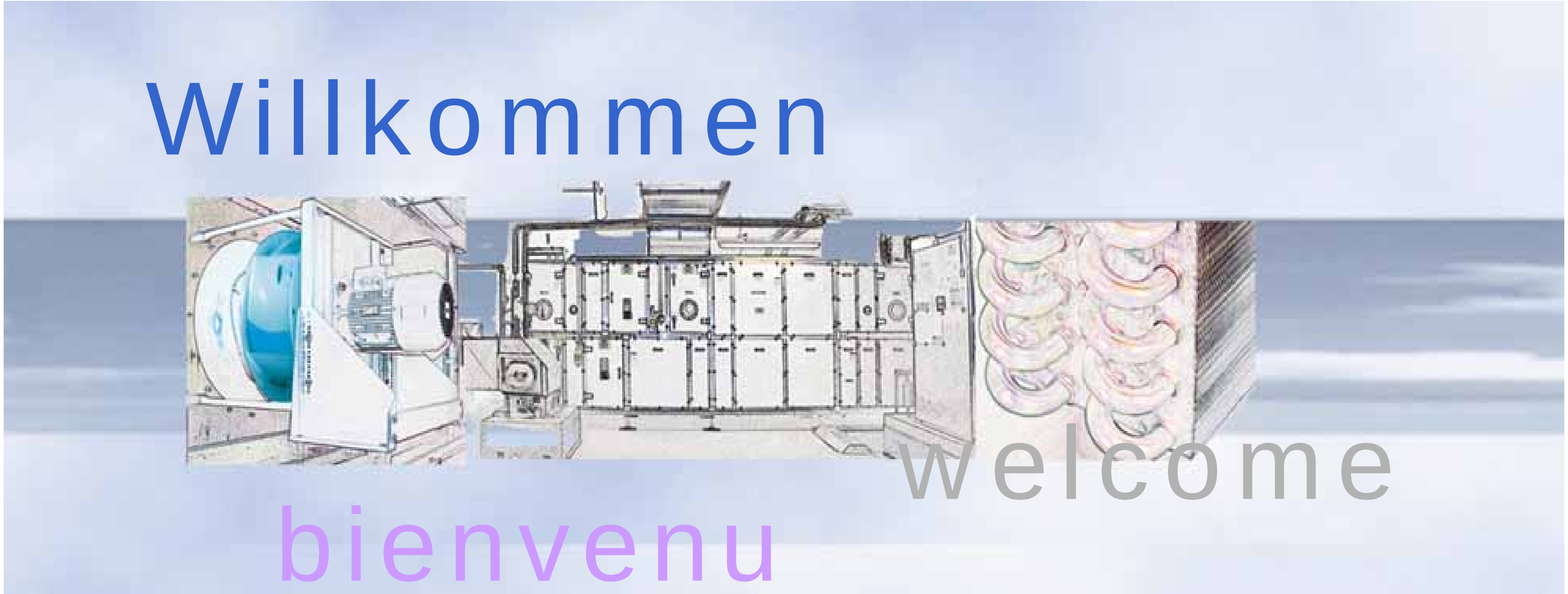

Electric efficiency in drives

Energy consumption in air handling units reduction of electric power consumptions based on plugged fans

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Electric power consumption

$$P_m = \dot{V} \bullet \Delta p \bullet 1 / \eta$$

P_m	Electric power consumption [KW]
$\dot{V}$	Air flow rate [m³/s]
Δp	Total pressure losses of the AHU [Pa]
η	Systemefficiency of the drive [./.]

$$\eta = \eta_F \bullet \eta_M \bullet \eta_D \bullet \eta_C$$

Fan • Motor • Drive • Control

DIN EN 13779

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

Ventilation of non-residential buildings – Performance requirements for ventilation and room-conditioning systems

Specific Fan Power (SFP)

$$P_{SFP} = \frac{P_{Input}}{q_V} = \frac{\Delta p_{fan}}{\eta_{total}}$$

P_{SFP}	Specific fan power [W/(m³/s)]
P_{Input}	electric power consumption [W]
q_V	nominal air flow rate [m³/s]
Δp_{fan}	Total pressure of the fan [Pa]
η_{total}	systemefficiency of the drive [-]

Specific Fan Power

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class	P_{SFP} W/(m³/s)	Δp_{Fan} [Pa] η_{total} 0,55	Δp_{Fan} [Pa] η_{total} 0,65
SFP 1	≤ 500	275	325
SFP 2	≤ 750	410	485
SFP 3	≤ 1.250	685	810
SFP 4	**≤ 2.000**	1.100	1.300
SFP 5	≤ 3.000	1.650	1.950
SFP 6	≤ 4.500	2.475	2.925
SFP 7	> 4.500		

Application	Default value
ETA without HR	SFP 2
ETA with HR	SFP 3
SUP without HR	SFP 3
SUP AC	SFP 4

For special components (e. g. HEPA-filter, HR H1 or H2) add. SFP-Values shall be used.

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Additional fan power

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	Component	add. P_{SFP} [W/(m³/s)]
1	add. filterstage	+ 300
2	HEPA filter	+ 1.000
3	Gasfilter	+ 300
4	HR class H2-H1	+ 300
5	High capacity cooler	+ 300

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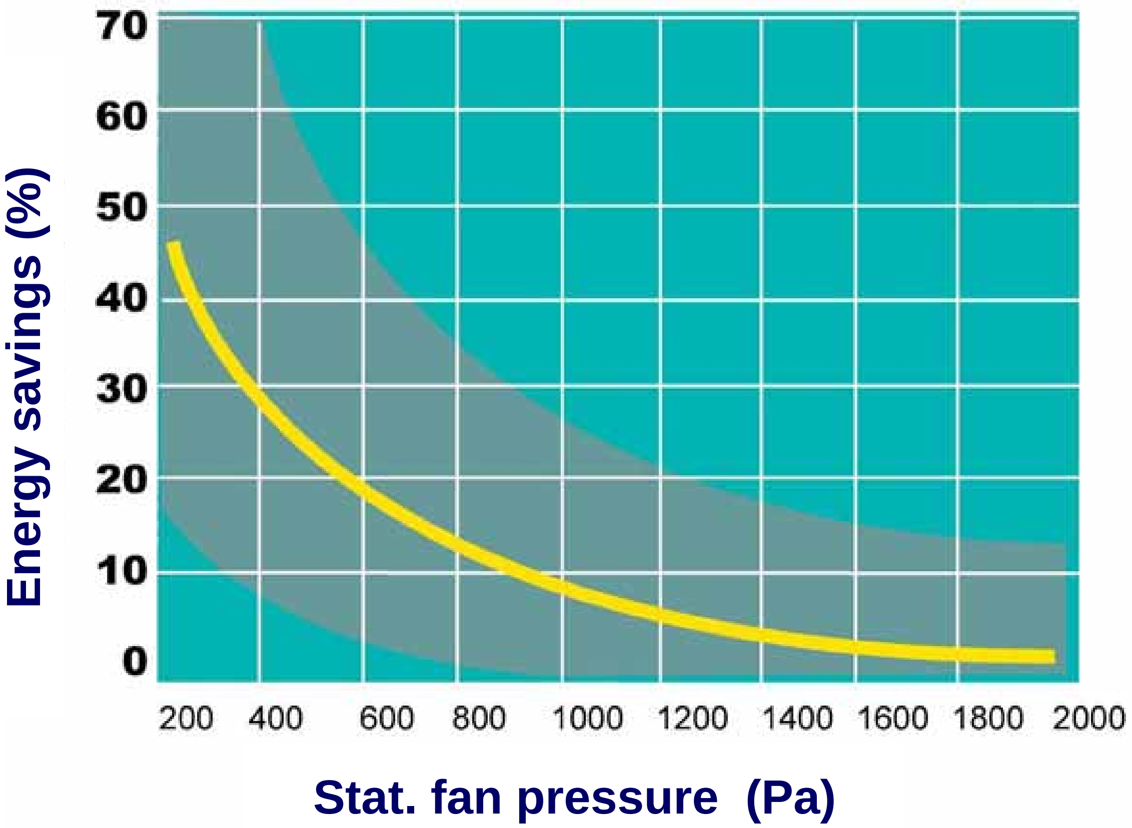
Drive optimization

Drive optimization

- Reduction of the drive power (plugged fans)



Control device with axial inlet flow

- Efficiency ▲ Turbulence ▼

Drive optimization

- Plugged fan (direct driven)
- Continuous speed controlling device (FI)
- Energy-optimized motor EFF 1 (EI 2)
- Reduced inlet airflow losses
- Reduced outlet airflow losses

Motor

Principles

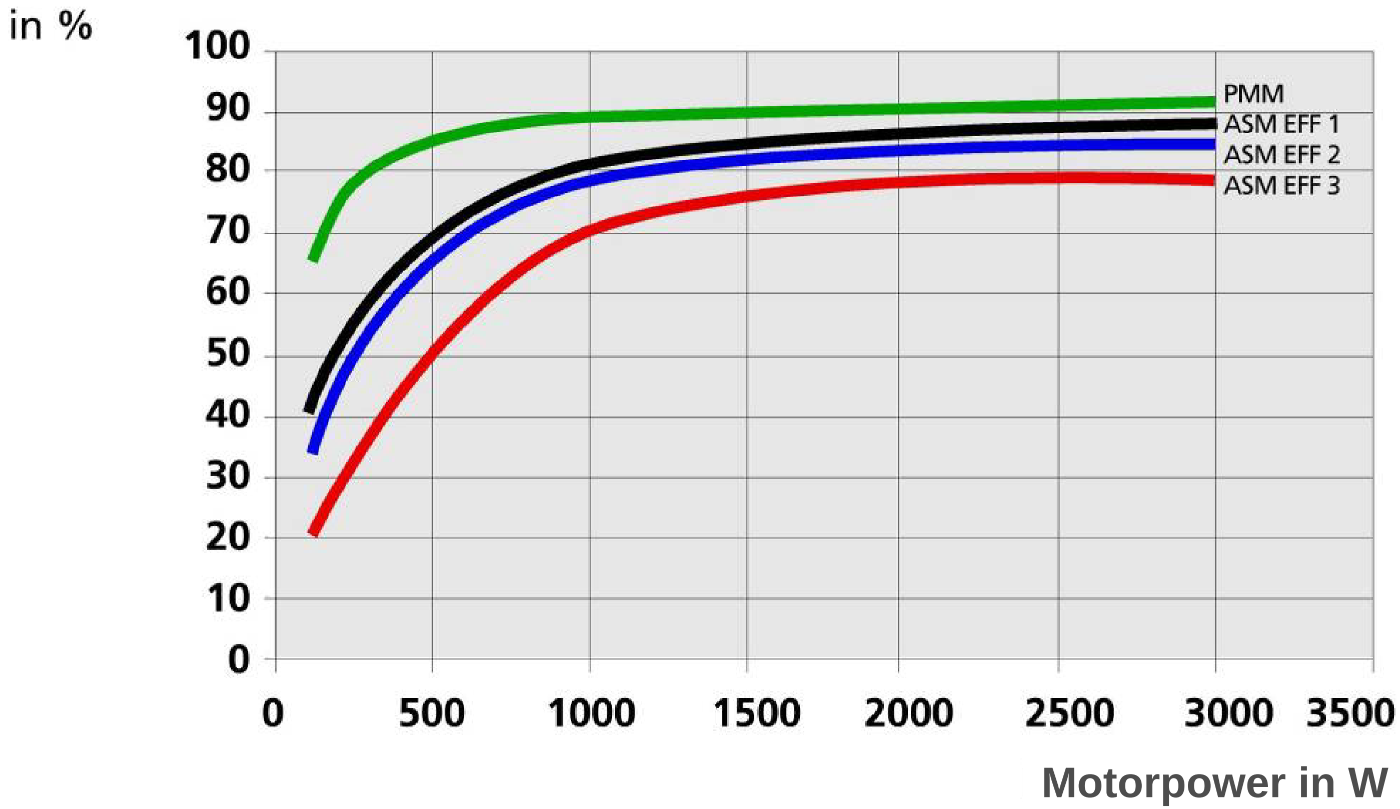
AC	EC	PM
Three-phase motor	Electric commutaded	Permanent Magnet motor
Alternating current	Continuous motor	

Motor

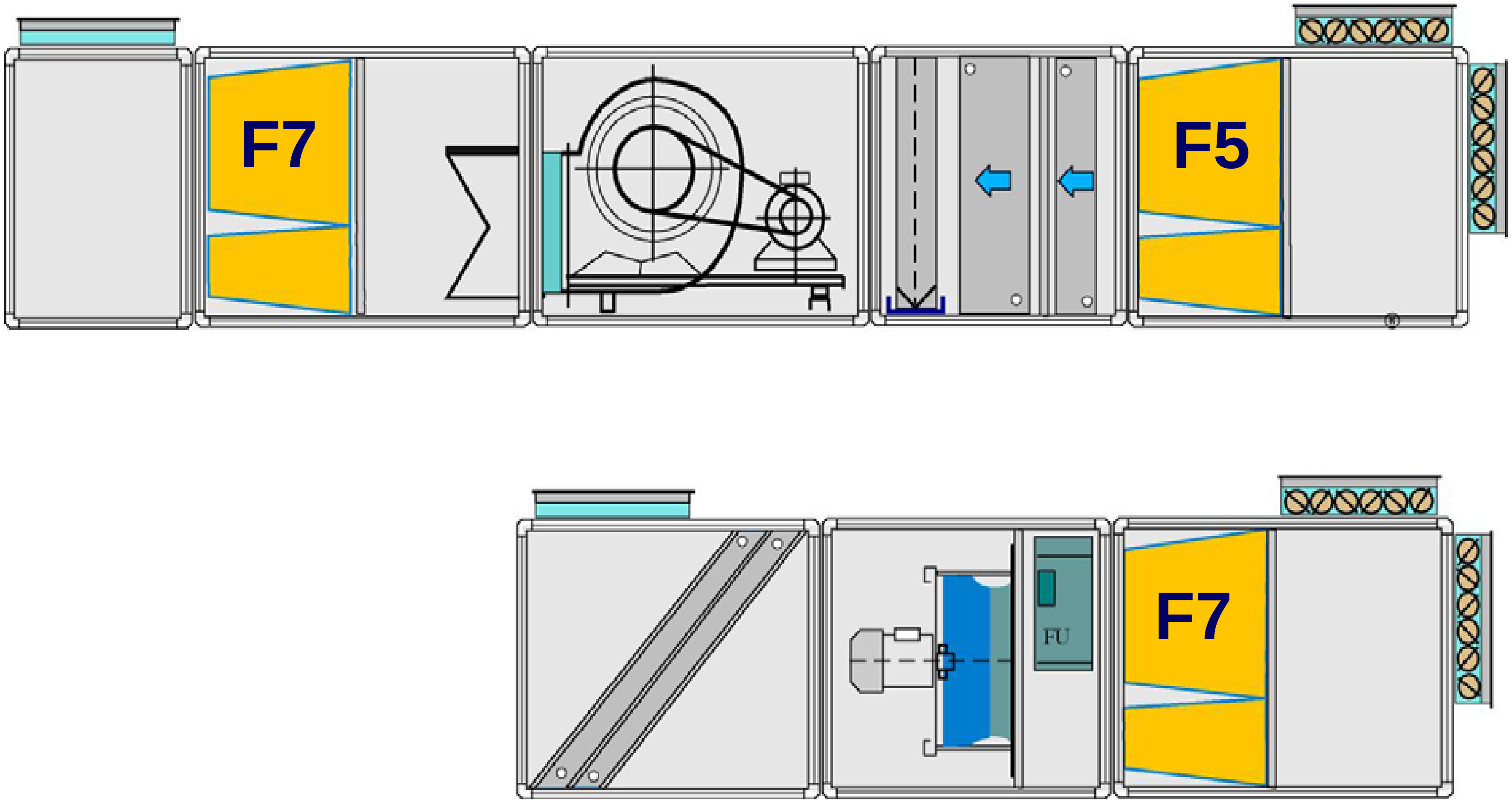
Efficiency (Example n = 1500 1/min)

Nominal power	EFF2	EFF1 (EI 2)
1,1 KW	77,0 %	84,0 %
2,2 KW	82,0 %	86,5 %
4,0 KW	85,0 %	88,5 %
7,5 KW	87,0 %	90,3 %
55,0 KW	93,5 %	95,1 %

Motorefficiency



System comparison



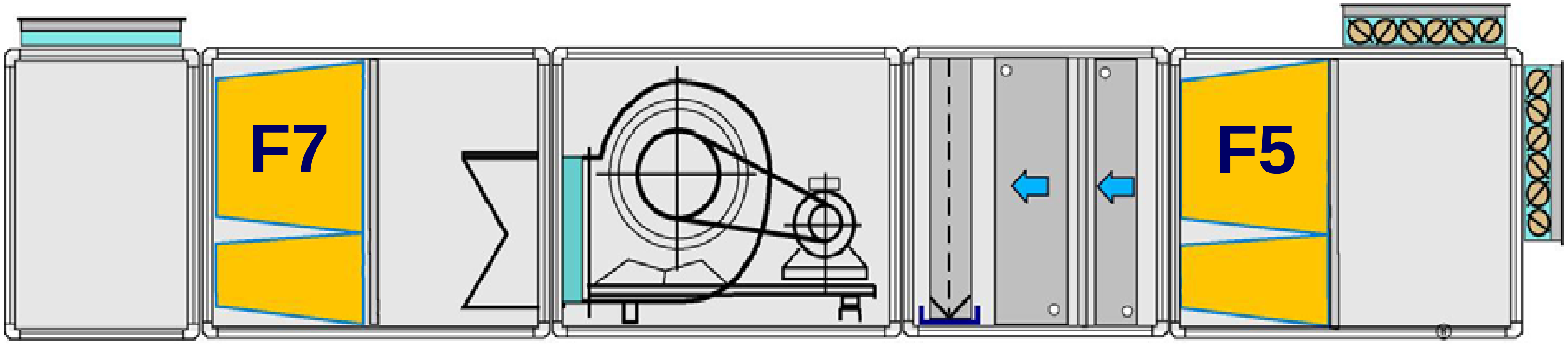
Drive optimization

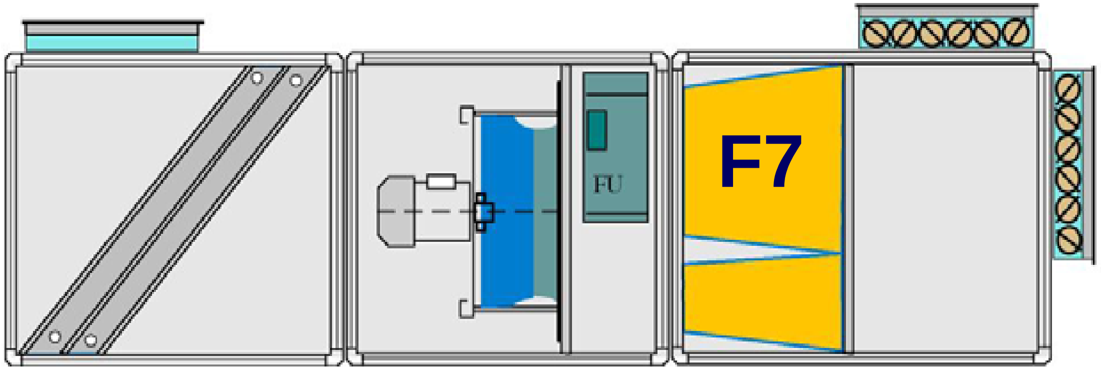
- Single-step filtering possible
- Use of the fan as a mixing device
- Use of the cooler on pressure side (dry)
- Improves incident flow of the components
- No belt drive and abrasion

Filter technology

- Single stage filter technology
- First Stage F 7 (80 % at 1 µm)
- Better protection of the AHU
- Reduction of pressure losses
- Reduction of the AHU length

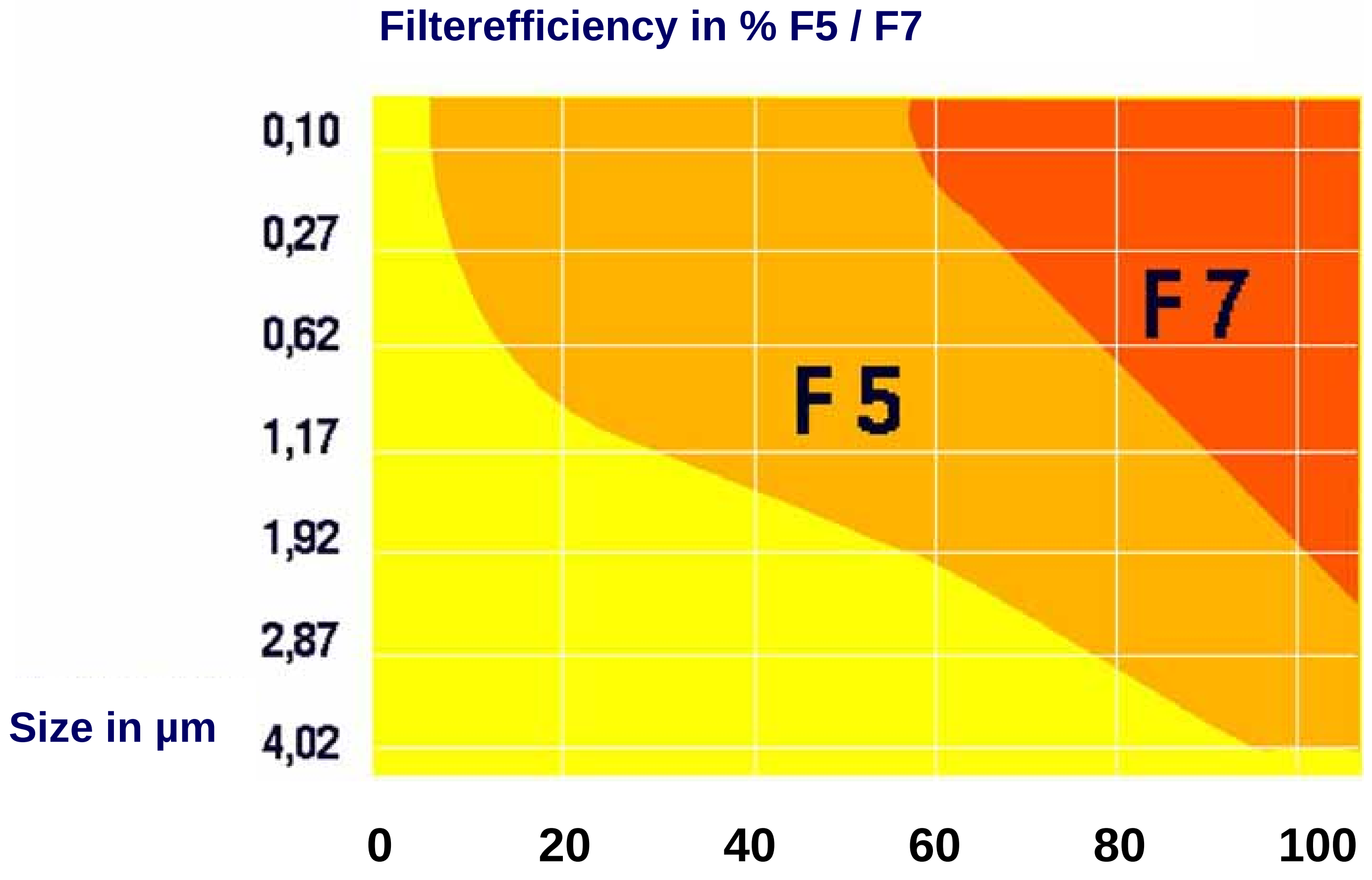
System comparison



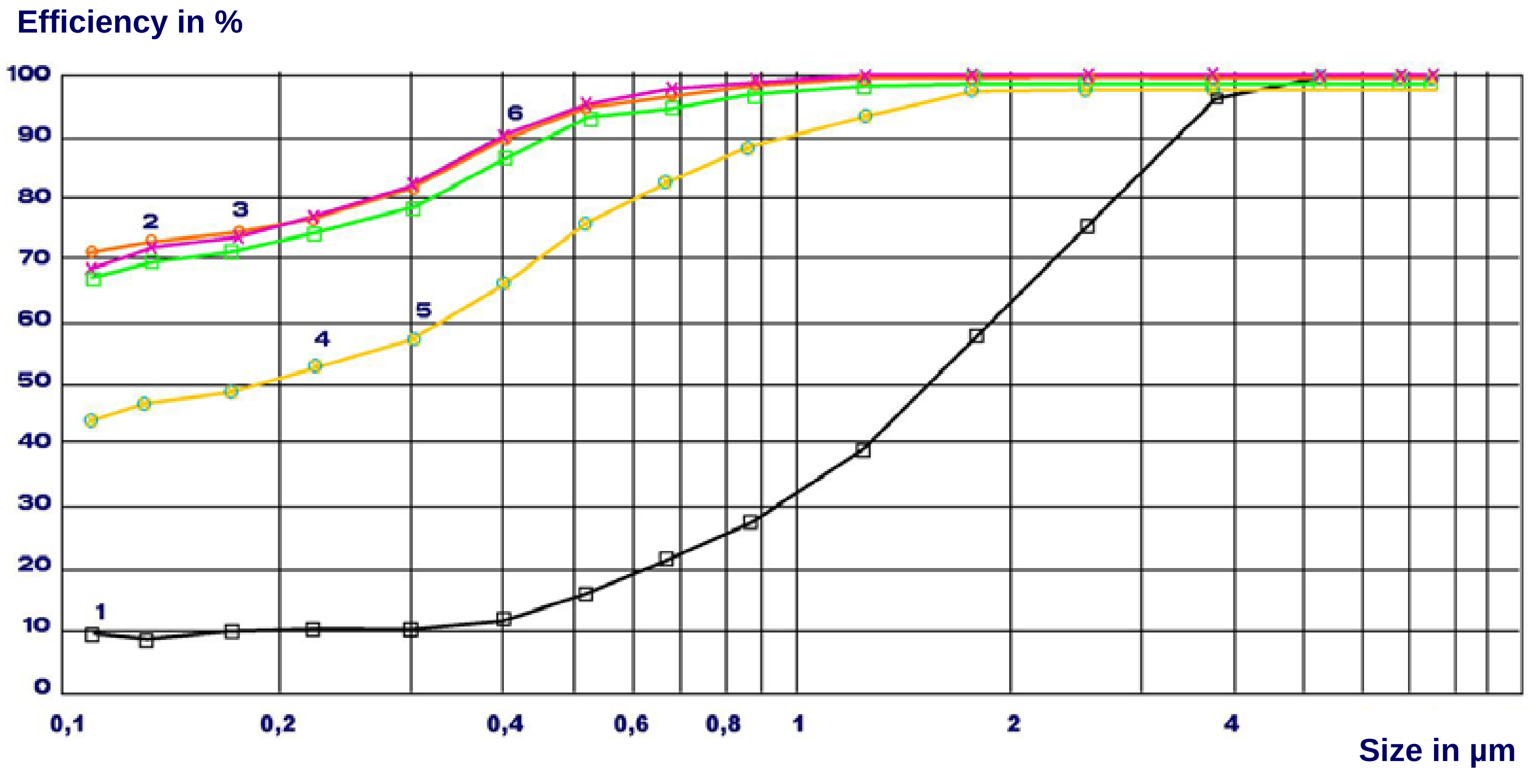


Comparison F5 to F7 filters

99,9 % of the particles are smaller than 1 µm



F7 / F7 Filterstages



4,5 m²	F5	55 Pa	200 Pa	3400 m³/h	450 Pa
9,0 m²	F9	140 Pa	250 Pa	3400 m³/h	
9,0 m²	F7	95 Pa	150 Pa	3400 m³/h	260 Pa
9,0 m²	F7	95 Pa	110 Pa	3400 m³/h	

Filter technology

- Two-stage filtering F 7 - F 7
- Quality corresponds to F 5 - F 9
- Better protection of the AHU
- Reduction of final press. drop app. 200 Pa
- Reduction on the average 100 Pa
- To provide with stock only 1 medium

Control

Air flow rates

Speed control
e. g.
Frequency inverter

losses:

3 – 5 %

Throttel control
e. g.
dampers

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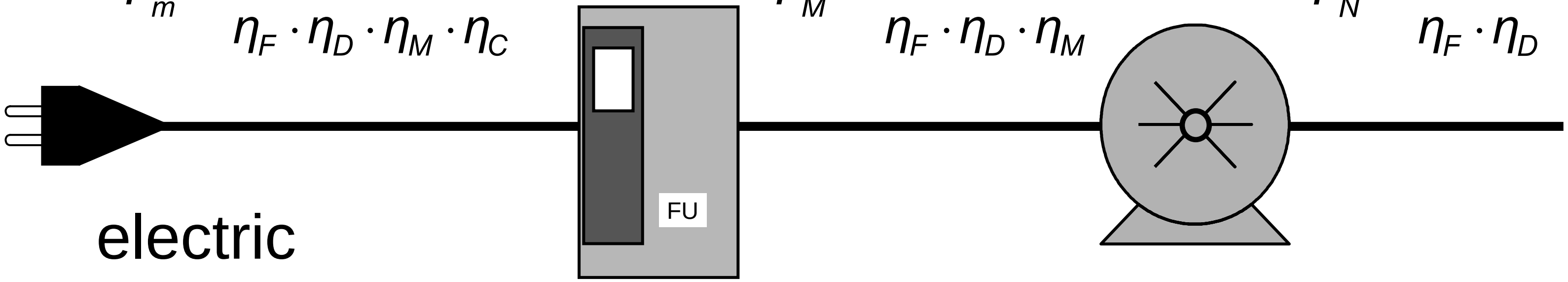
Power and efficiency

Mechanical efficiency

$$P_m = \frac{\dot{V} \cdot p_t}{\eta_F \cdot \eta_D \cdot \eta_M \cdot \eta_C} \qquad P_M = \frac{\dot{V} \cdot p_t}{\eta_F \cdot \eta_D \cdot \eta_M} \qquad P_N = \frac{\dot{V} \cdot p_t}{\eta_F \cdot \eta_D}$$

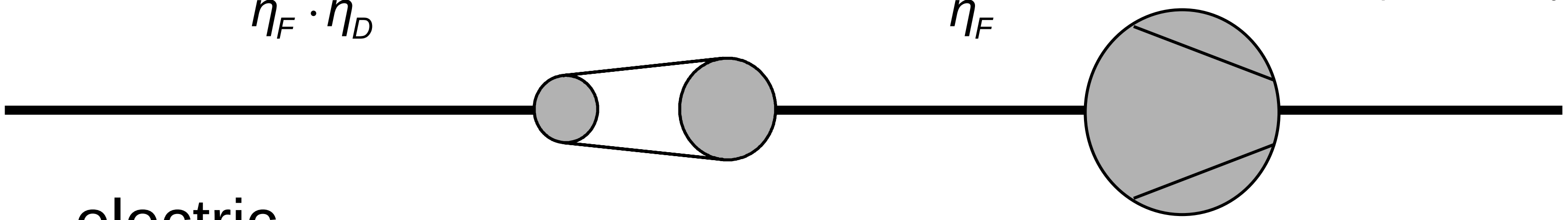


$$P_m = U \cdot I \cdot \sqrt{3} \cdot \cos \qquad P_M = U \cdot I \cdot \sqrt{3} \cdot \cos \quad \cdot \eta_C \qquad P_N = U \cdot I \cdot \sqrt{3} \cdot \cos \quad \cdot \eta_C \cdot \eta_M$$

Power and efficiency

Mechanical efficiency

$$P_N = \frac{\dot{V} \cdot p_t}{\eta_F \cdot \eta_D} \qquad P_D = \frac{\dot{V} \cdot p_t}{\eta_F} \qquad P_F = \dot{V} \cdot p_t$$

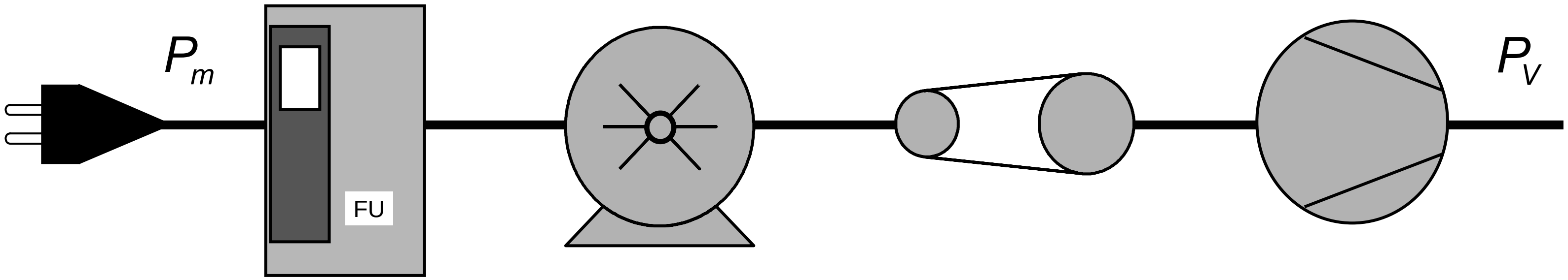


electric

$$P_N = U \cdot I \cdot \sqrt{3} \cdot \cos \quad \cdot \eta_C \cdot \eta_M \qquad P_D = U \cdot I \cdot \sqrt{3} \cdot \cos \quad \cdot \eta_C \cdot \eta_M \cdot \eta_D \qquad P_F = U \cdot I \cdot \sqrt{3} \cdot \cos \quad \cdot \eta_C \cdot \eta_M \cdot \eta_D \cdot \eta_F$$

Power and efficiency

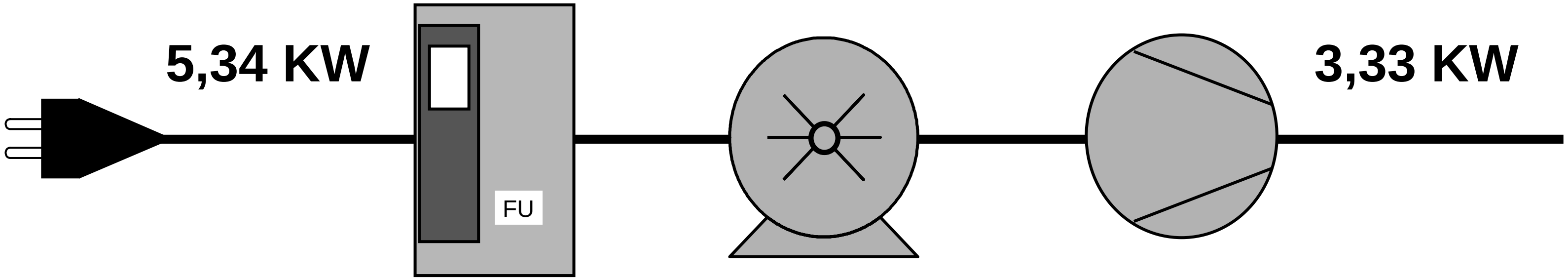
System efficiency η_{Sys}



$$\eta_C \cdot \eta_M \cdot \eta_F \cdot \eta_D = \frac{P_F}{P_m} = \eta_{Sys}$$

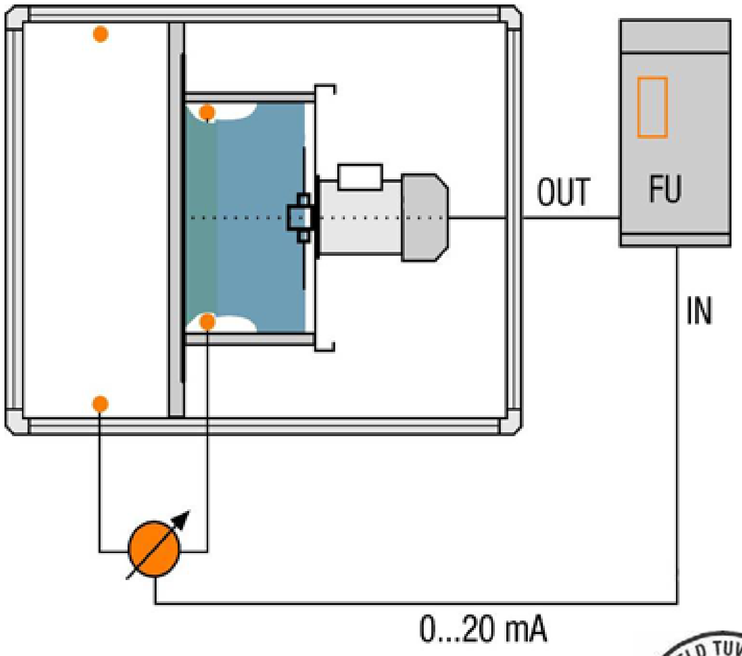
Power and efficiency

Example

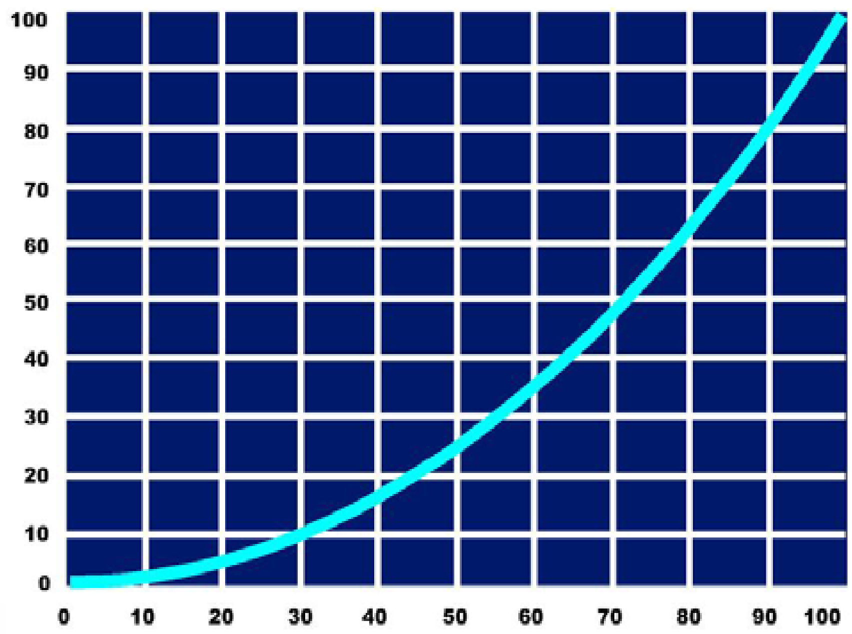


Air flow measuring system

- Function:
  Effect pressure to the flow rate



Eff. Pressure in % to nominal pressure



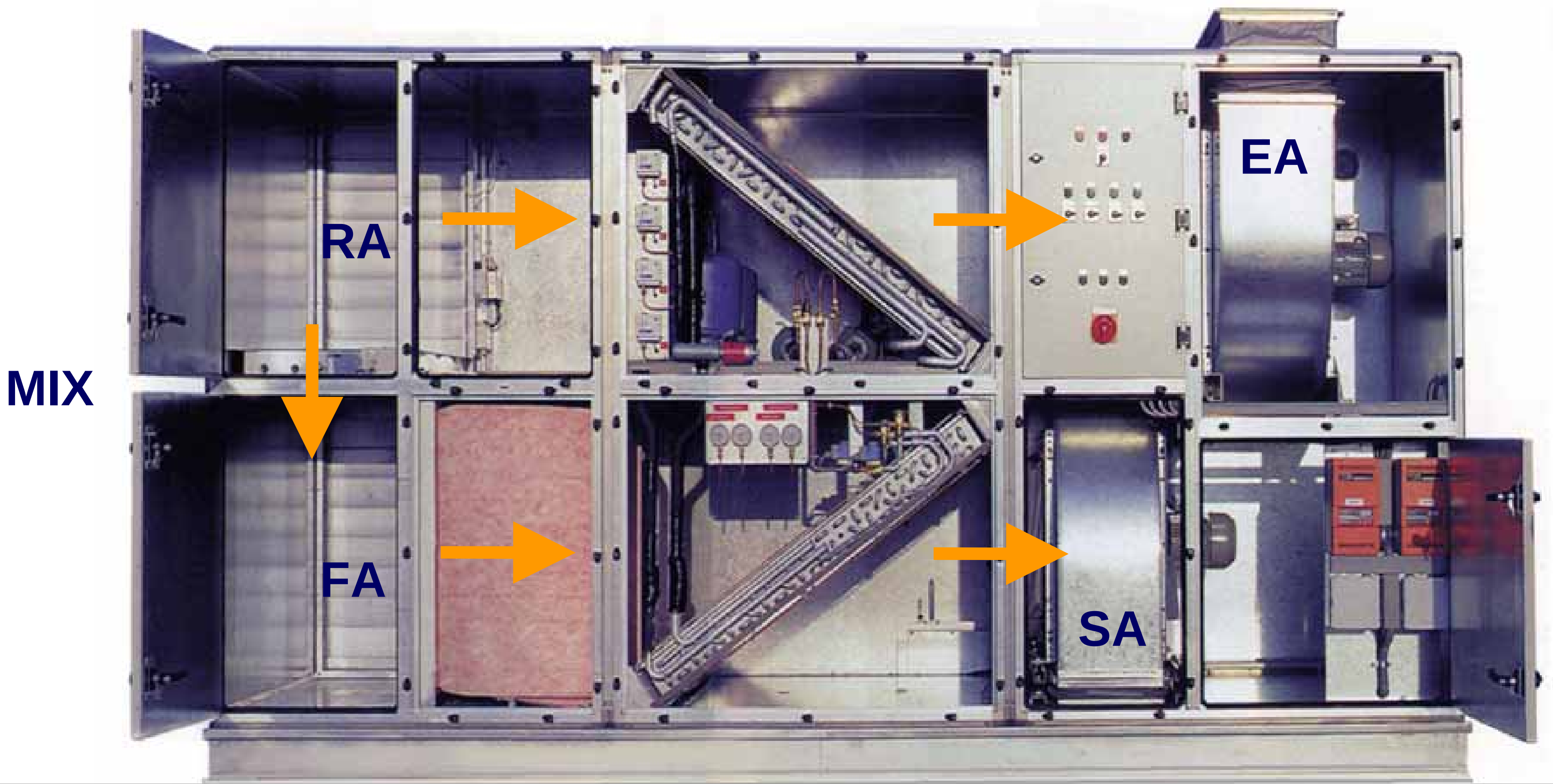
Flow rate in % to nominal flow rate

Air flow measuring system

- Measurement by eff. pressure (fan nozzle)
- Accuracy 5 %
- Wired on FI (readable on display)
- Flow rate automatic constant control PID
- Further parameters (N, n, U, I, etc.) at the FI
- Output 0...20 mA at the FI (1:1)

Exhaust fan with air mixture chamber

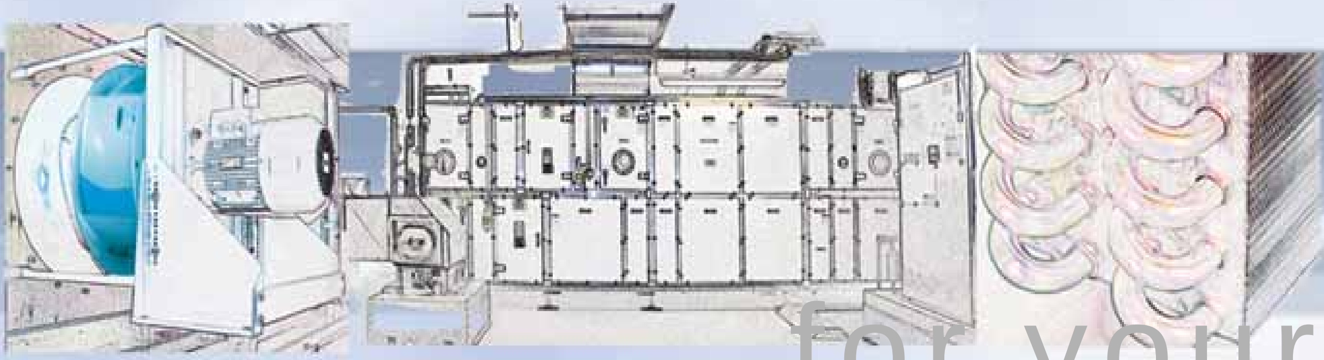
- Positioning exhaust air opposite room air
- Frequency-regulated over dP_{RA}



Exhaust fan with air mixture chamber

- Positioning in the exhaust air
- Speed adjusted over dP_{RA}
- Energy conservation 80 %
- Only with air mixture operation possible
- Only with balanced ext. pressures

Thank you very much for your Attention



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