Filtration Solutions in COVID19 times

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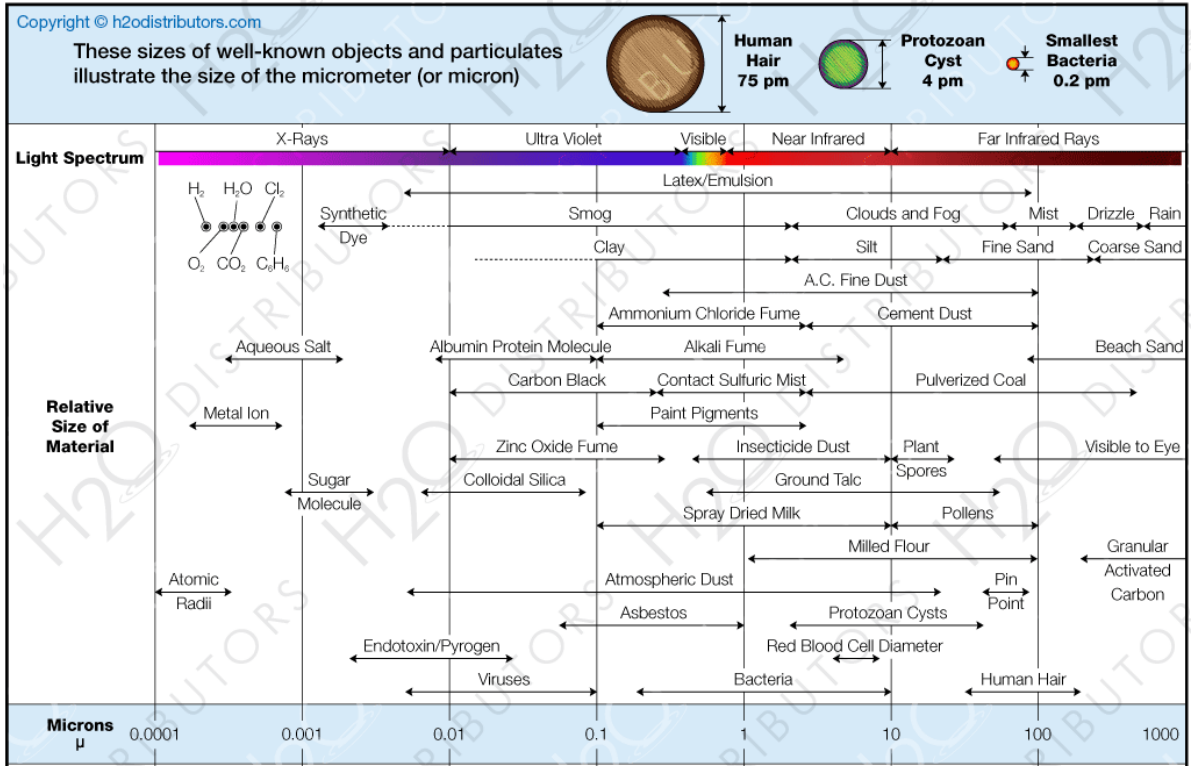
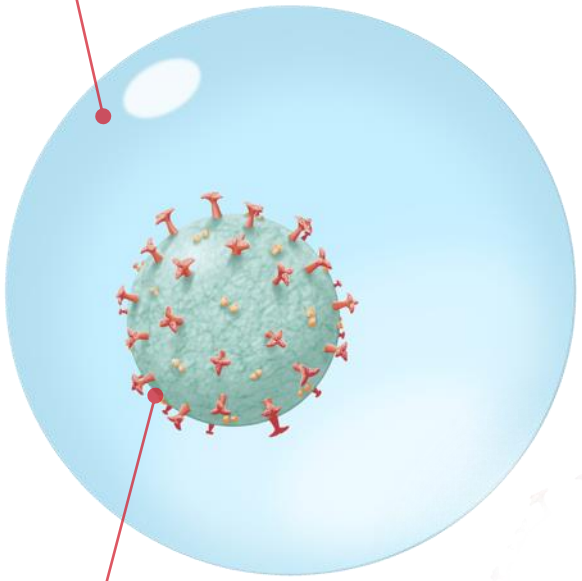
Particle sizes

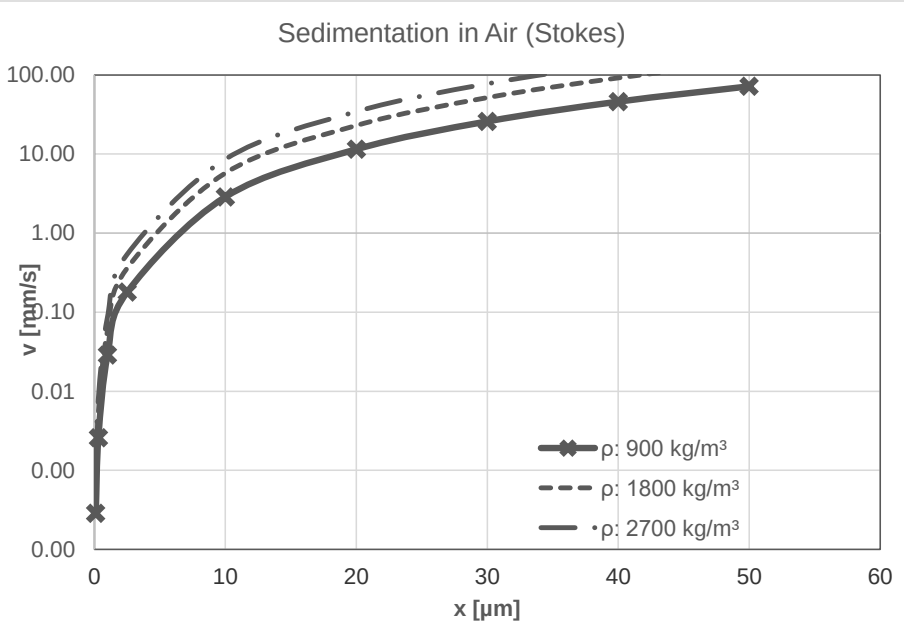


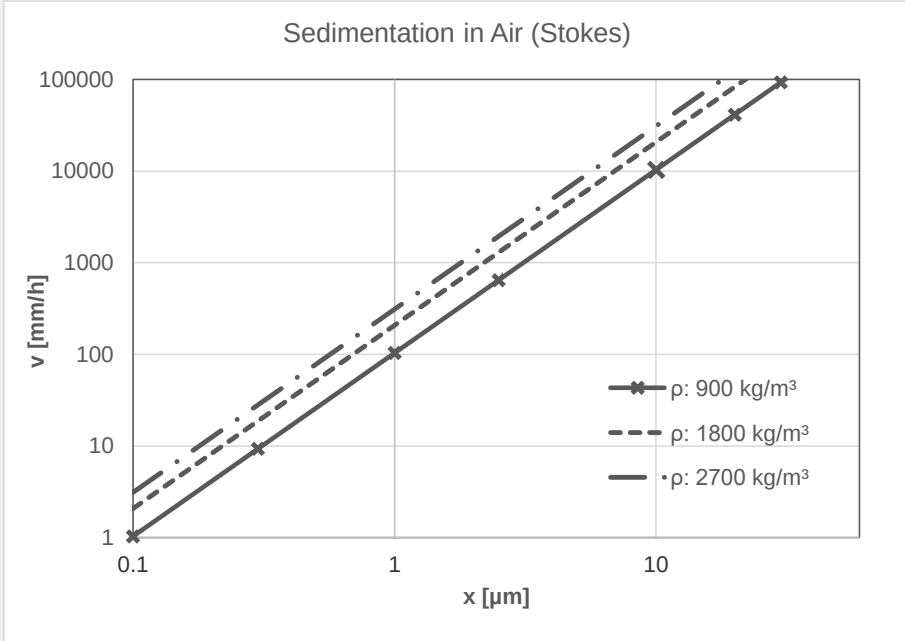
liquid droplet >1 µm (saliva – water, sugar, salts, proteins) when exhaled, drying out down to <1 µm



Corona virus
Ø approx. 0,130 µm

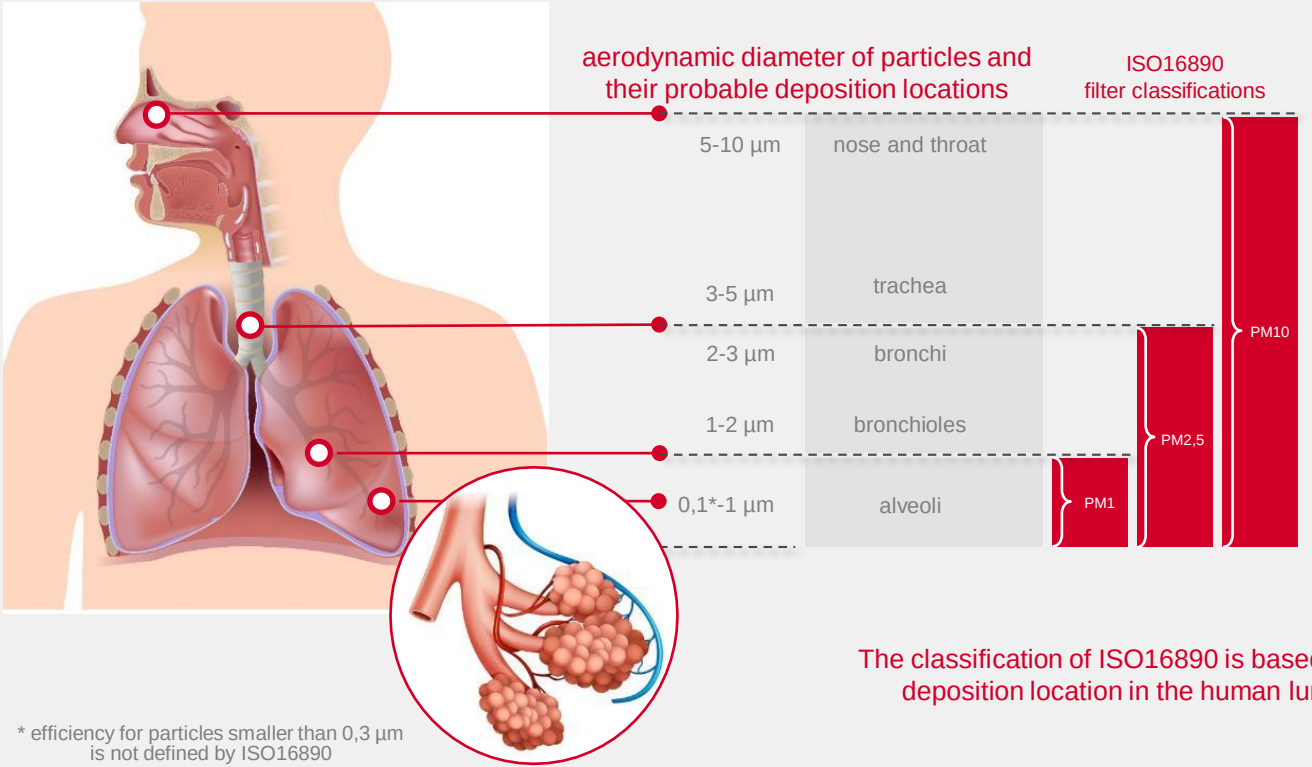
Particle Settling Velocity (Sedimentation)





Stationary settling velocity, Stokes laminar flow regime, 20°C, 1bar

Particle size ranges PM_{10}, $PM_{2,5}$ und PM_1



The classification of ISO16890 is based on the deposition location in the human lungs.

* efficiency for particles smaller than 0,3 µm is not defined by ISO16890

Actual filter clases – filtration efficiency and pressure drop

increasing filtration efficiency but also increasing pressure drop

ISO16890

ISO coarse	ISO ePM_{10}	ISO $ePM_{2,5}$	ISO ePM_1
30 Pa	65 Pa	90 Pa	115 Pa

Typical pressure drop values at nominal air flow (EUROVENT listed filters, median values)

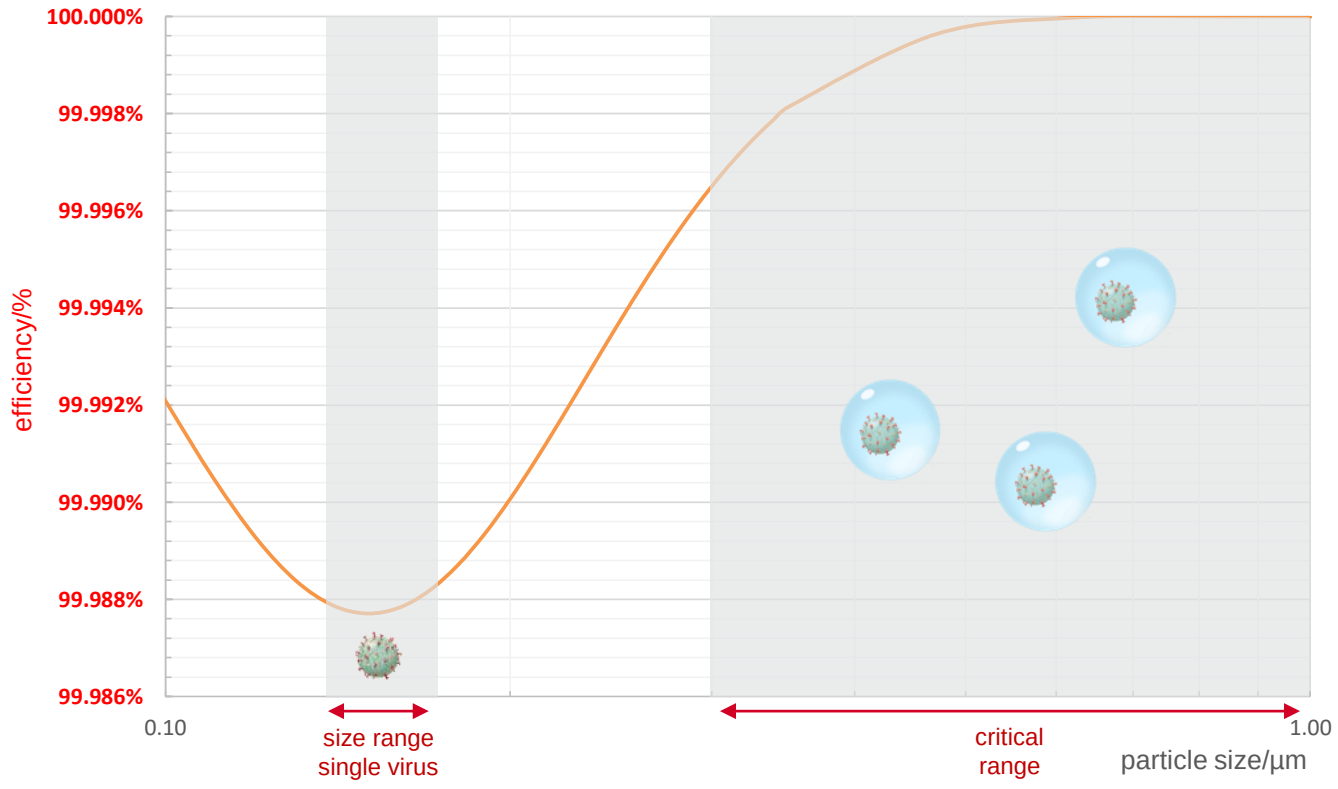
EN1822

HEPA

H13: 200-250 Pa
H14: 250-300 Pa

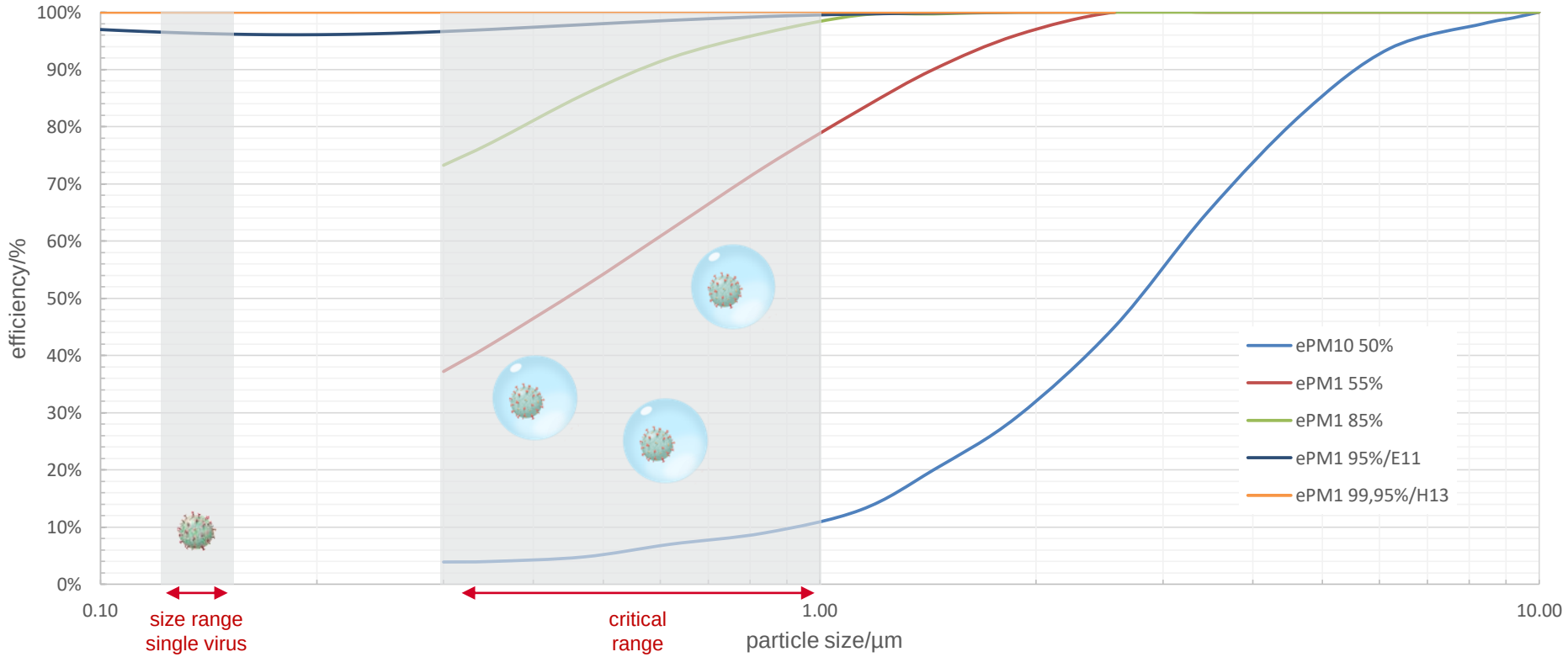
- problematic in retrofitting
- Usually the installed fan power is not sufficient
- possibly also problems with leaks

Filter efficiency H13 HEPA filter for critical particle sizes



- HEPA filters are well suitable to filter viruses and virus loaded particles.
- As higher the filter class as better.
  - H13 reducing virus load by >99,95%.
  - H14 reducing virus load by >99,995%.
- But HEPA filters generate relatively high pressure drop compared to filters usually used in air handling units.
- Although HEPA filter installation would make a lot of sense in terms of filtration efficiency, the high pressure drop would require an upgrade of the fan and the whole air handling unit and duct work might run into air leakage problems.

Filter efficiencies for critical particle sizes



Ventilation and air exchange

ASR 3.6: Supply air that is conducive to health - remove material loads, moisture loads, heat loads - CO_2 content as a quality criteria

Natural ventilation:

Window ventilation: burst ventilation, continuous ventilation

free ventilation (one-sided ventilation, cross ventilation)

Mechanical ventilation:

Must ensure CO_2 content of <1000ppm

Must be state of the art (VDI6022)

Air change and number of air changes:

Exchange of all air within an hour

With virual load:

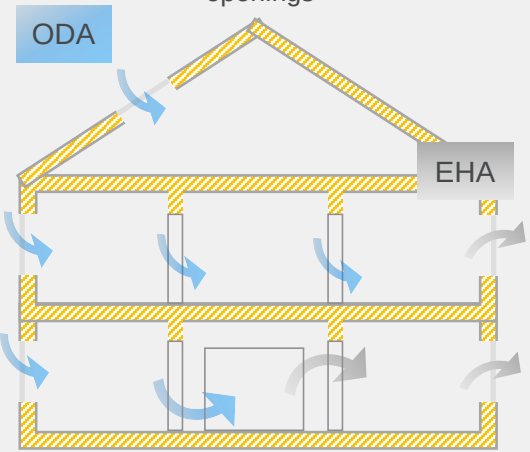
Dilution of the aerosol = reduction of the risk of infection

	Exemplary typical air exchange rates from practice (1 / h)	
	Min.	Max.
Living room	0,5	3,6
Class room	2	
Office space	1	4-8
Movie theater		5-8
Shower room		15-25

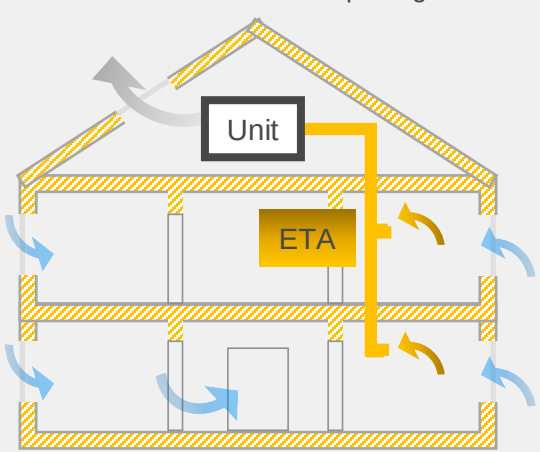
Ventilation options

Remove material loads, moisture loads, heat loads - free and mechanical ventilation, recirculation

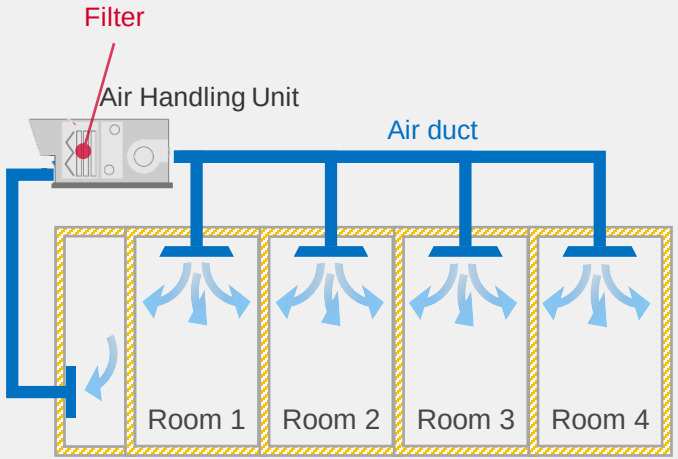
Free Ventilation
via windows and door openings



Mechanical Ventilation
extract system with central fan and fresh air supply via windows and door opening



Recirculation System



ODA	Out Door Air
ETA	ExTract Air
EHA	ExHaust Air

Ventilation and air changes

So far ventilation was focussing on managing indoor:

- odors
- humidity
- temperature
- CO_2 concentration (easy to measure quality criteria for „fresh“ air)

Diluting indoor air with fresh virus free air is reducing virus load:

➔ More ventilation

➔ Lower risk!

Limiting factors:

- fan capacity
- comfort (draft)
- noise level
- energy consumption

Air Change Rate as measure for ventilation:

$$ACR = \frac{\dot{V}}{V_{Room}}$$

ACR	Air Change Rate (1/h)
V_{Room}	Volume of room (m^3)
$\dot{V}$	Volume flow (m^3/h)

Example:

- volume of room: 5,0 x 4,0 x 3,5 = 70 m^3
- volume flow: 210 m^3/h
- ACR: 210/70 = 3 (1/h)

➢ 3-times per hour the air is changed in the room, e.g. one air change every 20min

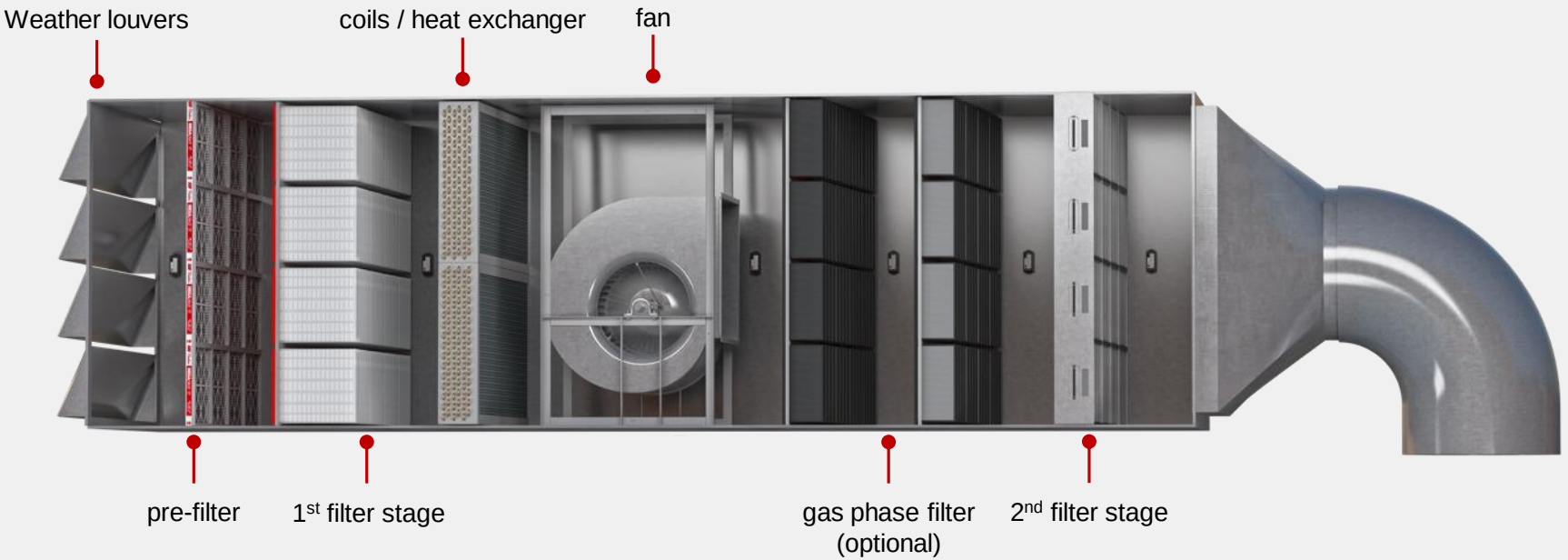
Air Change Rates (ACR) from literature I

building / room	ACR (1/h) min	ACR (1/h) max	minimum air volume flow per person in (m^3 / (h x person)] DIN EN1946-2	standard
Residential buildings / living spaces	0,5	3,6		DIN 13779 (withdrawn)/ EN 12831
Residential building with mechanical ventilation	>1			DIN 13779 (withdrawn)/ EN 12831
Residential buildings> 3 floors	>2			DIN 13779 (withdrawn)/ EN 12831
Kitchens	1,5			DIN 13779 (withdrawn)/ EN 12831
Bathroom	1,5			DIN 13779 (withdrawn)/ EN 12831
Lecture halls		6-8		DIN EN 16798-3; ASR 3.6
Classroom	2			DIN EN 16798-3; ASR 3.6
Offices	1	4-8		DIN EN 16798-3; ASR 3.6
Movie theater		5–8		VDI 2082
Restaurants		4–8	40–60	VDI 2082
Salesrooms		4–8		VDI 2082
Gym		4–6		
Workshops	4–6	10–20		VDI 2082
Commercial kitchens		15–30	6–60	VDI 2052
Fish and meat preparation			25	VDI 2052
Vegetable and salad preparation			25	VDI 2052
Cold kitchen			6–10	VDI 2052
Storage			6 m^3/(h x m^2)	VDI 2052
Distribution rooms			60	VDI 2052

Air Change Rates (ACR) from literature II

building / room	ACR (1/h) min	ACR (1/h) max	minimum air volume flow per person in (m^3 / (h x person)] DIN EN1946-2	standard
Swimming pool				VDI 2089
Entrance				VDI 2089
Showers / sanitary facilities		15–25		VDI 2089
Laboratory	2–5	8–15		VDI 2051
Chemical rooms		5		VDI 2051
Pressurized gas cylinder rooms		2		VDI 2051
Hospital		5–8		DIN 1946- 4
OP	-		measures	DIN 1946- 4
OR with gas application			40+ 150 per patient	DIN 1946- 4
Adjacent rooms			40	DIN 1946- 4
Patient room			40+ 100 per patient	DIN 1946- 4
Ice sports facility with spectators / multi-purpose hall		4–6	30–40	VDI 2075
Ice rink without spectators	1,5		30–40	VDI 2075
Take a shower		15–25		VDI 2075
Changing rooms		6–8	50	VDI 2075
Conditioning rooms		4–6		VDI 2075
Slope bar			50	VDI 2075
Gastronomy			50	VDI 2075

Air Handling Unit



Preferred filters

Highly separating and at the same time energy efficient!

filter	depth	filter area	initial pressure drop	Energy consumption / classification		dust holding capacity
	mm	m^2	Pa	kWh	Eurovent	g
DriPak NX+ ePM1 65%	635	7,2	55	720	A+	1700
VariCel Aero V HXL ePM1 95%	440	25,7	115	1390	A	1150

DriPak NX+ ePM1 65%

VariCel Aero V HXL ePM1 95%

Preferred filters

1st Filter Stage
DriPak® NX+ ePM1 65%

- Highest media area of a highly separating filter layer for fine particles in a pocket filter.
- Low initial resistance - energy class A +.
- Fully synthetic medium.

2nd Filter Stage
VariCel® Aero V HXL ePM1 95%

- Increased protection against airborne disease transmission.
- High filtration efficiency (level EPA filter class E11), min. 95% filtration efficiency at 0,3 µm.
- Low initial resistance - energy class A.
- The extra large filter area of the VariCel Aero V HXL filter (440mm depth) not only offers increased filtration efficiency compared to the standard filter (292mm depth), but also a further increase in dust storage capacity and, due to the lower pressure drop, even lower operating costs.
- Arrangement of the water-repellent filter medium in vertical folds for optimal moisture removal.
- A burst protection on the downstream side ensures increased stability and robustness.

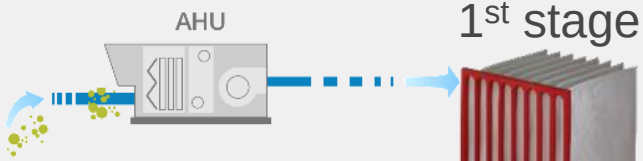
Combined Efficiency
on virus-laden aerosols:
99,7%

Number of airchanges needed to achieve 99,7% efficiency
#1

Δpi
Initial combined pressure drop:
170 Pa

Combined DHC
(Dust Holding Capacity)
2.850 g

Filter stages in air handling units



1st stage

2nd stage

55 Pa

67% (ePM$_1$ 65% class)

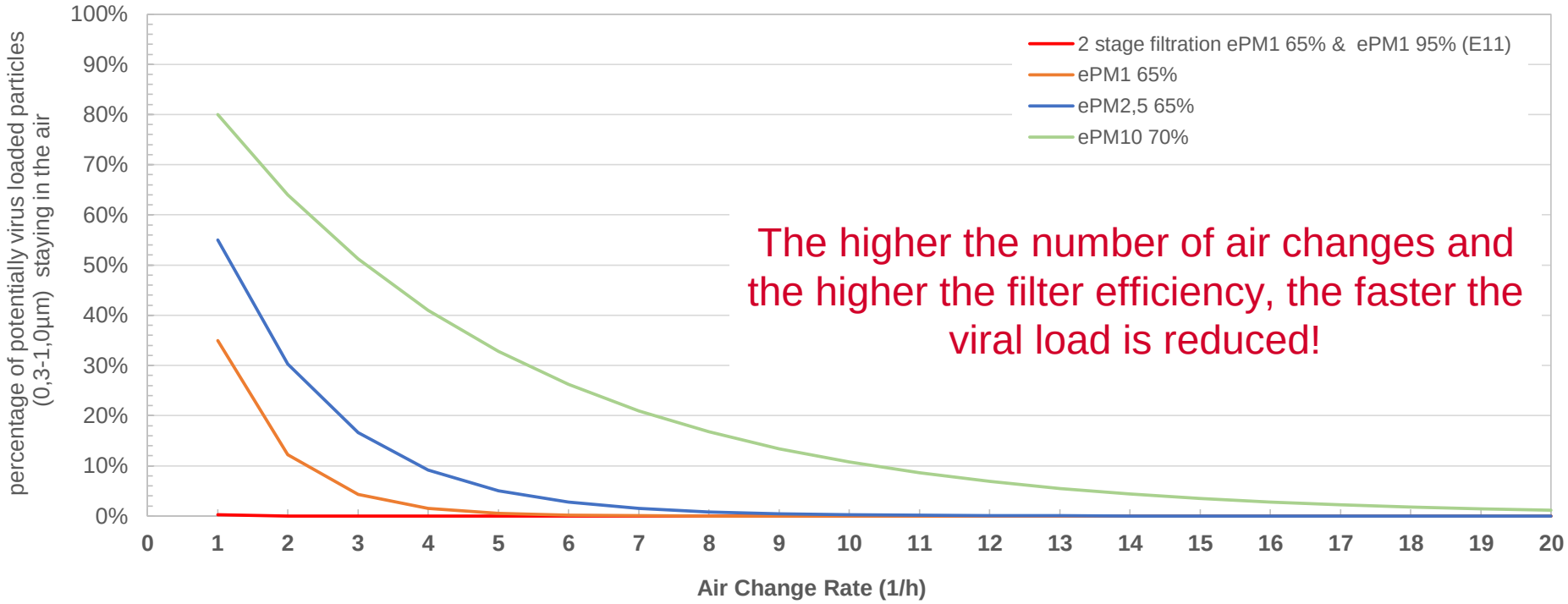
115 Pa

99,1 % (ePM$_1$ 95% class)

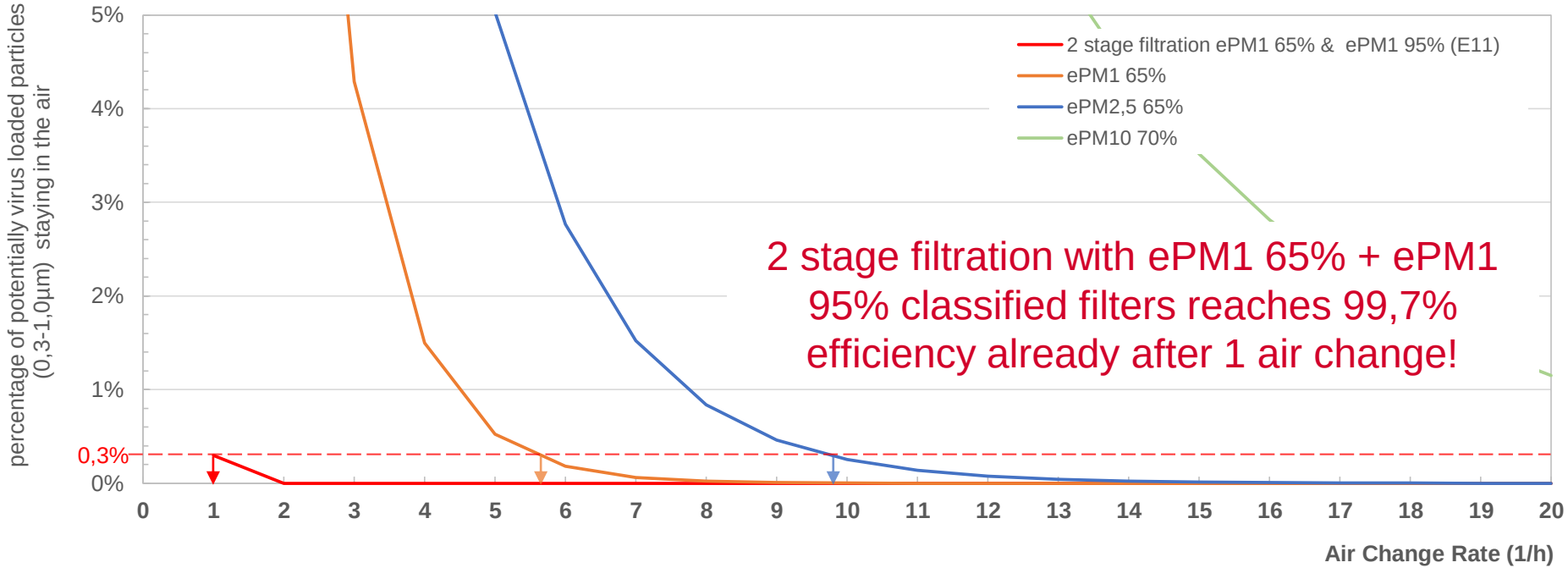
100 → 67 → 33 → 32,7 → 0,3

99,7% total ePM1 efficiency at 170 Pa pressure drop!

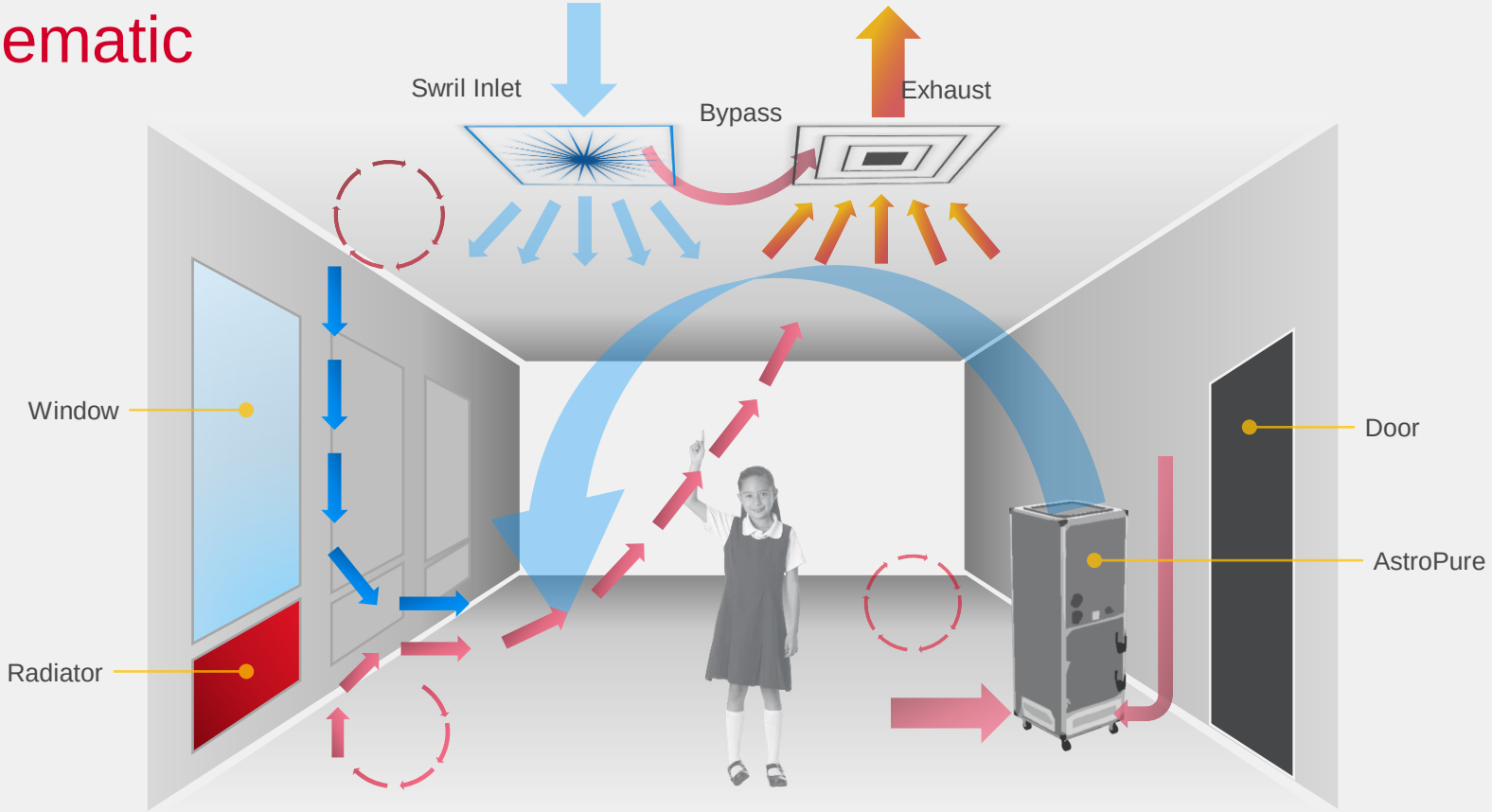
Filtration efficiency depending on Air Change Rate and Filter class



Filtration efficiency depending on Air Change Rate and Filter class



Schematic


Swril Inlet
Bypass
Exhaust
Window
Door
AstroPure
Radiator

AstroPure Range

AstroPure: Nominal cleanable room volume = mathematical estimate, Effectiveness depends on the place of installation and extraction efficiency

	AP 700	AP 2000	AP 4000	AP 6000	AP F2F
					
Maximum Flow Rate [m³/h]	**700**	**2000**	**4000**	**6000**	**1200**
ACH [1/h]	Nominal cleanable room volume [m³]				
4	**175**	**500**	**1.000**	**1.500**	**-**
6	**117**	**333**	**667**	**1.000**	**-**
10	**70**	**200**	**400**	**600**	**-**

Example Office

Office

- Area = 12 m²
- Height = 2,5 m
- Volume = 30 m³

- ACR = 6

➢ Air flow = 360 m³/h

Example Meeting Room

Meeting Room

- Area = 30 m²
- Height = 2,5 m
- Volume = 75 m³

- ACR = 6

➢ Air flow = 450 m³/h

Example Open Plan Office

Open Plan Office

- Area = 240 m^2
- Height = 3,5 m
- Volume = 840 m^3

- ACR = 6

➢ Air flow = 5.040 m^3/h

Example Cash Desk

Cash Desk

AstroPure F2F

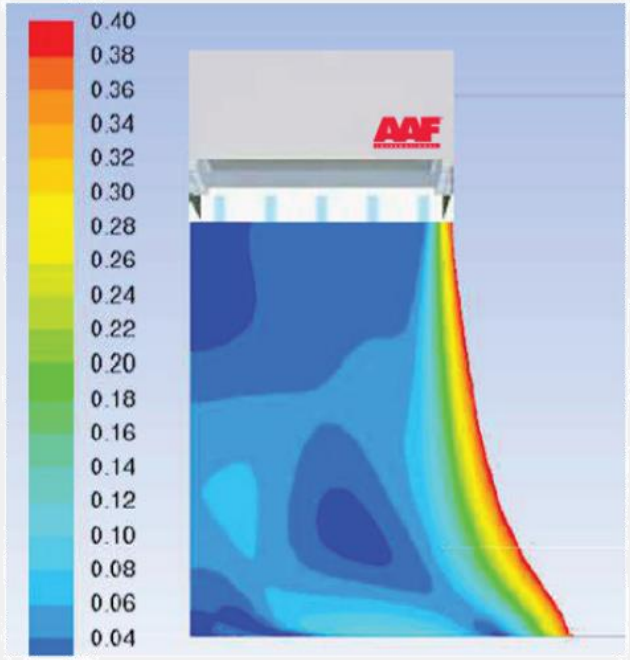
Max. Air flow = 1.200 m³/h

Variable speed control

RGB LED workspace light

Remote control

Example Cash Desk – Working Principle



AstroPure Air Purifiers

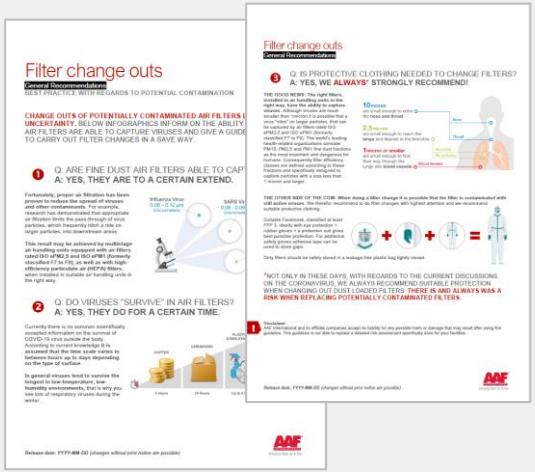
type		AP 700	AP 2000	AP 4000	AP 6000	AP F2F
max flow rate	m^3/h	700	2000	4000	6000	1200
variable speed control	-	yes	yes	yes	yes	yes
standard pre-filter	-	ISO coarse 70%	ISO coarse 70%	ISO coarse 70%	ISO ePM1 85% (cartridge)	ISO coarse 70%
optional pre-filter (VDI6022)	-	ISO ePM10 70%	ISO ePM10 70%	ISO ePM10 70%	-	ISO ePM10 70%
gas phase filter	-	ISO coarse 65%	ISO coarse 65%	ISO coarse 65%	-	-
HEPA filter class (EN1822)	-	H14	H14	H14	H14	H14
UV-C stage	-	yes	optional	optional	-	-
W x D x H	mm	800 x 715 x 1300	770 x 720 x 1630	1440 x 720 x 1630	2000 x 2000 x 2000	1200 x 600
electrical power	kW	0,4 (single phase)	0,5 (single phase)	1,0 (single phase)	5,5 (three phase)	0,4 (single phase)
sound pressure level	dB(A)	< 54	35 - 52	35 - 52	-	35 - 52

Personal Protective equipment for filter changes

WHEN REPLACING POTENTIALLY CONTAMINATED FILTERS, THERE IS AND ALWAYS A RISK.

Not only in view of the current discussion about the coronavirus, we ALWAYS RECOMMEND suitable protection when changing dust-laden filters.

For more information, check out our infographics with background information and best practices.



Suitable facial mask, classified FFP 3, ideally with eye protection

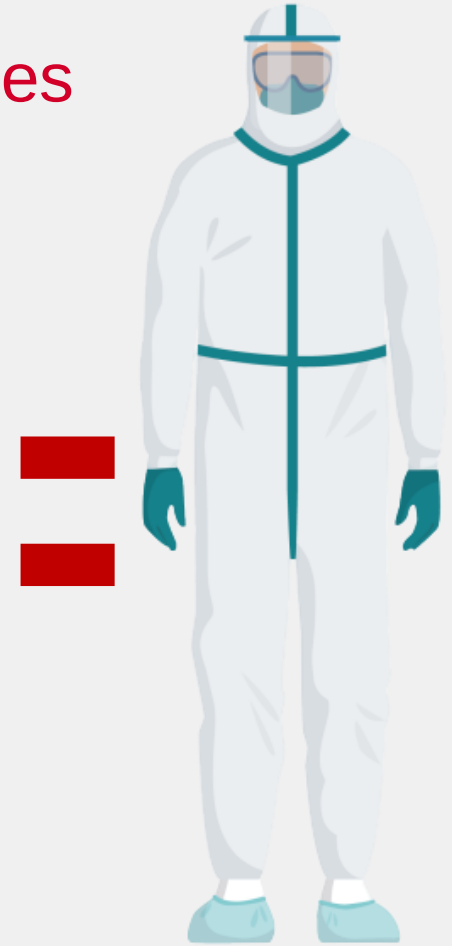
+

Rubber gloves

=

+

Protective suits offer the best possible protection
For added security, tape can be used to close gaps between suit / gloves and suit / shoes.



It’s filtration time!

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