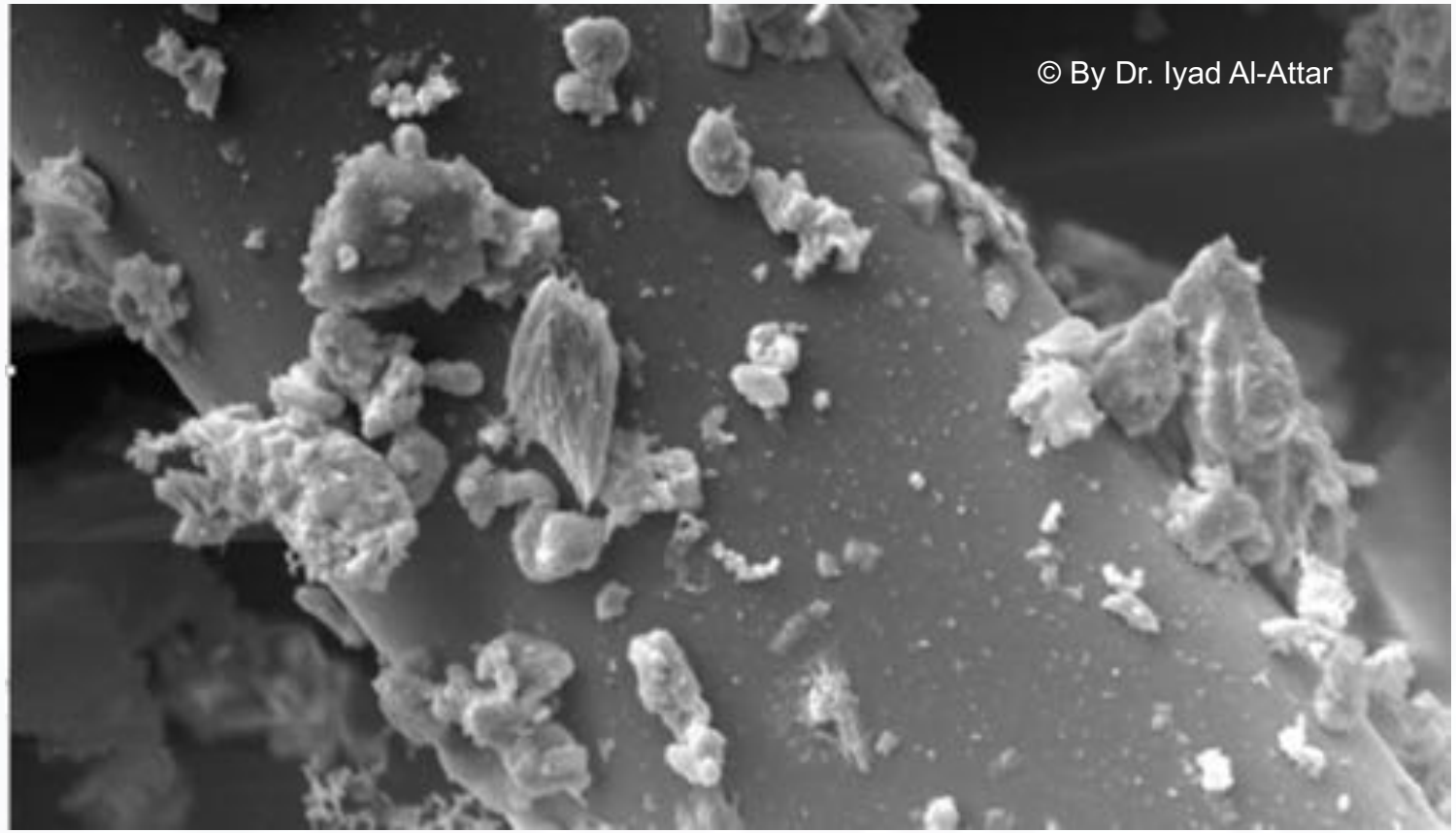
*The Indoor Time:87-90%



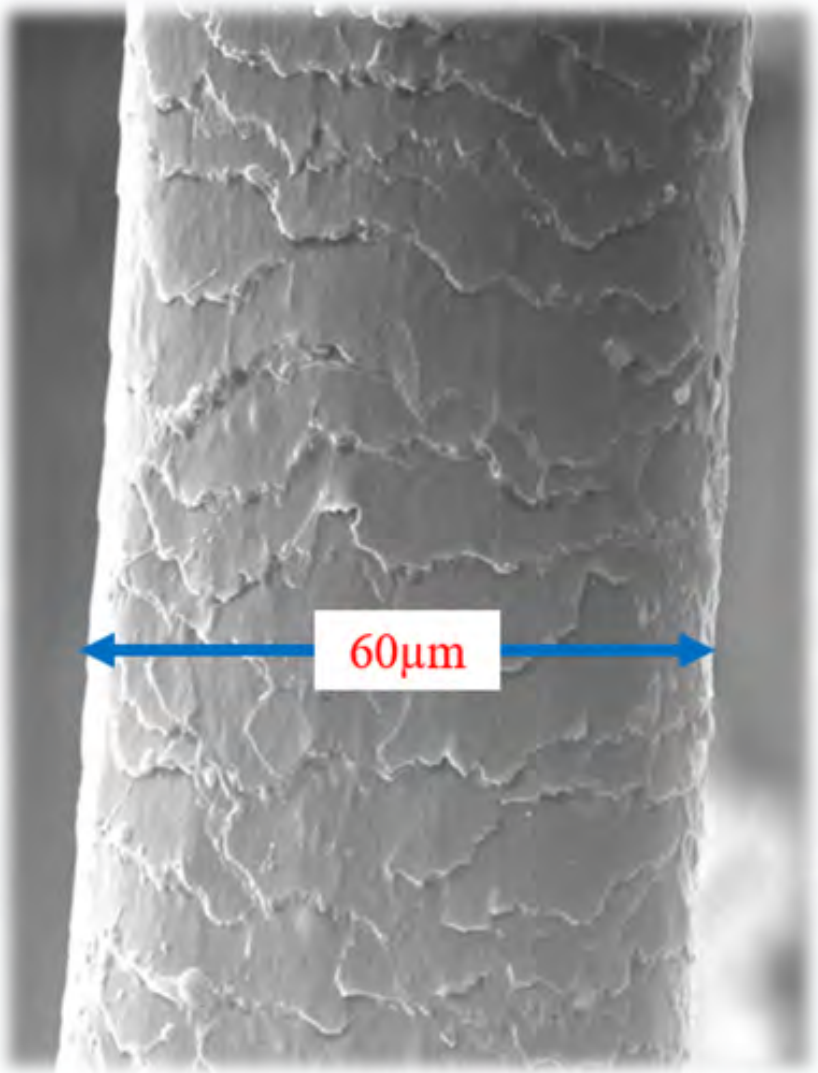
Filtration

*The National Human Activity Pattern Survey (NHAPS): https://indoor.lbl.gov/sites/all/files/lbnl-47713.pdf

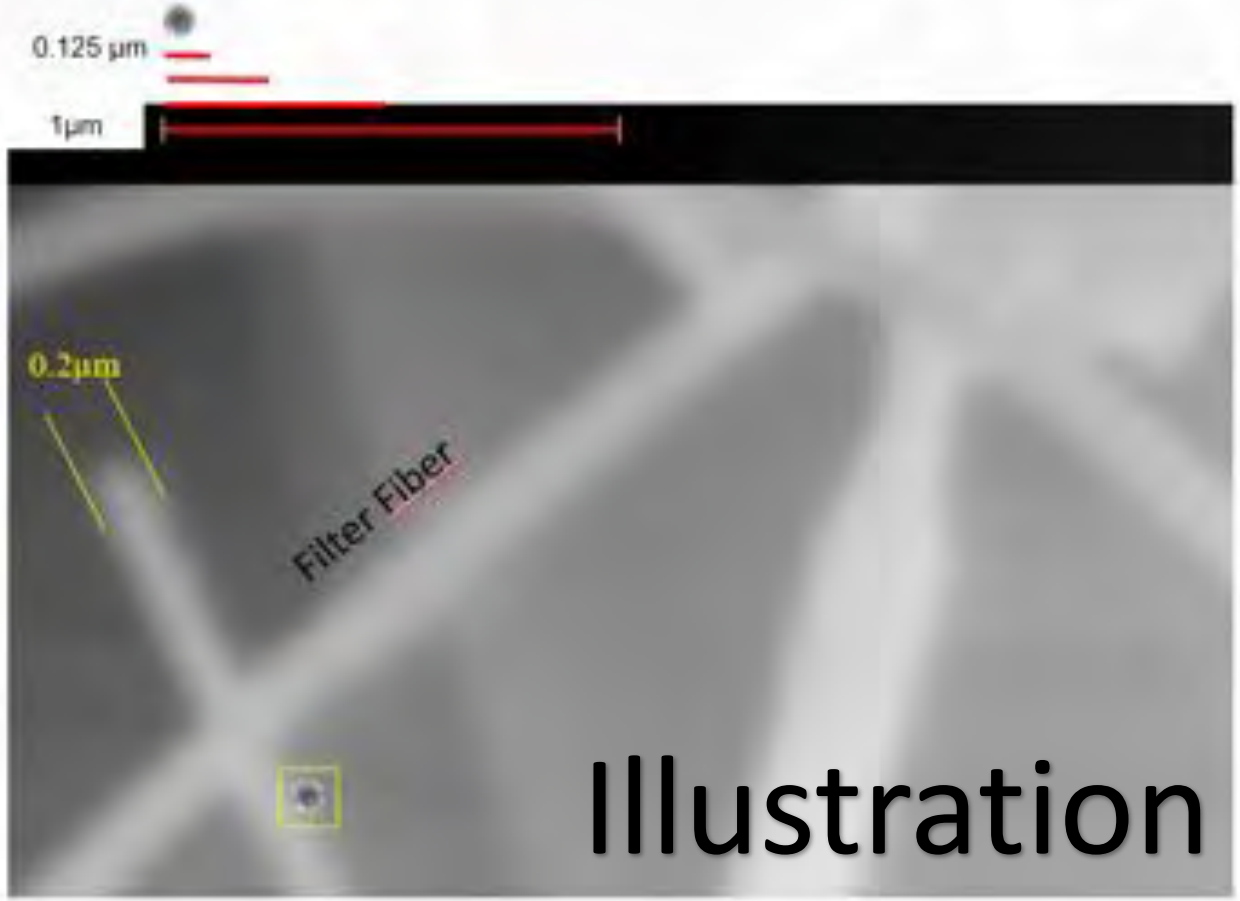
Filtration:
The Essense of Particle Capture



Particle size perception



Particle size perception



Emitting around the clock

- Car emissions
- Fossil fuel combustion.
- Chemicals from factories,
- PM (Dust, pollen and mold spores)
- Air quality (indoors ∝ outdoors)
- Ventilation:
  (Rh%, q, Physical, Chemical, Bioaerosol)
- The kind of filtration we bring to bear

Contaminants Types

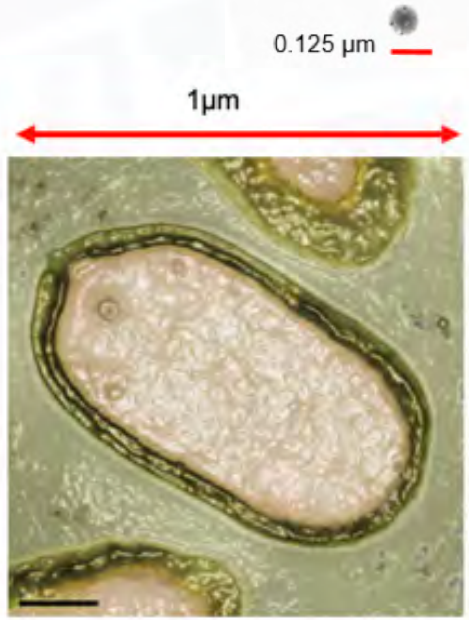
Possible Sources of Indoor Pollutants:

1. **Facilities**
2. **People**
3. **Tools**
4. **Fluids**
5. **Manufactured Product**

Particle Characteristics

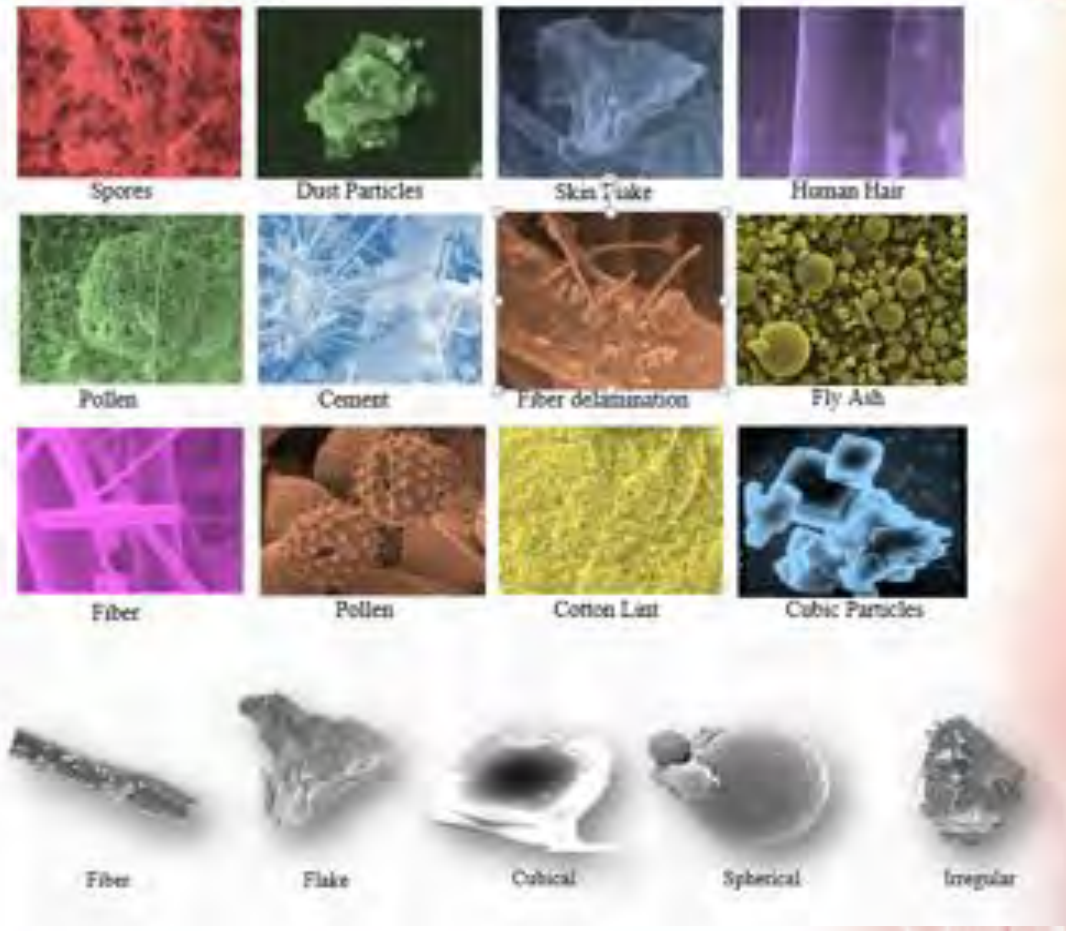
Viruses

- Infectious particle
- Smaller than bacteria
- Various shapes
- Life/non-life characteristics
- Range in size between **20-400 nm** in diameter
  The ***Pandoraviruses***, are about 1µm (the largest).



Pandoraviruses

https://www.virology.ws/2013/08/01/pandoravirus-bigger-and-unlike-anything-seen-before/



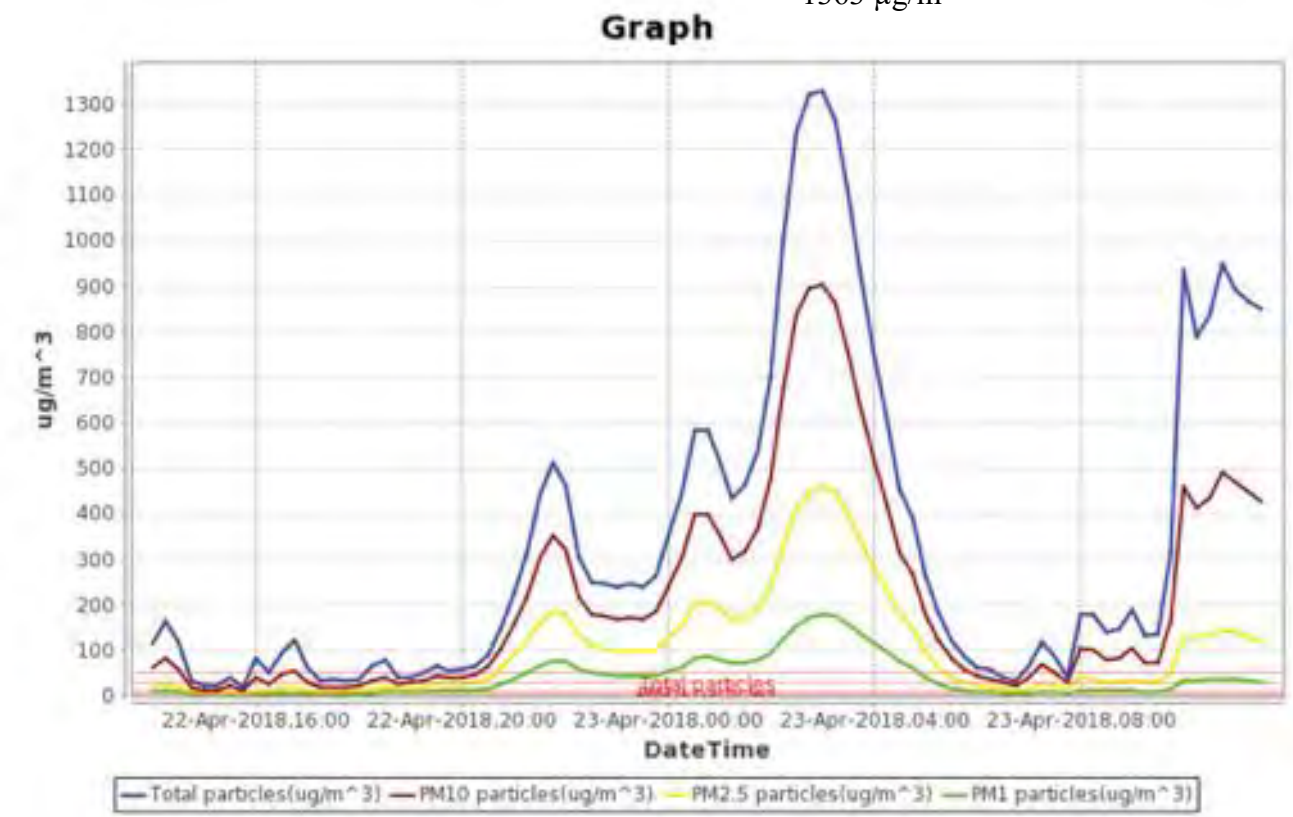
Various Particle Shapes

Aerosol Monitoring

Sand Storms Physical Characterization :

- 60% (PM10)
- 29% (PM2.5)
- 11% (PM1)

1363 µg/m^3 435 µg/m^3



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Filtration Mistakes... are expensive

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The Equation is Simple

+

=

+

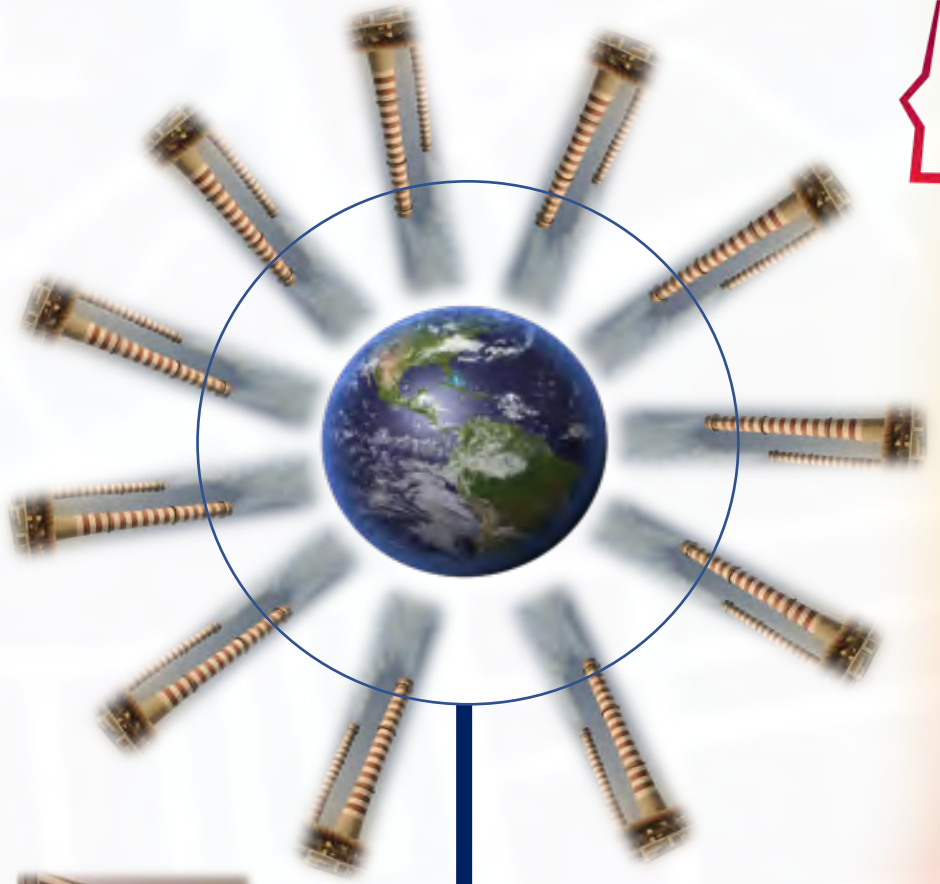
=

Where do we want our contaminants to land?

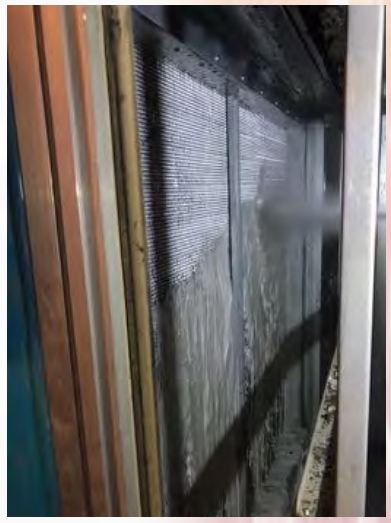
School of Thought

Before we agree on defining "Better Air Quality", let's first define what do we really mean by "Air Quality". - *Dr Iyad Al-Attar*

- How "fresh" is outdoor air?
- Indoor & outdoor air pollution sources
- Air quality monitoring devices
- Physical and Chemical Characterization of **outdoor and indoor** air.
- Appropriate air filter selection
- **THINK preventative**
- **Do not** allow your **Filter efficiency** and **IAQ to degrade**



Duct cleaning & coil washing



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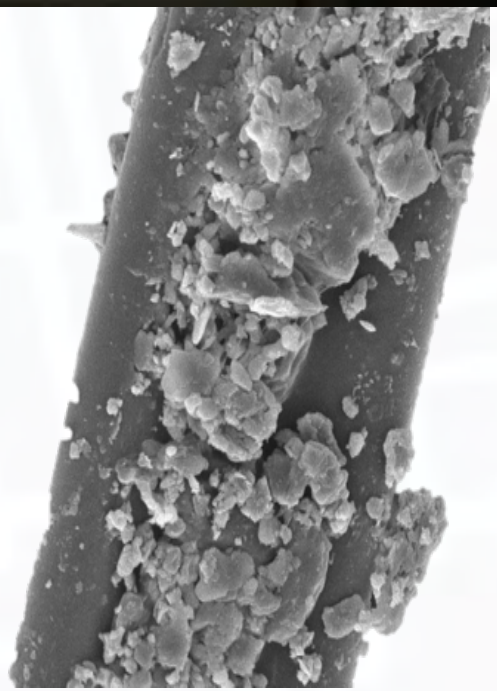
Enhance Air Quality

- **Re-do the math?**
- **Technologies…Not tricks.**
- **Maintenance measures….Not mistakes**
- **Filtration efficiency ….not deficiency**
- **Strategy not shortcuts**
- Relevant Testing Standards
- Verify Filter Performance
- Climate Conditions, it is not only dust.
- It is not only Filtration …



Technologically speaking, we are what it takes to confront COVID-19.

Dr Iyad Al-Attar

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Air filtration recommendations

Mr Tobias Zimmer
VP Product Management & Standards
Camfil

camfil
CLEAN AIR SOLUTIONS

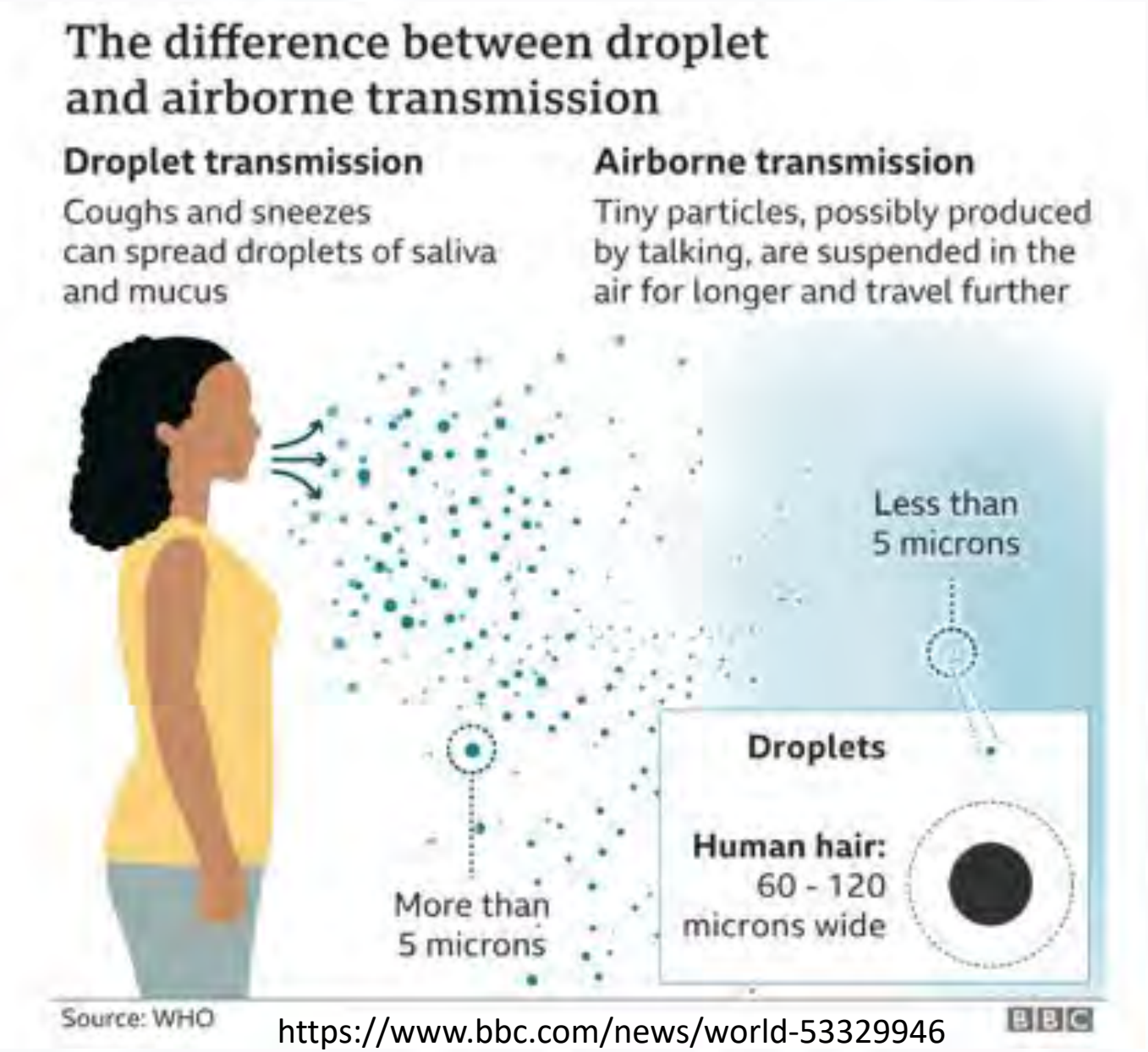
Air Filtration and COVID-19

- How do air filters mitigate the spread of COVID-19 virus ?

As per REHVA COVID-19 guidance document, 3 August 2020, the airborne transmission of the virus is now conclusively stated.

Two types of air transmission through droplet carriers are possible

1. Short range – 1- 2 m
2. Long range – through droplets ranging less than 50 microns



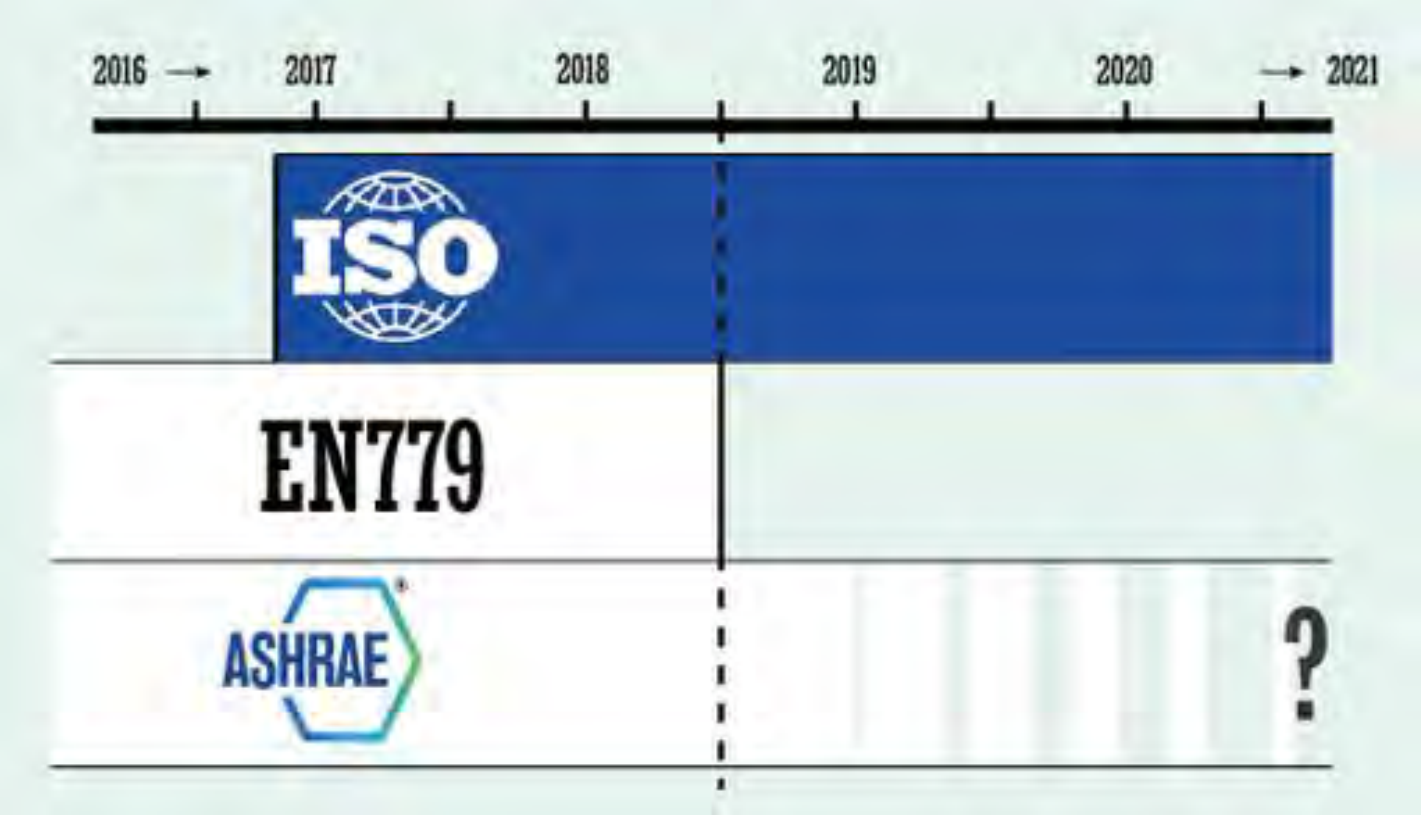
https://www.bbc.com/news/world-53329946

Recommended Guidelines by REHVA

- Ventilation rates
- Ventilation operation times
- Continuous operation of ventilation
- Window opening
- Recirculation
- Fan coil and induction unit
- Outdoor air and extract air filters
- IAQ monitoring

- The are 15 check points mentioned in the guidance, 08 are directly linked to air filtration
- Financial obligation and climatic condition prevent compliance with all ventilation checks.
- Hence increased recirculation air changes through efficient air filtration is the practical solution.
- HEPA filtration is the suggested filter for recirculation, but an installation without additional static pressure is tough to meet.
- The best practical solution is then upgrading the filtration to the latest standard – **ISO 16890** with a minimum **ePM1 80%** filter as final stage.

New Air Filtration Standard - ISO 16890



EN 779:2012	ISO 16890
M5	ePM10 60%
M5	ePM10 60%
M5	ePM10 60%
[illegible]	ePM2.5 50%
M6	[illegible]50%
[illegible]	ePM2.5 50%
F7	ePM1 60%
F7	ePM1 60%
F7	ePM1 60%
F8	ePM1 70%
F8	ePM1 70%
F8	ePM1 70%

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Eurovent Guidence 4/23 - Examples for Supply Air Classes (SUP)

CATEGORY	GENERAL VENTILATION	
SUP 1	-	
SUP 2	**Rooms for permanent occupation.** Example: Kindergardens, offices, hotels, residential buildings, meeting rooms, exhibition halls, conference halls, theaters, cinemas, concert halls.	 
SUP 3	**Rooms with temporary occupation.** Examples: Storage, shopping centers, washing rooms, server rooms, copier rooms	 
SUP 4	**Rooms with short-term occupation.** Examples restrooms, storage rooms stairways	 
SUP 5	**Rooms without occupation.** Examples: Garbage room, data centers, underground car parks	 

CATEGORY	INDUSTRIAL VENTILATION	
SUP 1	**Applications with high hygienic demands.** Examples: Hospitals, pharmaceutics, electronic and optical industry, supply air to clean rooms.	
SUP 2	**Applications with medium hygienic demands.** Example: Food and beverage production.	
SUP 3	**Applications with basic hygienic demands.** Example: Food and beverages production with a basic hygienic demand	
SUP 4	**Applications without hygienic demands.** Example: General production areas in the automotive industry	
SUP 5	**Production areas of the heavy industry.** Examples: Steel mill, smelters, welding plants	

Table 4: Industrial ventilation - indicative examples of application matched to corresponding SUP categories

Eurovent Recommendation 4/23 – Which Classes of Filter to Use

Outdoor air quality		SUP1	SUP2
ODA 1	example 1	ePM10 50% + ePM1 60%	ePM1 50%
	example 2	ePM1 70%	-
ODA 2	example 1	ePM2,5 50% + ePM1 60%	ePM10 50% + ePM1 60%
	example 2	ePM1 80%	ePM1 70%
ODA 3	example 1	ePM2,5 50% + ePM1 80%	ePM2.5 50% + ePM1 60%
	example 2	ePM1 90%	ePM1 80%

Table 7: examples of filter classes meeting respective ODA/SUP categories requirements

Efficiency Vs IAQ Vs Air Changes

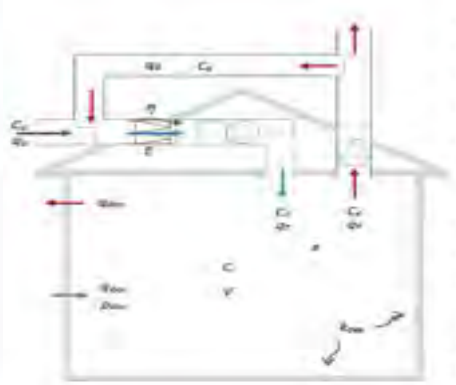

Importance of ventilation filters for particle concentrations in indoor air

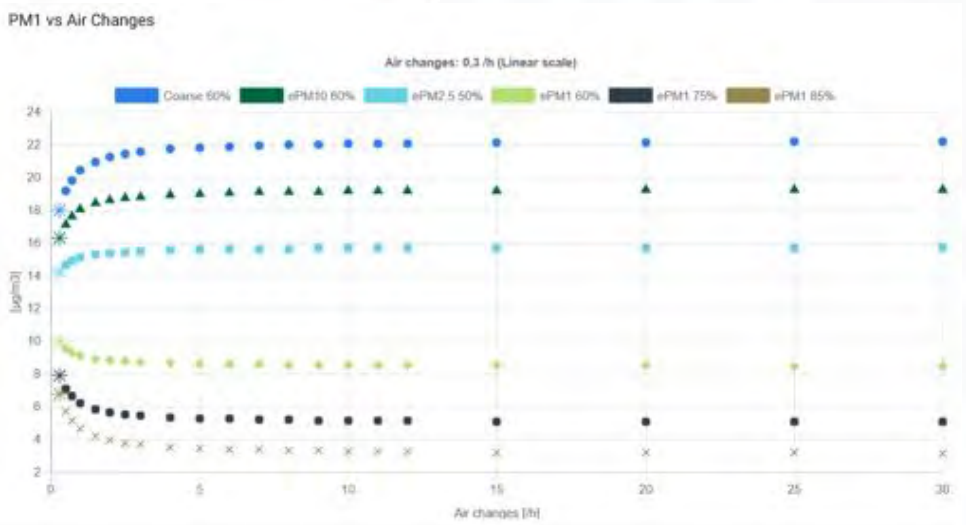
Ordered by

Camfil Svenska AB

Study performed by

Lars Ekberg, CIT Energy Management AB





Comparing filter efficiencies

PARTICLE SIZE TEST RANGE	FRACTIONAL EFFICIENCY VALUES ACCORDING TO ISO16890-1:2016					
						
Virus Particle Size Range in Micrometers (µm)	ePM1 60%	ePM1 60%	ePM1 70%	ePM1 70%	ePM1 80%	ePM1 85%
0.3 -0.4	54%	48%	62%	57%	79%	86%
0.4 -0.55	62%	57%	78%	67%	85%	87%
0.55 -0. 7	67%	67%	78%	77%	90%	93%
0.7 -1.0	73%	75%	86%	86%	95%	96%

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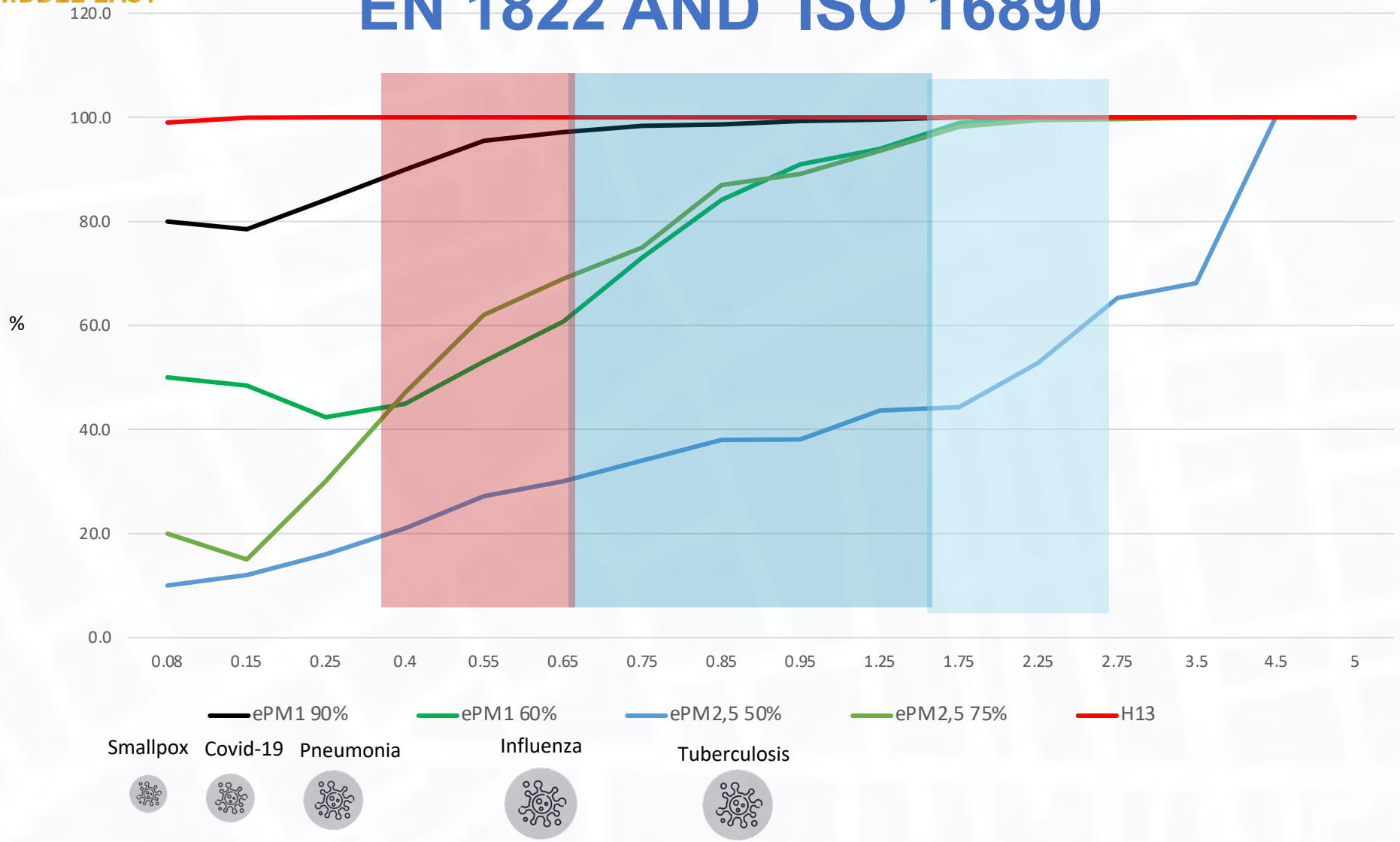
EN 1822 AND ISO 16890



Summary of Filter Classes

IAQ Enhancement Through Air Cleaners

- Not all ventilation systems are ideally designed
- Buildings with FCUS, split units and small AHUs do have a compromised IAQ due to lack of air filtration
- REHVA recommends air cleaners
- Air cleaners enhances the IAQ by increasing the air changes and HEPA filtration

REHVA COVID-19 guidance document, August 3, 2020

(this document updates previous April 3 and March 17 versions. Further updates will follow as necessary)

4.10 Room air cleaners and UVGI can be useful in specific situations

How to choose the right clean air solution

Technology Standards

Components Certified

Clean Air Delivery Rate

No foreign substance created

Most reliable technology is HEPA filtration

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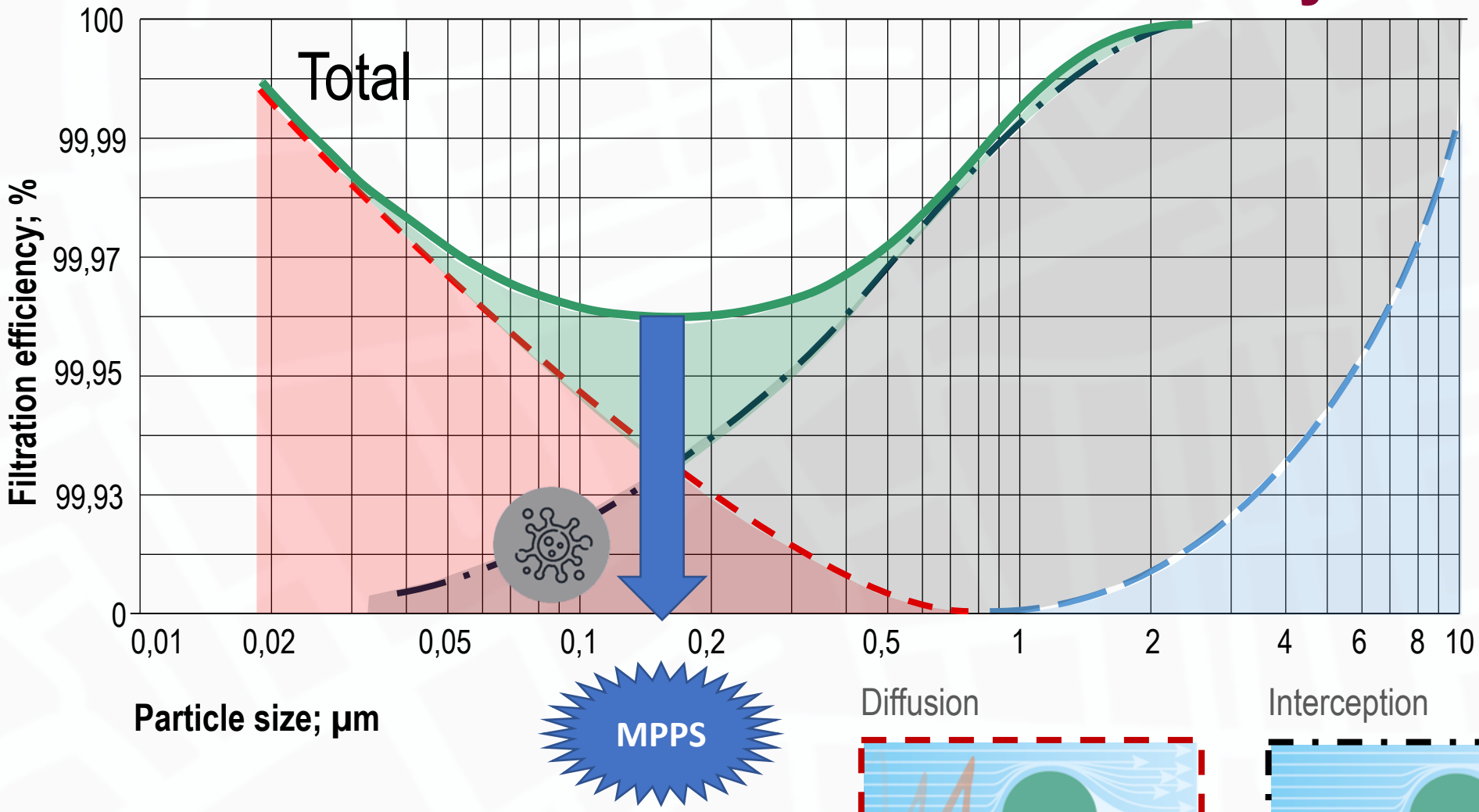
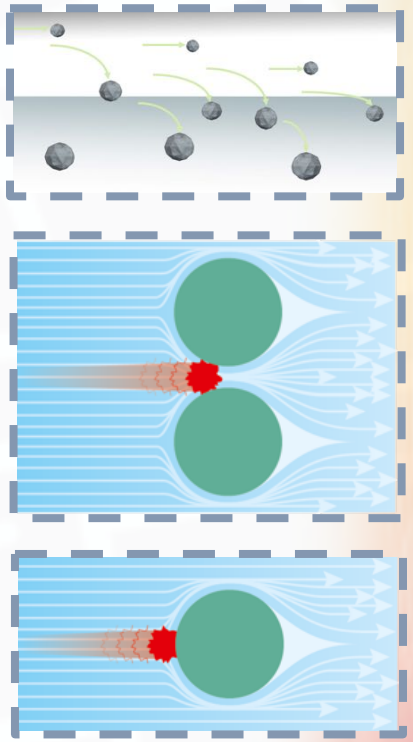
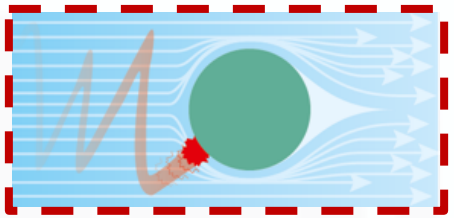
Combined Filtration Efficiency



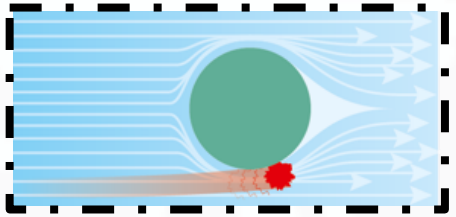
Impaction, Straining, Sedimentation



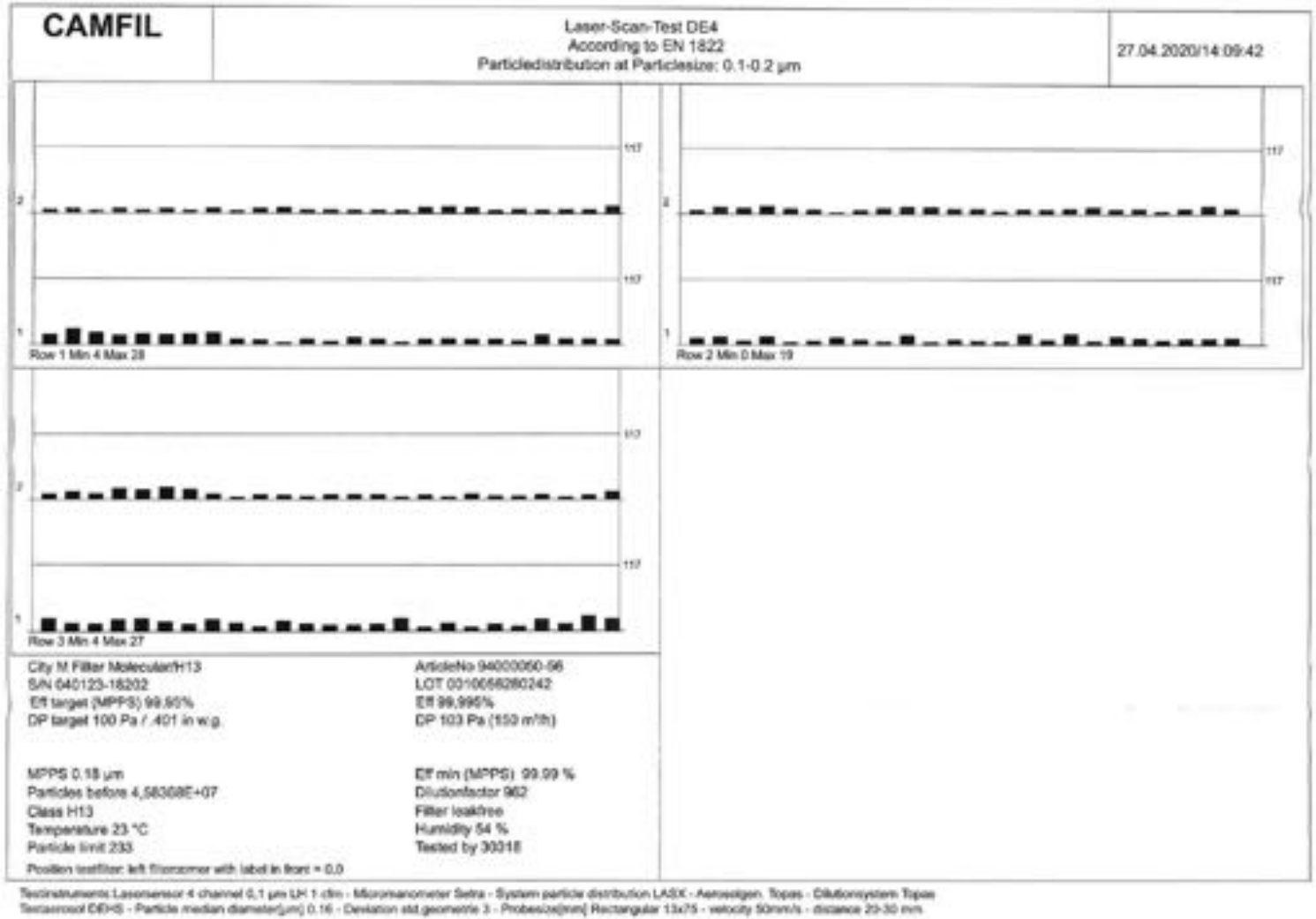
Diffusion



Interception



Proven Efficiency on Both MPPS AND COVID-19



Remember - Not All HEPA Filters are Created Equal

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Recirculation and the role of energy recovery

Mr Stephan Eder
Director HVAC
Hoval

Hoval

Recirculation and the role of energy recovery

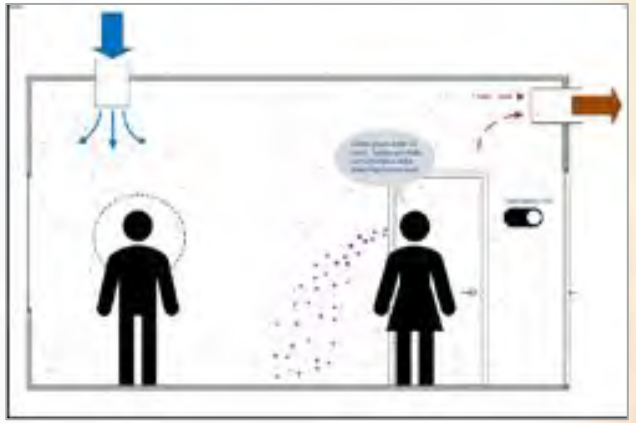
Fresh Air AHU / Recirculation Air AHU

SARS-CoV-2 brought more importance to energy recovery and reduces the possibility of recirculated air in fresh air AHU

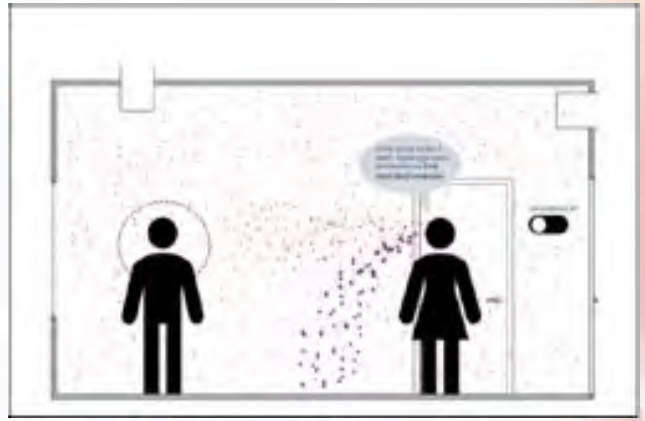
Transmission routes SARS-CoV-2

Fresh air AHU have an important role in decreasing airborne transmission

- Increase the use of air change
- Increase the use of fresh air
- Extend the operation times before and after regular period



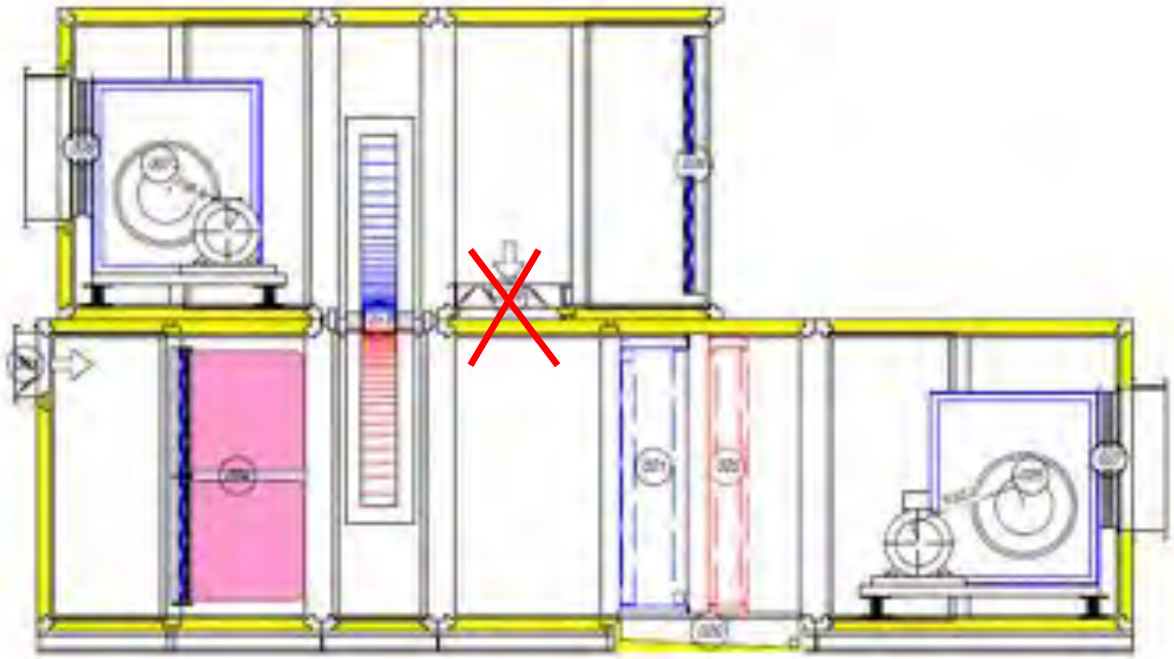
ON - Air Handling Unit



OFF - Air Handling Unit

Recirculation mode with fresh air AHU

- Reduce recirculation to a minimum
- To remove particles and viruses from the return air ePM1 or HEPA filters needed
- HEPA filters have a very high pressure drop



NO RECIRCULATION MODE

Energy Recovery

Rotary Heat Exchanger

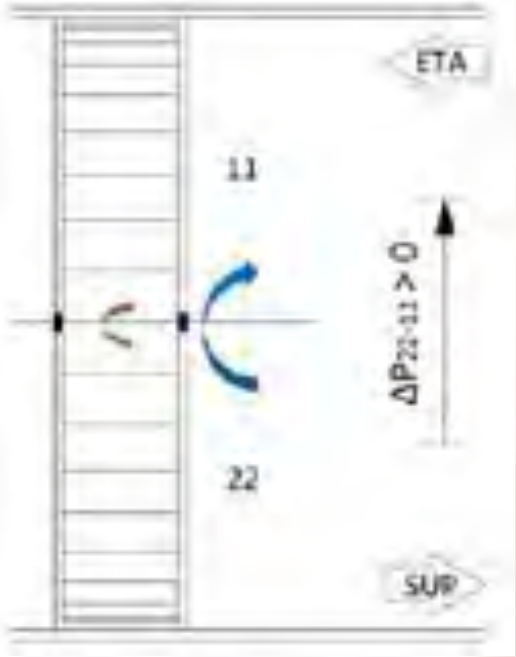
Temperature and Humidity Recovery

Plate Heat Exchanger

Temperature Recovery

Energy Recovery – Rotary Heat Exchanger

- Internal leakage of contaminated air leaving the room to supply air through the exchanger is expressed by Exhaust Air Transfer Ratio (EATR) in %.
- EATR is a function of the pressure difference between supply air (p22) and the extract air (p11), the type of sealing, the rotor speed and purge sector.
- The main target is to keep over pressure on the supply air side.



$\Delta P_{22\text{-}11}$ in AHU

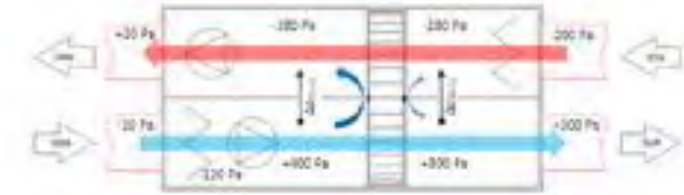
Energy Recovery – Rotary Heat Exchanger

- Measures to keep the exhaust air leakage low

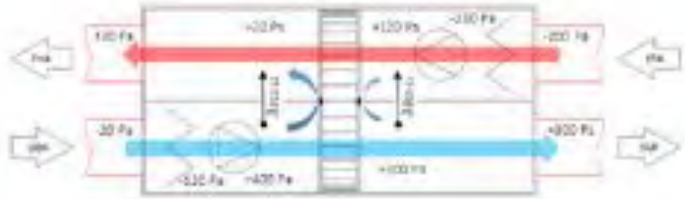
Correct positioning of the fan

Best configuration. Both fans after the rotor

Both fans on building side



Both fans on the outdoor side

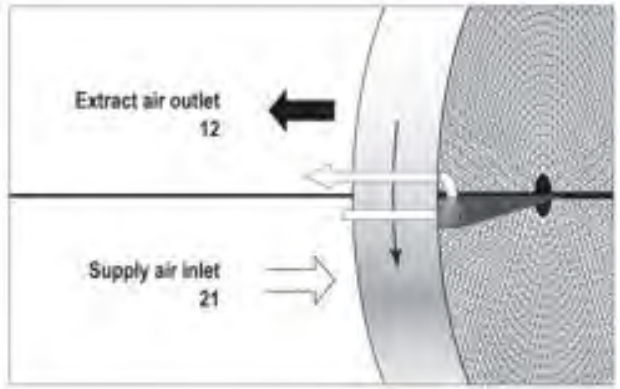


Both fans upstream the exchanger.

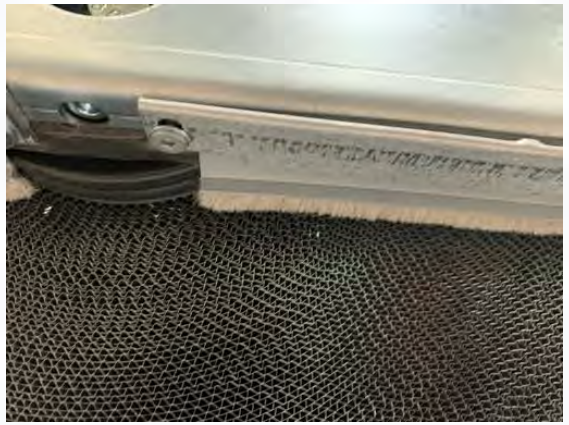
Pressure p_{11} shall be at least 20 Pa less than pressure p_{22}

Energy Recovery – Rotary Heat Exchanger

- Correct application of purge sector-positioning and setting



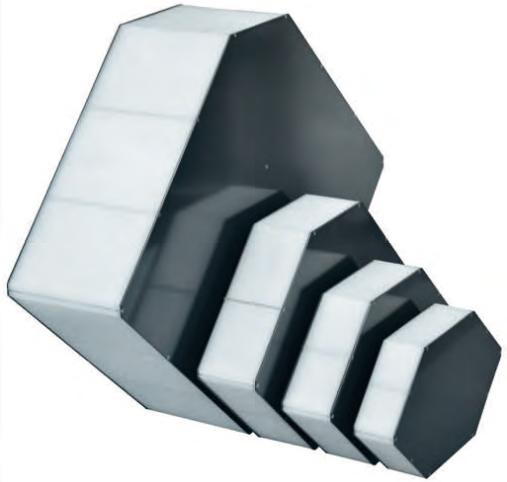
- Effective seal of the rotor



Energy Recovery – Plate Heat Exchanger

No exhaust air leakage (max. 0,1% with a pressure difference of 250 Pa)

Humidity transfer



Will be available for reasonable price in the future!

Cleaning, Maintenance and UVC

- Regular maintenance of the AHU (cleaning of rotor matrix, changing of the sealing, adjustment of the belt, …)
- UVC irradiation of the supply air – currently under evaluation

Summary

- Fresh air AHU have an important role in decreasing airborne transmission
- Increase the use of fresh air
- Do not use recirculated air in fresh air AHU
- Maintain and clean the fresh air AHU regularly
- Main energy recovery system can be used without risk if correctly designed

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Hygienic Air Handling Units

Mr Orkun Yilmaz
Geniox R&D manager
Systemair Group

systemair

1. Air Handling Units - Hygiene concepts

Air Handling Unit

A factory-made encased assembly or flat-packaged unit that consists of a fan or fans and other necessary equipment in order to perform one or more of the following functions:

- Air Circulating
- Filtration
- Heating
- Cooling
- Heat recovery
- Humidifying
- Dehumidifying
- Mixing

1. Air Handling Units - Hygiene concepts

Air Handling Unit

What else happens inside?

• Metallic parts	→ Corrode in time
• Non-Metallic parts	→ Microorganisms may grow
• Servicing and Cleaning	→ May not have enough space
• Construction	→ Dust and dirt can accumulate
• Casing	→ Leakages, thermal bridges

1. Air Handling Units - Hygiene concepts

Hygiene concepts

Hygiene:

The degree to which people keep themselves or their environment clean, especially to prevent disease

Hygienic:

Clean, especially in order to prevent disease

1. Air Handling Units, hygiene concepts
Hygienic Air Handling Unit

- AHU which conforms to different hygiene levels defined by specific norms with respect to the site or application that it will be operated in
- Helps preventing deseases thanks to its' enhanced accesibility, cleanability, materials and constructional features

2. Relevant Standards

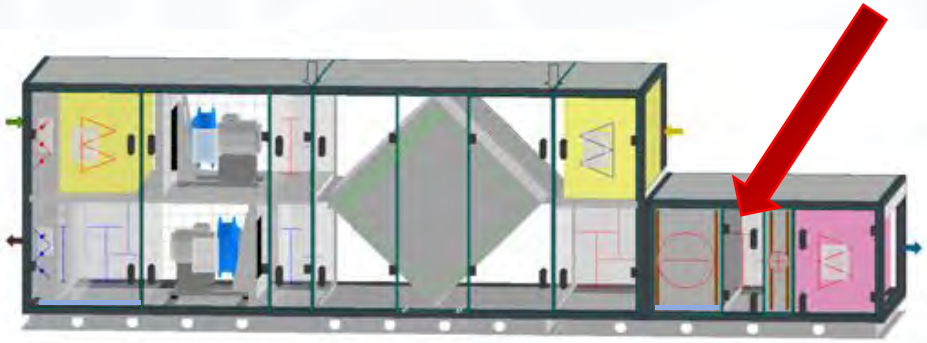
- VDI 6022-1
  - SWKI 99-3
  - Önorm H 6021
  - Other local norms and guidelines
- DIN 1946-4
  - Class Ia
  - Class Ib
  - Class II
- RS 6/C/011-2018
  - Level 3
  - Level 2
  - Level 1

3. Basic principles of a Hygienic AHU
Air Handling Unit

- Accessibility
- Cleanability
- Materials used
- Mechanical Characteristics
- Selection of Components
- Sequence of Components
- Labelling & Documentation

3. Basic principles of a Hygienic AHU
Accessibility

All components shall be easily accessible from both sides or shall be easily removable up to a 1,6 m height.



3. Basic principles of a Hygienic AHU
Accessibility (Eurovent Certified HAHU)

AHU SECTION SIZE (+- 1%)		ALL LEVELS		LEVEL 1	LEVEL 2	LEVEL 3
Internal unit depth L = IMC-D per air stream	Internal unit height (=IMC-H) per air stream	Designed type of IMC (after entering the unit, all relevant inner surfaces shall be matched with the hand)		Minimum IMC length IMC-L (for quickly removable components, including free space when component is removed)		
< 800mm	> 300 mm and <1600 mm	Standing outside and entering the unit with the arm or with arm plus the shoulder		250 mm	400 mm	550 mm
≥1000mm	>400 mm and < 1400 mm			400 mm	400 mm	550 mm
<1300mm	>550 mm and ≤1300 mm	Standing outside and entering the unit with the upper part of the body.		650 mm	650 mm	700 mm
Any	>800 mm and <=800 mm	Entering the unit partially or with the full body by crawling and working in lying position		650 mm	650 mm	700 mm

3. Basic principles of a Hygienic AHU
Accessibility (Eurovent Certified HAHU)

AHU SECTION SIZE (+- 1%)		ALL LEVELS		LEVEL 1	LEVEL 2	LEVEL 3
Internal unit depth [= IMC-D] per air stream	Internal unit height [=IMC-H] per air stream	Designed type of IMC (after entering the unit, all relevant inner surfaces shall be reached with the hand)		Minimum IMC length IMC-L (For quickly removable components, including free space when component is removed)		
Any	>600 mm and <=1800 mm	Entering the unit by crawling on the knees and working in sitting, kneeling or squatting position		950 mm	950 mm	700 mm
Any	>1800	Entering the unit by access on the feet and working in standing or at least bended position		400 mm	550 mm	550 mm
Other size combinations		Not Allowed				

3. Basic principles of a Hygienic AHU
Cleanability

- Inner surfaces shall be smooth/flat without grooves to allow easy cleaning
- Casing materials which come into contact with the airflow shall be resistant to disinfectants.

3. Basic principles of a Hygienic AHU
Materials

- Corrosion resistant
- Abrasion resistant
- Odourless
- Emissions-free
- Humidity-free

Stainless Steel Drip Tray

ISO 846 for non-metallic components

Closed cell materials

3. Basic principles of a Hygienic AHU
Mechanical Characteristics (EN 1886)

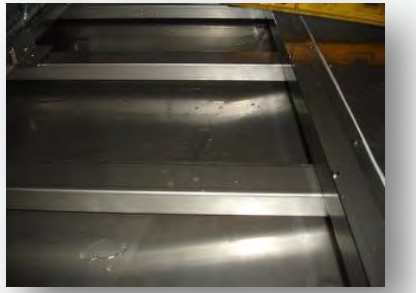
DIN 1946-4	VDI 6022-1	Eurovent RS 6/C/011-2018
D2 (R)	D2 (R)	
L2 (R)	L3 (R)	Lev1&2: L2 Lev3: L1
FBL Class PM1/≥80	Depending on filter class	Manuf. shall be cert. accord.
T2 (M)	T3 (M)	
TB3 (M) (in some cases TB2)	TB3 (M)	Lev1&2: TB3 (M) Lev3: TB2 (M)

3. Basic principles of a Hygienic AHU
Selection of Components










3. Basic principles of a Hygienic AHU
Sequence of Components

- No humidifiers allowed directly upstream the filter or attenuator
- “Wet” cooling coils not allowed directly upstream a filter

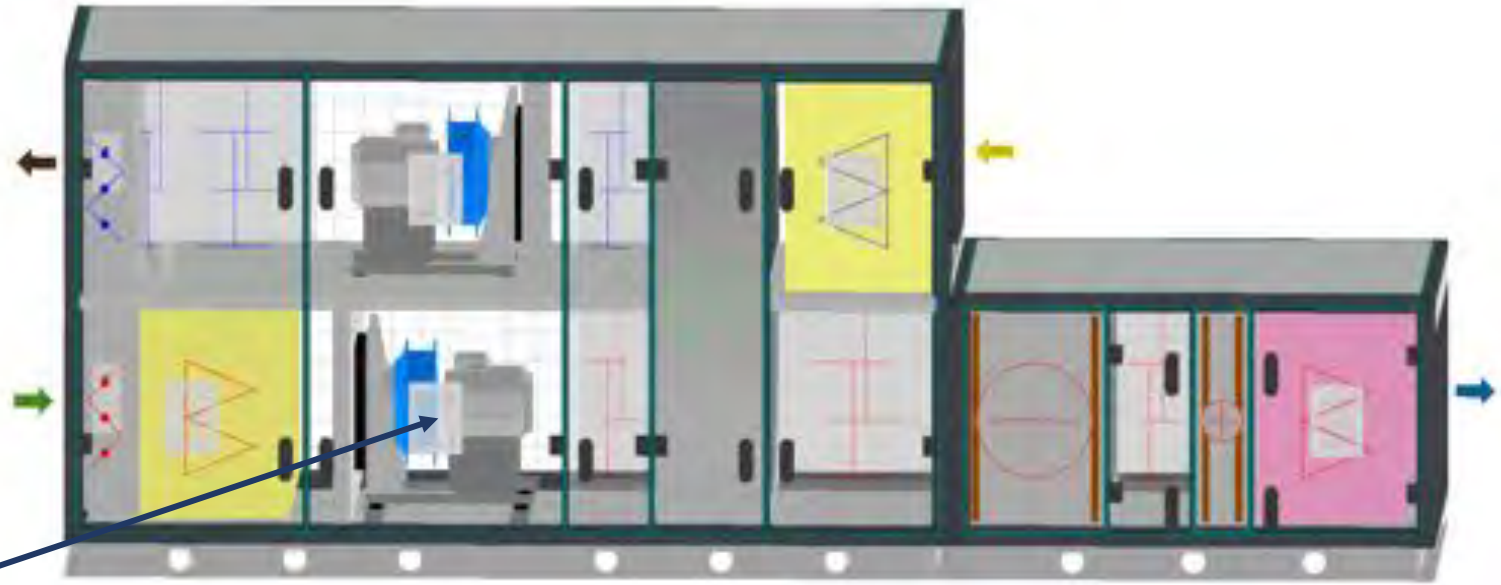
3. Basic principles of a Hygienic AHU
Sequence of Components

- Energy Recovery types

- Eurovent RS 6/C/011-2018
- VDI 6022-1

- DIN 1946-4

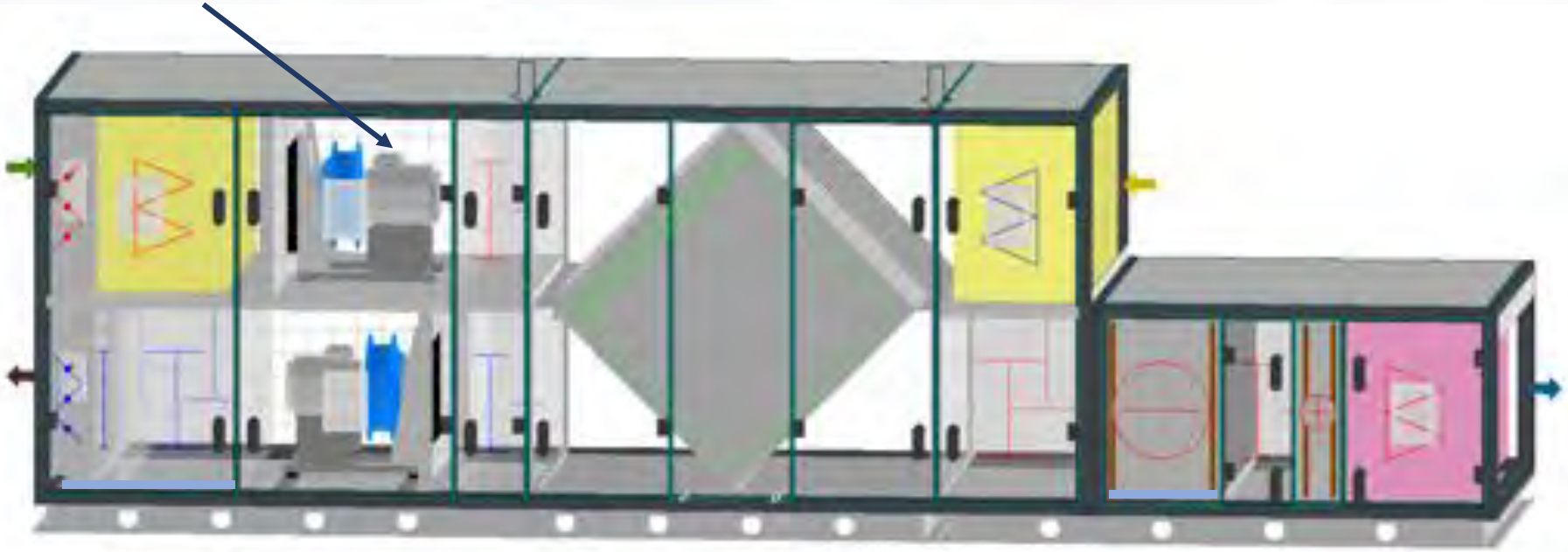
3. Basic principles of a Hygienic AHU
Selection Examples



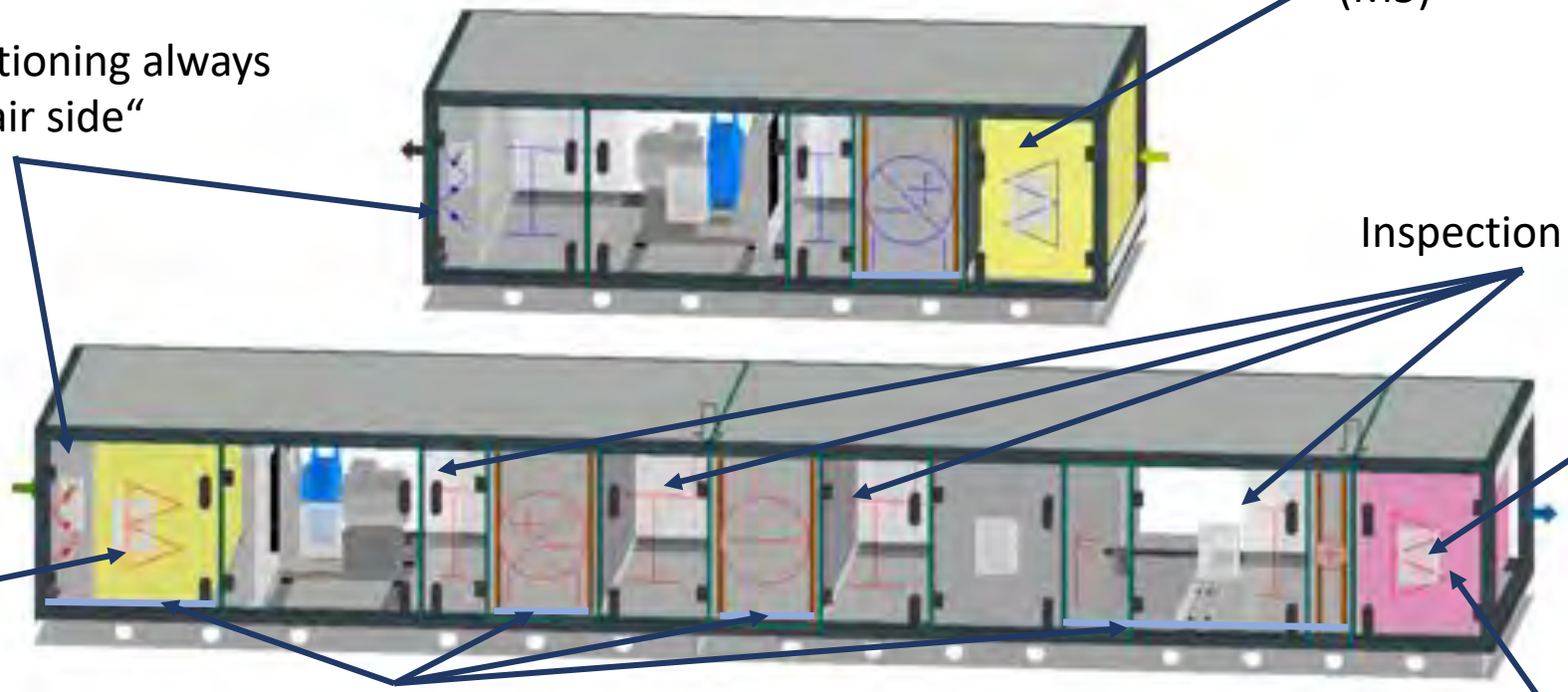
Fan keeping the supply side on positive pressure

Basic principles of a Hygienic AHU
Selection Examples

Fan keeping the supply side on positive pressure

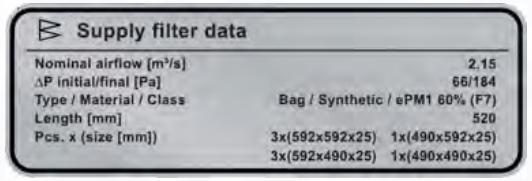


Basic principles of a Hygienic AHU
Selection Examples



3. Basic principles of a Hygienic AHU
Labelling and Documentation

- Operation and maintenance of the complete system is also covered in these standards
- Installation & Operation Manual shall clearly explain how to clean and disinfect the unit
- Filter & Fan Labels shall include some specific information requirements



In a nutshell…

Accessibility

Materials
Corrosion
ISO 846

Components
Selection
Sequence

Cleanability

Casing

Labelling & Documentation

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

Eurovent Certification for Hygienic AHUs

Mr Sylvain Courtey
Technical Director
Eurovent Certita Certification (ECC)

Eurovent Certita CERTIFICATION

Context – Origin of the Program

Environmental context

Environmental Challenges

Energy Performance

Comfort

Quality

"Indoor air quality is a key element of building performance"

Hywel Davies, CIBSE technical director

ECP AHU Existing Program

The existing ECP Program only certify the performance of an AHU:

- Air Flow
- Heating and Cooling Capacity
- Heat Recovery Efficiency
- Etc.

And the casing performance

But there are no Hygienic Criteria

Context – Origin of the Program

NEW Hygienic Option for the Existing AHU Certification Program

The aim of this option is to ensure:

- Hygienic aspects of an AHU
- Air quality for the building
- Components suitable for a hygienic unit
- Compliance with hygienic standards such as EN ISO 846

A certification for all types of commercial buildings

Not only for hospitals

Context – Origin of the Program

How did we proceed to develop this option?

Existing Technical Certification Rule (TCR) Updated

Specific Rating Standard (RS)

Context – Origin of the Program

How did we proceed to develop this option?

AHU Compliance Committee

Technical Sub-committee

Project Development Manager from ECC

Headlines of the Program

First requirement is to be certified in the frame of the Eurovent certification programme for AHU, this includes:

- **Certification of the AHU selection software**
- **Audits of all production places**
- **Test of the complete AHU system including all relevant components**

Headlines of the Program

Certification by range proposing 3 levels of certification represented by stars

Level 3

Level 2

Level 1

Headlines of the Program

The levels can be associated to a type of building

Offices

Schools / University

Hotels

Retails

The levels can be associated to a type of building

Hospitals

A level 2 unit can also be used for an office, a school, a hotel or a retail

The levels can be associated to a type of building

Pharmaceutical

Food Process

White Room

A level 3 unit can also be used for a hospital, an office, a school, a hotel or a retail

The hygienic option consists of a list of requirements covering several categories

59 Requirements overall organized in 3 main categories

General (Manufacture, Shipment, etc.)

Unit Housing (Material, Maintenance, AHU arrangement, etc.)

Air Treatment (Filter, Coils, Fans, etc.)

Program Content – Overview of the requirements

All the requirements are listed in the RS, they are related to the following topics:

General

- Planning
- Manufacture
- Shipment

Unit Housing

- Metallic Materials
- Non-Metallic Materials
- General AHU Arrangement
- Inner Casing Surface
- Inspection, Maintenance and Cleaning
- Filter Maintenance

Air Treatment

- Filter
- Cooling and Heating Coil
- Humidifier
- Dehumidifier
- Heat Recovery System
- Fans
- Silencer

Program Content – Overview of the requirements

Each requirement comprises a description as well as the criteria for each level

A reference document clear and easy to use

Reference of the requirement →

Description of the requirement →

Criteria for each level →

R31. To avoid condensation, the certified model box shall have a minimum thermal bridging class of **X**.

Level 1&2: X=TB3

Level 3: X=TB2

R32. The certified model box shall have at least a tightness class of **X**.

Level 1&2: X = L2 (M)

Level 3: X = L1 (M)

R33. The certified model box strength shall be at least class **X**.

Level 1&2: X= D2 (M)

Level 3: X = D1 (M)

R34. All drain pans, condense trays and water tanks shall have a sufficient slope from any point of the bottom to the drain tube. The requirement is deemed to be fulfilled, if after filling them with 5 l/m² water, minimum the percentage **X** has been drained off over a period of 10 minutes.

Level 1: X = 95% (25 cl/m²)

Level 2: X = 97% (15 cl/m²)

Level 3: X = 99% (5 cl/m²) **and** a suitable disinfection facility is recommended to be used to reinforce the system safety. (Water UV device, etc.)

Note: The manufacturer shall provide the appropriate material to test this requirement during the audit

Program Content – Overview of the requirements

Compared to existing hygienic standard each requirement is quantified or clearly defined

Example on accessibility for inspection and maintenance:

VDI 6022-1:

4.1.1:

Factors decisive for the supply-air quality to be achieved include:

- accessibility for inspection and cleaning of wet and contaminated surfaces in contact with the handled air

4.3.5:

Sufficient space shall be available for maintenance.

ECP Hygienic Option:

IMC-D: IMC Depth

IMC-H: IMC Height

IMC-L: IMC Length

OW: Opening Width

OH: Opening Height

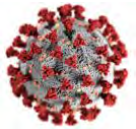
AHU section size (+- 1%)		All Levels		Level 1	Level 2	Level 3
Internal unit depth (= IMC-D) per air stream	Internal unit height (=IMC-H) per air stream	Designed type of IMC (after entering the unit, all relevant inner surfaces shall be reached with the hand)		Minimum IMC length IMC-L (For quickly removable components: including free space when component is removed)		
< 800mm	> 300 mm and <1900 mm	Standing outside and **entering the unit with the arm or with arm plus the shoulder**		250 mm	400 mm	550 mm
≤1000mm	>400 mm and < 1900 mm			400 mm	400 mm	550 mm

Program Content – Overview of the requirements

Reference documents also comprises few requirements on the software

The software shall propose the hygienic option and allow the display of the hygienic certification only if all the requirements listed in the RS are met

Program Content – Overview of the requirements



Pertinent requirements in view of the Covid-19 pandemic

REHVA COVID-19 Guidance (Aug 3, 2020)	ECP AHU Hygienic option requirement
Safe use of HR sections: Internal leakage from exhaust to supply side shall be limited	Section V.3.e **Heat Recovery System** (R51 to R53) Internal leakage <5% Sufficient filtration on supply or return side
Maintenance: "Rotary air to air heat exchangers …] may be liable to significant leakages in the case of poor design or **maintenance**" "Clogged filters are not a source of contamination in this context, but they reduce supply airflow, which has a negative effect on reducing indoor contaminants level. Thus, filters must be replaced according to normal procedures when pressure or time limits are exceeded, or according to scheduled **maintenance**."	Section V.2.e **General Requirements to the casing for Inspection, Maintenance and Cleaning (IMC)** (R20 to R26) Any component shall be easily accessible or quickly removable.

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Fundamentals of Air Handling Units

Mr Saad Ali
General Manager
Clima Uno AC Industries

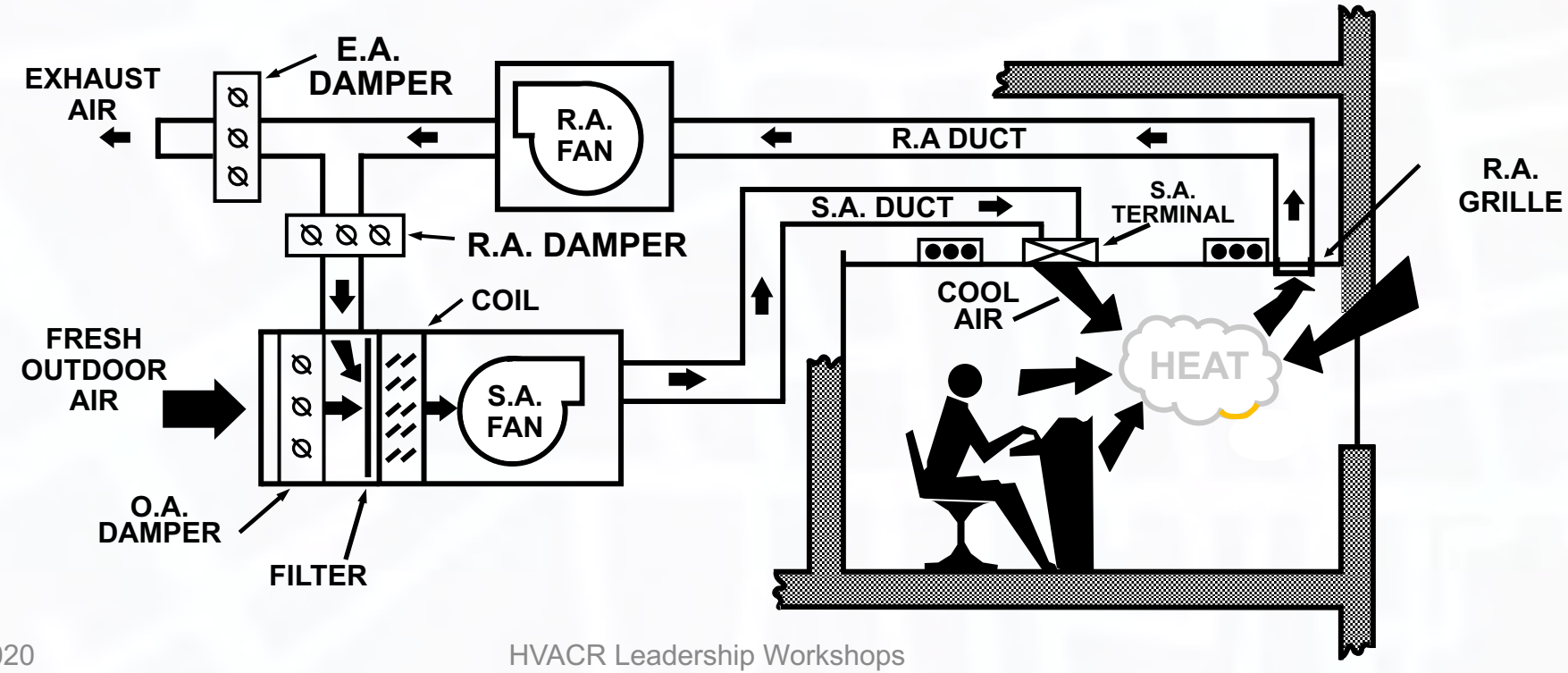
CLIMA UNO®

What is an Air Handling Unit?

An air handler, or Air Handling Unit, is a device used to regulate and circulate air as part of a heating, ventilating and air-conditioning system.

Types of Air Handling Units

- There are two types of AHUs: -
  1. Constant volume (CV) AHU
  2. Variable air Volume (VAV) AHU



Types of Air Handling Units

Fresh Air Handling Unit

- Used for cooling ambient air
- Medium to large capacities
- Provision for exhaust air
- Provision for Heat Recovery options

Why do we need AHUs?

Conditions of air required for *comfortable* human occupation

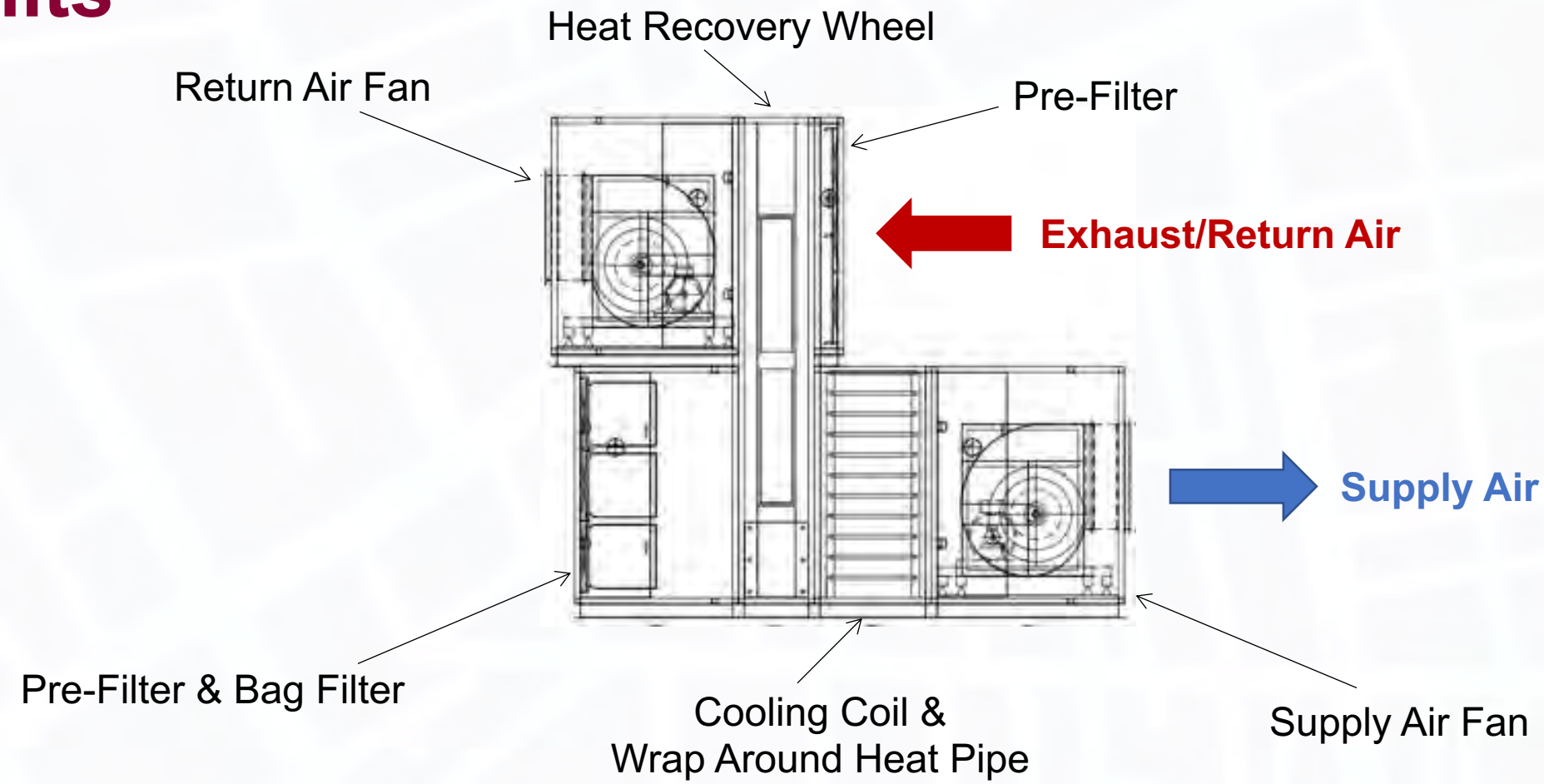
- Dry Bulb Temperature 23±2°c
- Humidity less than 60% RH
- CO2 level below 1000 ppm
- Free from particulate matter, dust, smoke
- Free from Viruses & Bacteria
- Non-Odourous

Why do we need AHUs?

Issues faced due to non ideal air conditions

Pollutant	Symptoms
Carbon monoxide	Headaches, Dizziness, Weakness, Nausea
Formaldehyde	Irritate the eyes, nose & throat, cause headaches, nausea, and damage to the liver, kidneys and central nervous system
Nitrogen dioxide	Respiratory symptoms, airway inflammation and decreases in immune defense, shortness of breath and increases risk of respiratory infection.
Asthma triggers (Molds, dust mites, secondhand smoke & pet dander)	Chest tightness, wheezing, and breathing problems. An asthma attack occurs when symptoms keep getting worse or are suddenly very severe. Asthma attacks can be life threatening

Basic Components of Fresh Air Handling Units

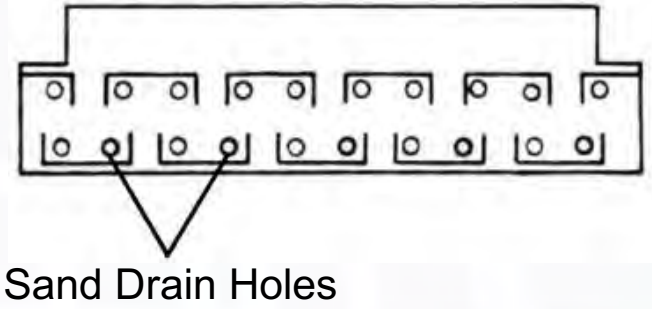


Sand Trap Louver

Sand trap louvers are specially designed to protect air intake from wind-driven sand.

This is used in FAHUs in dusty areas, to reduce the amount of sand/dust reaching the filter section.

Example of a Sand Trap Louver



Cross Section View

Filter Section

Air must be filtered before it is dehumidified & cooled so that the air in the conditioned space is free from particulate matter such as dust, sand, pollen, dander etc. Additionally, odours also must be removed in certain cases.

Filters in Air Handling units are broadly classified into the following categories:

- Coarse filters (Panel or Pre filters)
- Fine filters (Bag filters)
- Absolute filters (HEPA filters)
- Gas phase filters (Carbon filters)

Filter Section

Coarse Filters

- Filters Dry dust.
- Used as a pre filter to higher efficiency filters downstream.
- Synthetic filter media supported with metal mesh placed into metal frame.
- Media placed in zig-zag shape for low pressure drop and high dust holding capacity.

Fine Filters

- High efficiency filter after first stage filter.
- Series of sealed bags for high airflow and low pressure drop.
- Frame can be plastic or galvanized steel.

Heat Recovery Wheel Section

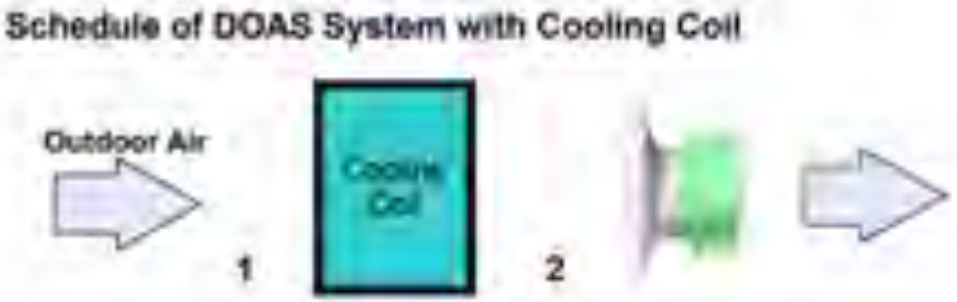
A **heat recovery wheel**, also known as a **rotary heat exchanger**, or **thermal wheel**, is a type of energy recovery heat exchanger positioned within the supply and exhaust air streams of an air-handling system.

A heat recovery wheel is slowly rotated within the supply and exhaust air streams of an air-handling system.

During rotation waste cooling energy from the exhaust air stream is transferred to the fresh air stream, reducing the temperature of the supply air stream by an amount proportional to the temperature differential between air streams.

Heat Recovery Wheel Section

FAHU without Heat Recovery

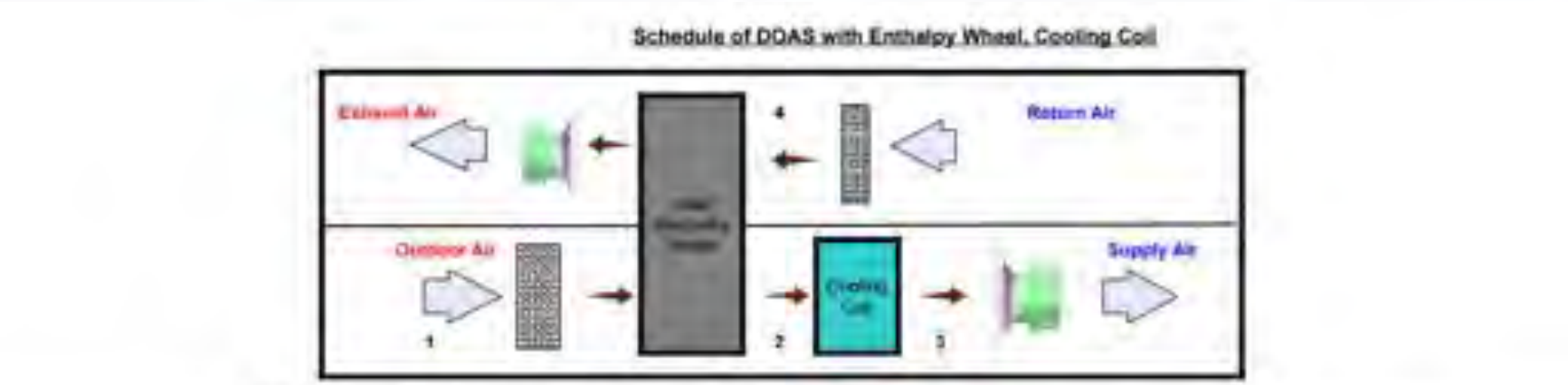


Air Flow (m3/h): 17000

S. No	Cities	1			2			Cooling Coil Capacity	
		Outdoor Air Conditions			Off Coil Conditions			Sensible Load (TR)	Total Load (TR)
		DBT °C	g/kg	kj/kg	DBT °C	g/kg	kj/kg		
1	Dubai Peak 1	46.1	20.4	99.1	12.78	9.20	35.98	54.0	98.6
2	Dubai Peak 2	35.0	25.1	99.6	12.78	9.20	35.98	36.0	99.3

Heat Recovery Wheel Section

FAHU with Heat Recovery



Air Flow (m3/h): 17000

S. No	Cities	1 Outdoor Air Conditions			2 Off Wheel Air Conditions			3 Supply Air Conditions			4 Return Air Conditions			Cooling Coil	
		DBT °C	G/Kg	Kj/Kg	DBT °C	G/Kg	Kj/Kg	DBT °C	G/Kg	Kj/Kg	DBT °C	G/Kg	Kj/Kg	Sensible Load (TR)	Total Load (TR)
1	Dubai Peak 1	46.1	20.4	99.1	28.91	12.11	59.94	12.78	9.20	35.98	23.89	9.24	47.46	29.15	37.68
2	Dubai Peak 2	35.0	20.1	89.6	28.37	13.31	60.38	12.78	9.20	35.98	23.89	9.24	47.46	22.02	38.35

By incorporating a Heat Recovery wheel, we can see a saving of 60% of cooling load in this example

Cooling Coil Section

A cooling coil is the primary component of an Air Handling Unit that is used for cooling & dehumidifying air, which can be either Fresh Air or Recirculated. It is often referred to as the heart of the AHU.

They are broadly classified into 2 types:

1. Chilled water coils
2. Direct expansion refrigerant coils

Cooling Coil Section

$$\text{Coil Face Velocity (m/s)} = \frac{\text{Airflow } m^3/s}{\text{Coil Face Area } m^2/s}$$

Air Velocity TOO LOW

- Non uniform leaving air temperatures
- Less accurate coil capacity readings

Air Velocity TOO HIGH

- Noise
- Higher air pressure drop
- Moisture carry over

A general guideline as per AHRI states that face velocity should not exceed 500 feet per minute (2.54 m/s) to avoid moisture carryover.

We can exceed 2.54 m/s, but we will have to include a drip eliminator.

Cooling Coil Section

Smaller coil face area

- Lower cost
- Smaller AHU footprint
- Higher air pressure drop
- Higher water pressure drop

Larger coil face area

- Higher cost
- Bigger AHU footprint
- Lower air pressure drop
- Lower water pressure drop

We can be flexible in designing based on a project-to-project basis

Fan Section

Fan section, often referred to as the blower is used to maintain the airflow rate and pressure through the AHU and duct system.

Classification based on blade geometry

- Forward curve
- Backward curve
- Airfoil

Classification based on blower construction

- Centrifugal (DWDI) fan
- Plenum fan

Fan Section

Centrifugal Belt Driven Fan

- Double-width Double-inlet (DWDI)
- Motor drives fan via pulley-belt system
- Easier to make minor manual adjustments
- VFD for speed control (optional)

Centrifugal Plenum Fan

- Single-width Single-inlet
- Motor directly mounted to fan
- Overall fan section is smaller
- VFD is mandatory

Fan Section

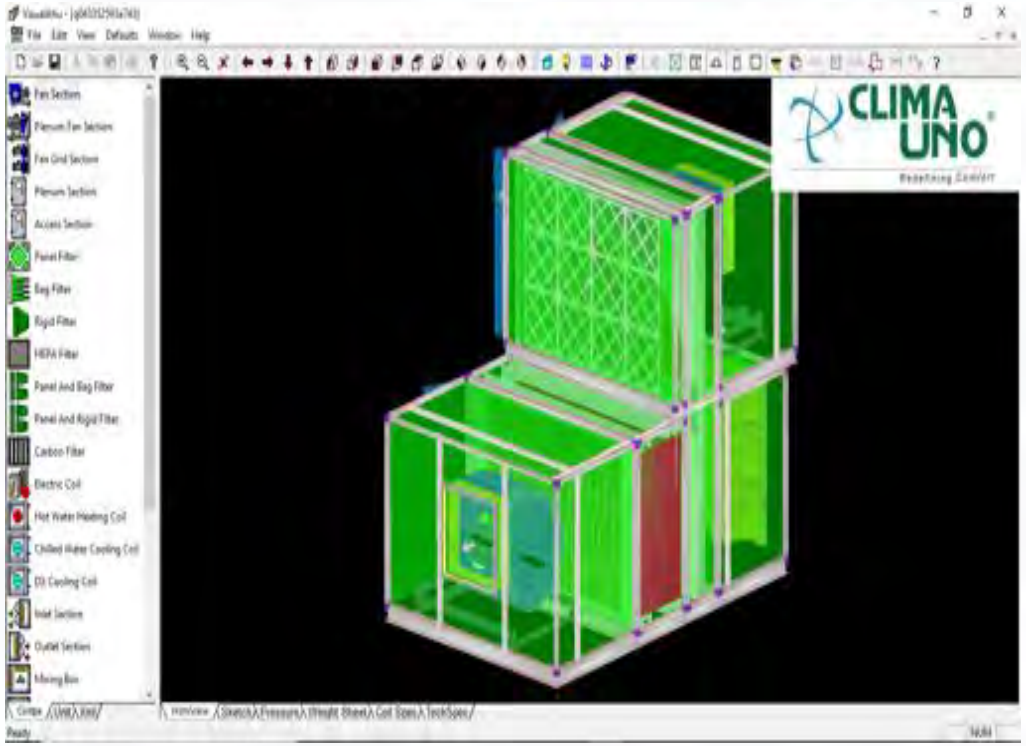
EC Fan (Electronically Commutated)

- Brushless EC motor
- Impeller directly coupled to motor
- Vibration isolators not required

Fan Wall or Fan Array (EC Fan)

- Load is shared in an array of smaller fans.
- Overall length reduced.
- Single fan failure will not affect the unit.

Selection Software for AHU Design



Software Features

- Certified (Eurovent)
- FAHU, AHU, ECU design
- Load calculations
- Includes technical selection of all components such as heat recovery devices, coils, fan/motors, filters.
- Flexible design to suit customer requirements

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Construction features in Hygienic AHUs and UVGI

Ms Lubna Shaikh
Business Development
Trosten Industries

TROSTEN®

Features of Hygienic AHU
Construction and Components

- Casing
- Fans
- Heat Exchangers
- Mechanical Filters
- UVGI

VDI 6022-1

DIN 1946-4

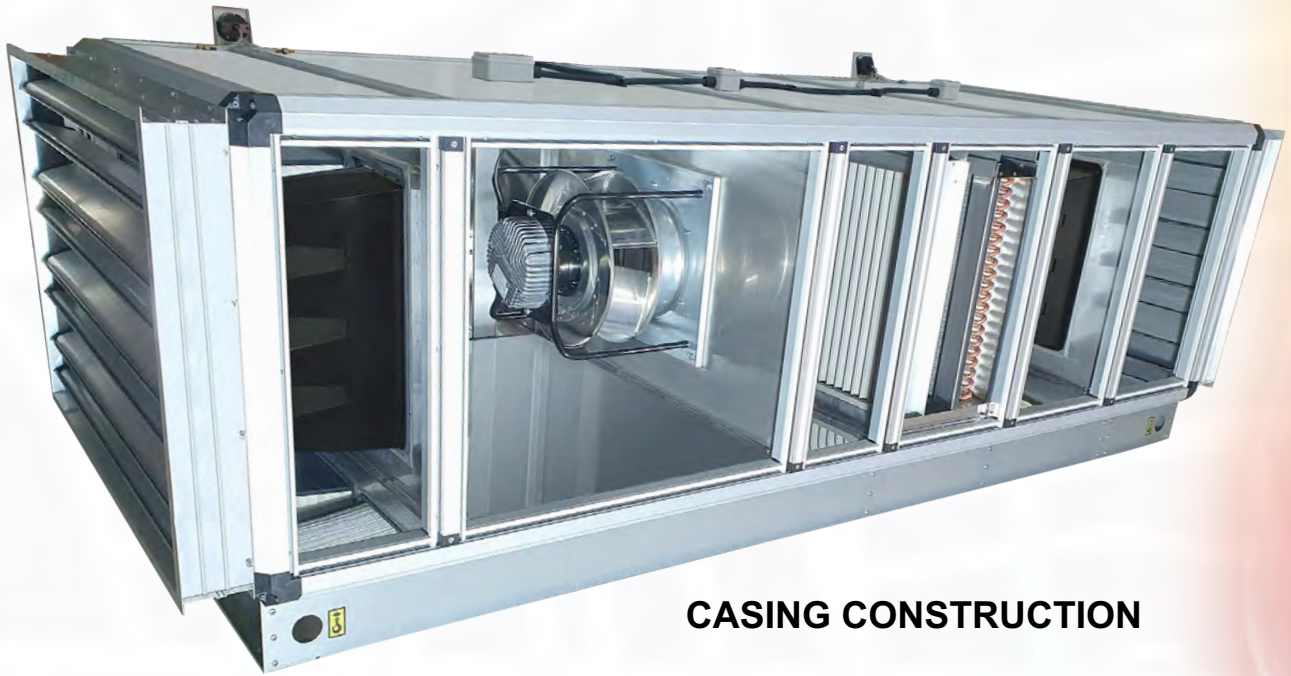
RS 6/C/011-2018

Casing Construction

- Floor Panels (inner): Stainless Steel/Aluminium
- Side & Roof Panels (inner): Minimum Sendzimir-galvanized steel with coating
- Inner surface shall be smooth, without grooves and recesses for effective cleaning
- Stainless steel hardwares and fasteners (non-ferrous materials)
- Hexagonal, plain head fasteners are permitted. While, PH head fasteners are not permitted

Casing Construction

- Gaskets and nylon parts to comply microbial inertness certified in accordance with the ISO 846 standard
- All gaskets should be of closed cell construction, removable or foam type. Glued gaskets are not permitted
- Casing height ≤0.8 m shall have removable access panel and for casing with clear height of ≤1.6 m, AHU components shall have access upstream and downstream or be easily removable type



CASING CONSTRUCTION

Fans

- Fans should be Plug type for the ease of cleaning the impellers
- Belt driven fans are not permitted
- Coated steel impellers
- Any other steel component as a part of fan assembly to be coated

PLUG FANS

Heat Exchangers Construction

- Wet section MOC shall be of stainless steel. (Coil end plates and drain pan)
- Depth of the cooling coil shall not exceed 300mm
- Coil coating is permitted only if the coating is VOC free, complying to microbial inertness and abrasion resistant
- Droplet Eliminator of Nylon (microbial inertness complied) / stainless steel are permissible
- Fin concentration not to exceed 12 FPI

HEAT EXCHANGER

Heat Exchangers
Drain Pan

- Drain pan MOC shall be stainless steel
- Drain pan construction should be designed to completely drain 5 litres of water per square metre within 10 minutes without any stagnation of water in the drain pan
- Drain pipe shall be minimum of 40mm in diametre

DRAIN PAN

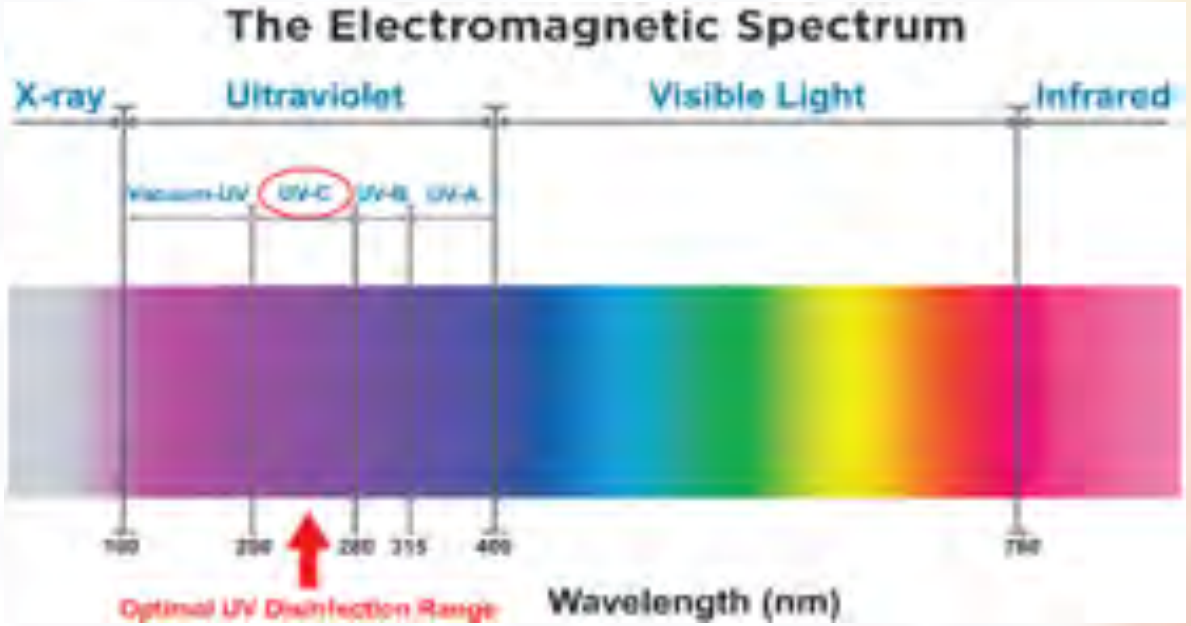
Mechanical Filters

- 1st stage filtration shall be of ISO ePM1 ≥ 50% (F7 grade) and 2nd stage filtration shall be of ISO ePM1 ≥ 80% (F9 grade).
- Filter removal to be of front-loading arrangement meeting F9 class of filter by-pass leakage
- Pressure differential monitoring is mandatory for each stage of filtration

FILTER MOUNTING ARRANGEMENT

Ultraviolet Germicidal Irradiation (UVGI)

- The sun produces specific UV wavelengths that destroy and deactivate biological and chemical contaminants
- Ultraviolet lamps produce the same UV wavelengths as of sun.
- UV-C energy alters the DNA of microorganisms preventing them from reproducing.
- UVC (254nm) wavelength used to disinfect fungi, mold, viruses.



UV-A (315nm -400nm)
- Black lights and tanning lamps

UV-B (280nm -315nm)
- Resin/ink curing, Medical treatments

UV-C (200nm -280nm)
- Germicidal -destroys DNA in cells, optimum at 254 nm

Ultraviolet Germicidal Irradiation (UVGI)

- Effective UV irradiation depends on location of UV lamps, dwell time and air velocity
- Recommended to place downstream of evaporator coil for disinfection (ASHRAE)
- Reduce the pressure drop and increase the efficiency of the cooling coil
- Different intensity lamps for air disinfection

UVC LAMPS

EUROVENT MIDDLE EAST

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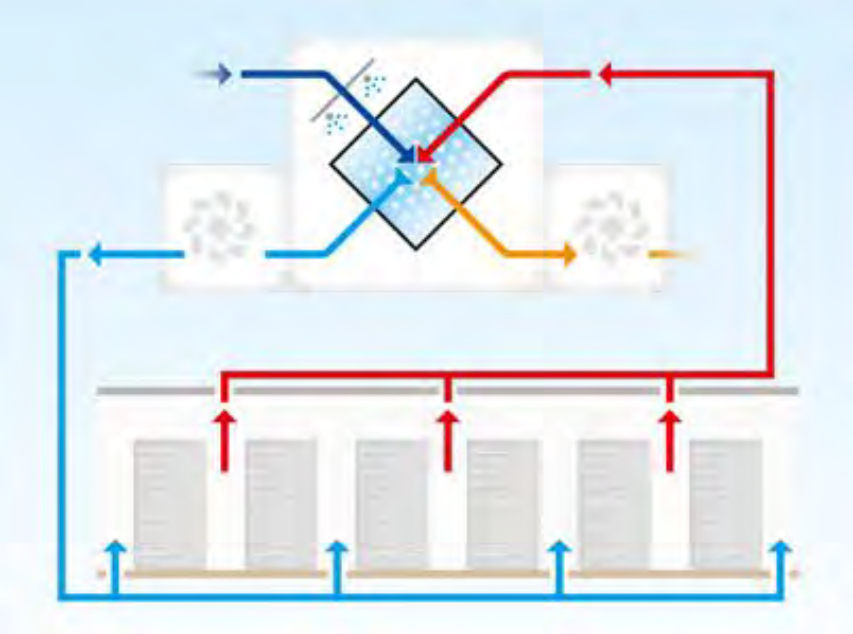
Energy recovery solutions

based on integrated logic between humidifiers and energy recovery

Mr Paolo Liberati
Project Leader R&D
Recuperator, CAREL Group

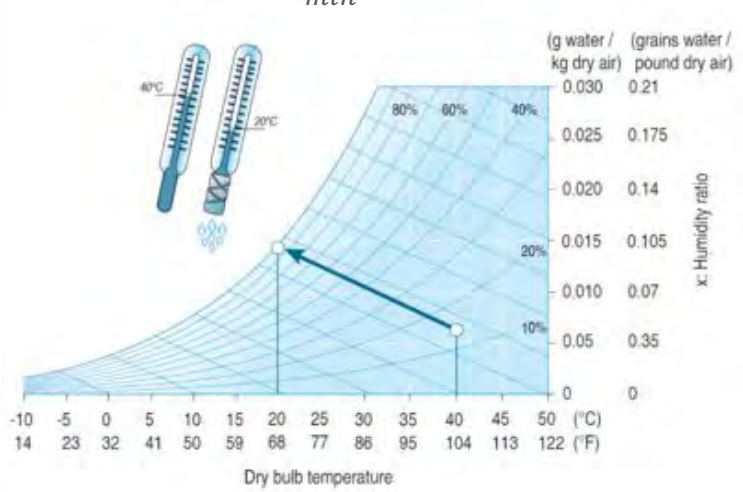
RECUPERATOR
member of CAREL group CAREL

Indirect Evaporative Cooling (IEC)



Wet bulb effectiveness

$$\varepsilon_{wb} = \frac{\dot{m}_p\left(T_{p,in} - T_{p,out}\right)}{\left(\dot{m}_p, \dot{m}_s\right)_{min}\left(T_{p,in} - T_{wb,s,in}\right)}$$



The use of indirect evaporative cooling technologies is an effective way to reach high energy efficiency systems and to reduce primary energy consumption In particular, such devices can be used in summer conditions to reduce chiller load in both existing and new buildings

Indirect Evaporative Cooling
Where can it be used?

Indirect Evaporative Cooling
What it is comprised of?

The overall efficiency of this kind of system depends on the performance of the individual components: the heart of the system is the **heat exchanger** and the **adiabatic humidifier**.

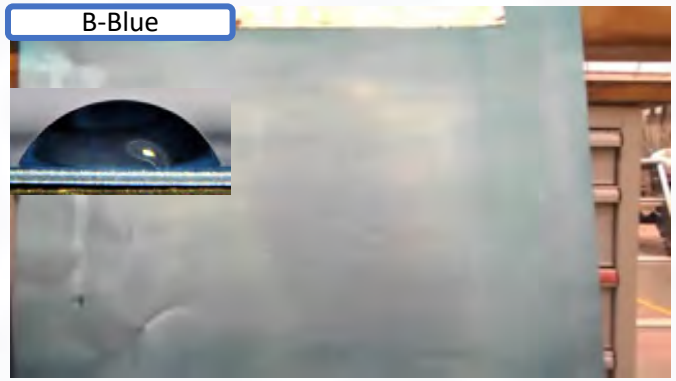
The components
Adiabatic humidifier

- Better absorption efficiency due to the smaller droplets
- Better temperature control
- Reduced pressure drop compared to wet pads
- Reduced maintenance, as the wet pad needs to be replaced periodically
- Possibility to easily create redundancy by doubling he spray systems: a double wet pad means either two ducts or double the pressure drop
- Possibility to wet the surface of the HX

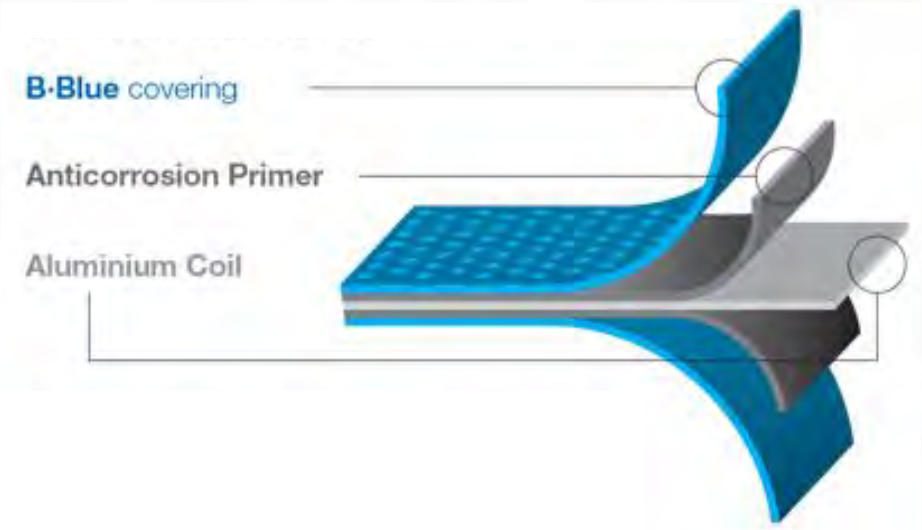
The components
The plate heat exchanger

- Best dry efficiency, meaning evaporative cooling is only used when necessary, thus optimising its water usage effectiveness
- It guarantees the best air and water tightness
- It can withstand a high differential pressure between the two air flows
- It can withstand ice formation due to its elastic modulus
- It can be washed using a high pressure cleaner without damage

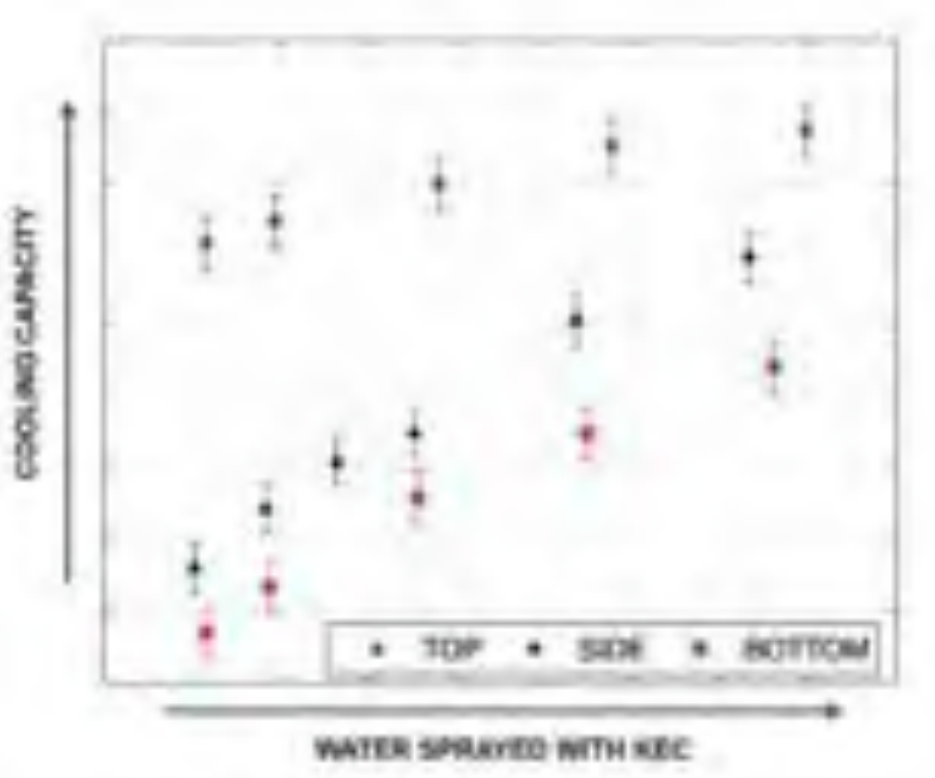
The components
The plate heat exchanger



- The hydrophilic adsorption coating increases the wettability of the plate compared to the standard epoxy protection increasing the cooling capacity of the system



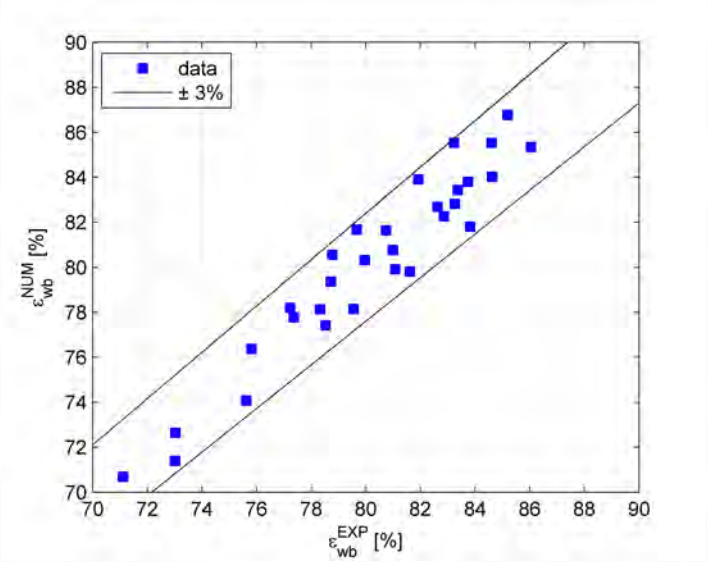
The performance
PHX and AH configurations

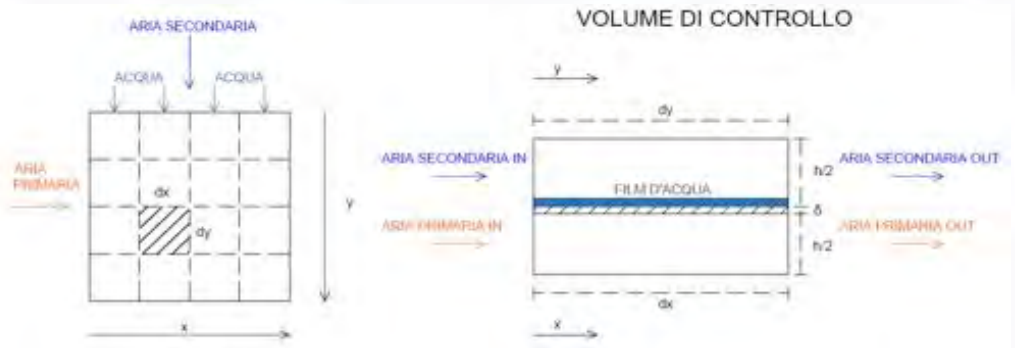


Different arrangements of the humidifier and PHX are possible. Research studies carried out by Recuperator and University of Milan show the performance trend of IEC systems for different configurations in terms of water sprayed

Case study
The model

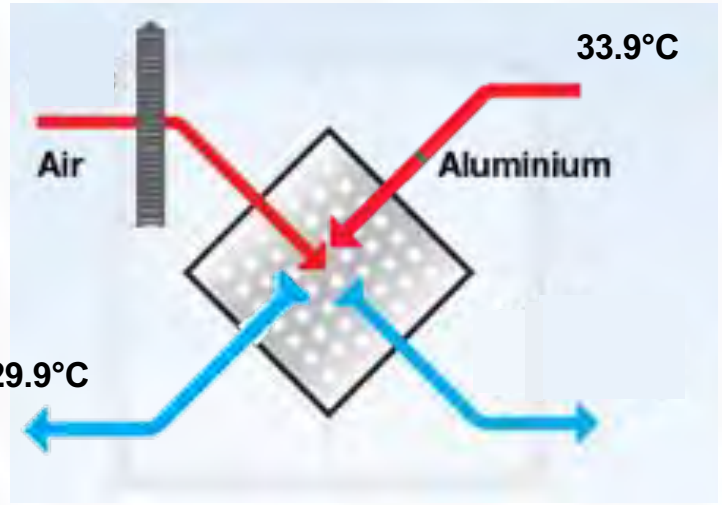
A software Rex, developed on the numerous results of the studies conducted on the indirect evaporative cooling technology, is used to evaluate the advantage of the IEC technology



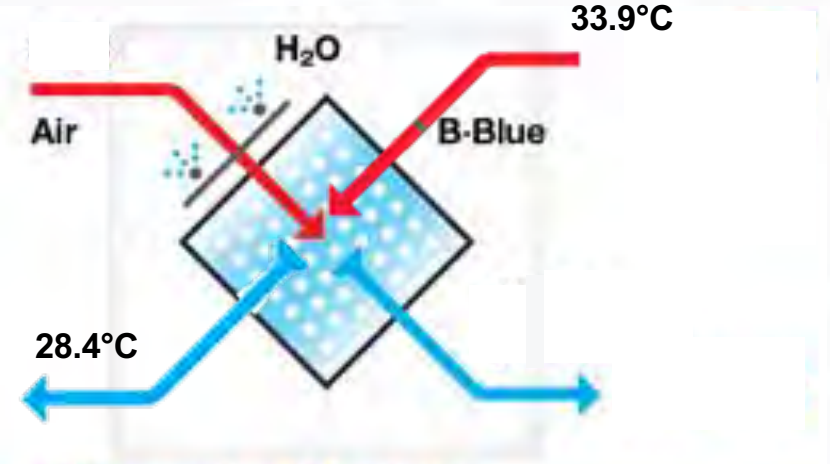


Case study
Comparison Data Centre Application

Data centre airflow: 43407 m³/h @ 33.9°C / 27%
Outdoor airflow: 33577 m³/h @ 40.2°C / 30%



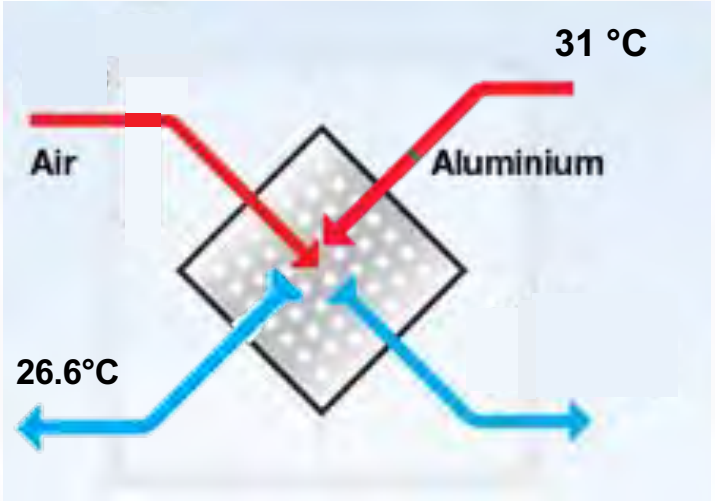
Wetpad Efficency 90%
FQ **AL** 20 N 2000 C 1 TV AE NS DC
58.1 kW



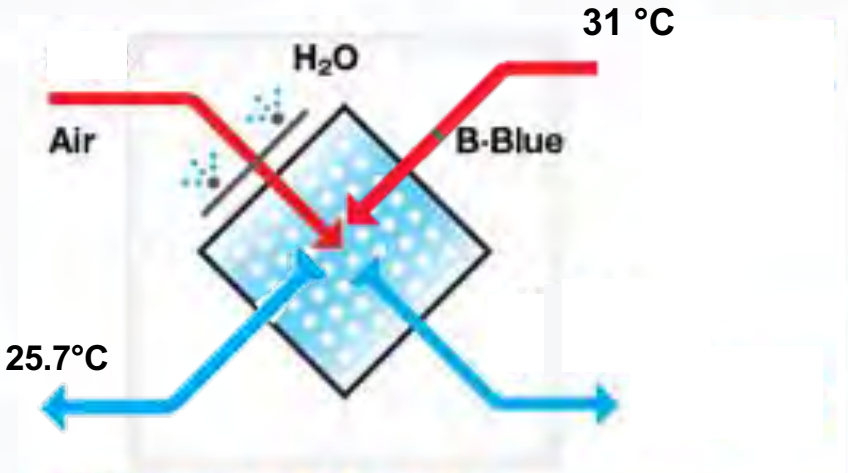
Water sprayed MP 1000l/h
FQ **AB** 20 N 2000 C 1 TV AE NS DC
79.5 kW (+36%)

Case study
Comparison Hospital Application

Supply airflow: 5000 m³/h @ 31°C / 60%
Outdoor airflow: 5000 m³/h @ 25°C / 50.1%



FI **AL** 08 N 1000 C 1 TV AE DC X2
6.4 kW



Water sprayed MP 30l/h
FI **AB** 08 N 1000 C 1 TV AE DC X2
8.8 kW (+37%)

Summary

- The Indirect evaporative cooling technology is able to reduce the energy consumption during summer period for industrial and NRVU applications
- The heart of the system is composed by the adiabatic humidifier and the plate heat exchanger, their combination and “interaction” can make the difference
- The arrangements of the system strongly increase the final performance of the system

EUROVENT MIDDLE EAST

HVACR Leadership Workshops

EC Fan Technology in Air Handling Units

Mr Koen Van Nistelrooij
Managing Director
Ebm-papst Middle East

ebmpapst

the engineer's choice

What is an EC plug fan?

All you need in 1 product

1 wall-plate

3 impeller

5 electronics

2 inlet ring

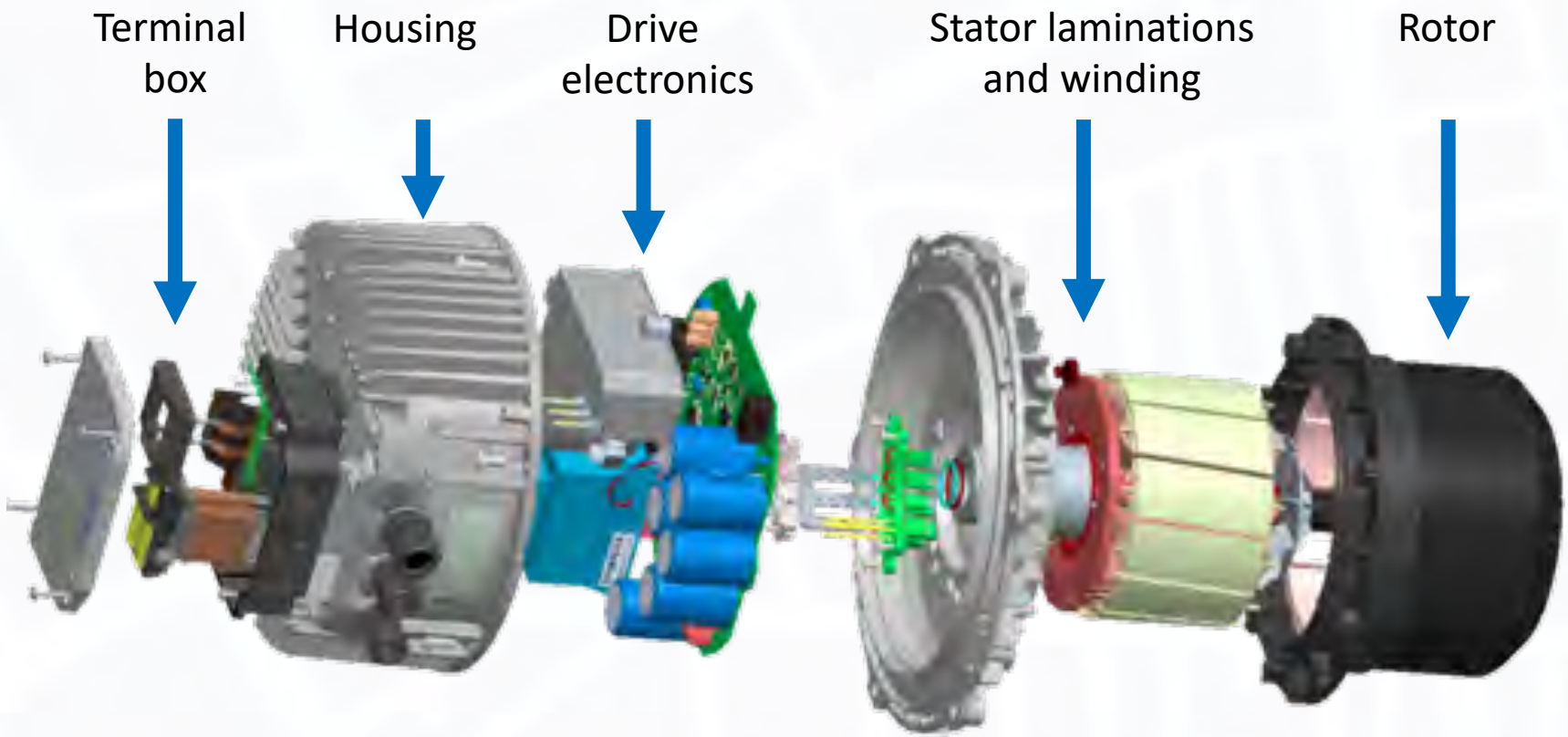
4 EC motor

6 support bracket

=

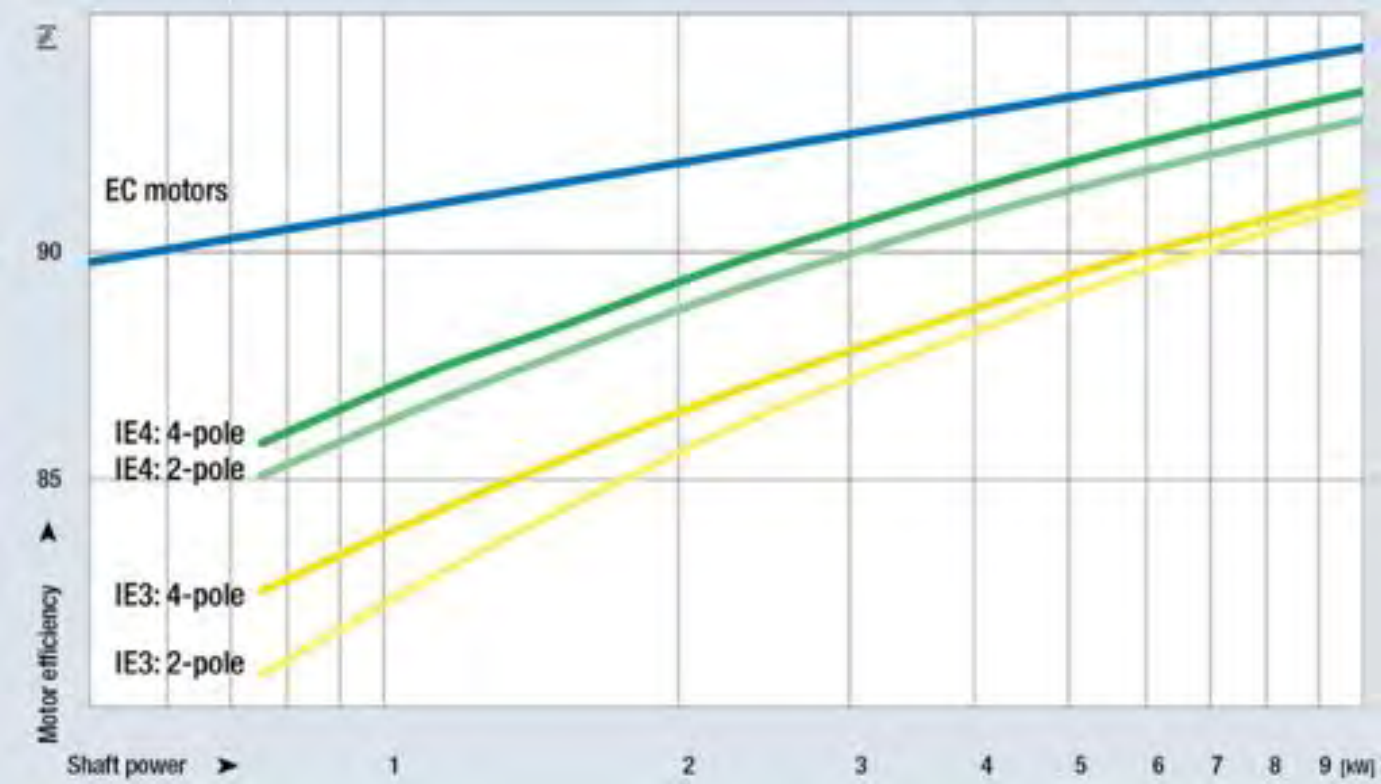
EC motor technology

EC motor details



EC motor technology

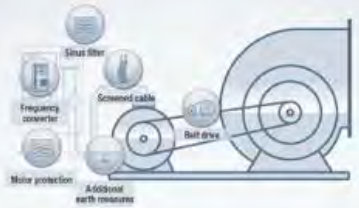
EC motors are ready for the future



Advantages EC plug fan in AHU

Plug and play solution with higher efficiency

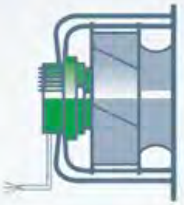
Component Based AC Fan System



- Each component is tested by itself and not as an entire system
- Typical **static efficiencies** wire-to-air range (but not limited to) from **40% to 55% for these systems** based on deployed/ measured data in various retrofit cases
- **Components have to be installed seperately**, which takes up considerable time and effort

VS

Integrated EC Fan System

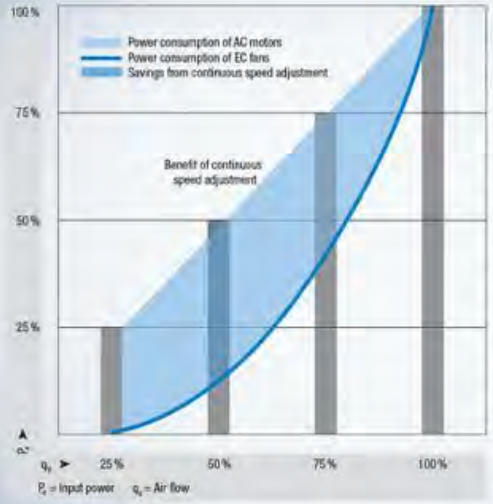


- The impeller, motor, variable speed drive and filters **are tested as a complete system**
- Components are optimised for each other
- **Static efficiencies** wire-to-air range from **60% - 70%** when deployed
- The system is much more **compact** and **easy to install**

Advantages EC plug fan in AHU

Lower energy consumption and less noise

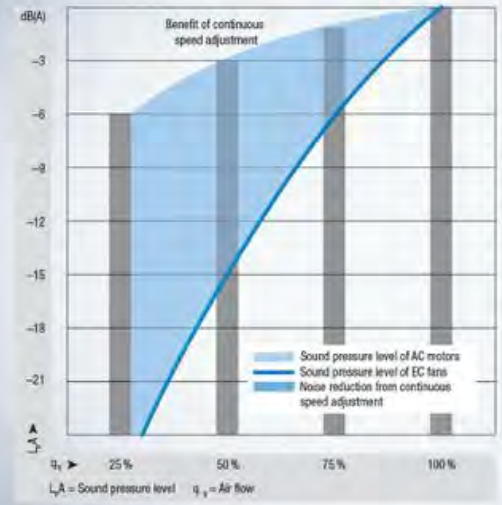
Lower Energy Consumption



The grey bars show the power consumption of fans which are switched on gradually as required (staging). The air performance drops by 50 % if two fans are switched off. The blue curve shows the power consumption with in-built variable speed control, resulting in up to 80% energy savings.

&

Less Noise

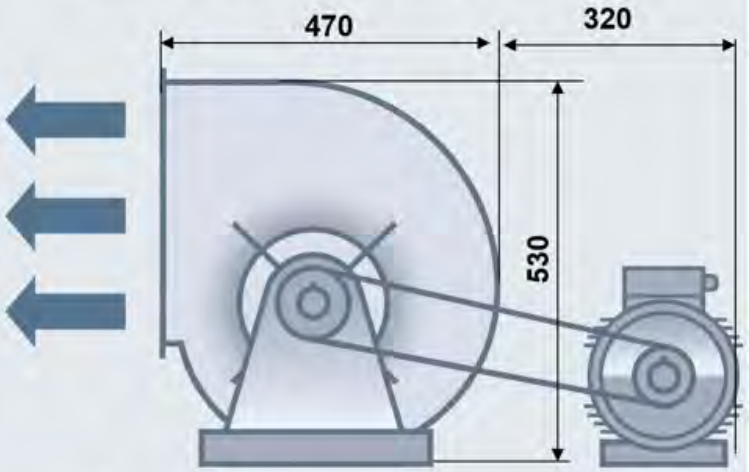


Whereas switching off half the fans (halving the air flow) only reduces noise generation by approximately 3 dB, speed reduction to half the air flow yields an improvement of 15 dB.

Advantages of EC plug fan in AHU

Less space required

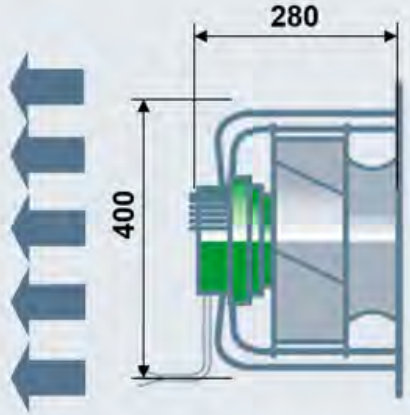
Double inlet blower,
forward curved impeller
Size 280 – 4000 m³/h @ 450 Pa



- - Fans with scroll need more space, especially in flow direction!

VS

Fan without scroll,
backward curved impeller
Size 355 – 4000 m³/h @ 450 Pa



+ + Direct driven
no belt and pulleys needed!!!

Retrofit in AHUs

EC plug fans are made for retrofit

Existing unit

Retrofit unit

Advantages of Retrofit

- 30-40% energy savings for like for like airflow
- 60-70% energy savings when modulating at parts load compared with fixed speed
  - Driven by 0-10v input signal or BMS
- Increased life span of existing AHU
- No maintenance costs on fans (no belts, pulleys or grease required)
- Lower noise
- Redundancy possible during fan failure


Thank You!