ventus

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Air Handling Units

Catalogue 2006

innovative air handling units

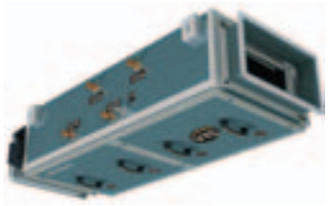
VTS

CASING

VENTUS

Construction: Non-skeleton casing

Function and application	Operation parameters



VS 10÷15

- Non-skeleton construction made of 'sandwich' type panels formed in 'C' shape and reinforced with an inner system of bulkheads.
- Panels' construction:
  - external material: zinc coated steel sheet S280GD+Z275 covered with anticorrosive coating;
  - Insulation: polyurethane foam.
- Casing equipped with a system of connectors enabling assembly of individual modules as well as suspension of the unit.
- Access to an AHU: top (L – laying) or bottom (S – suspended) respectively.

AHU designed for indoor installation.

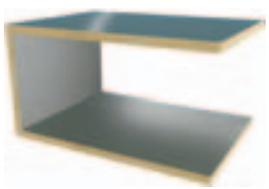
Casing:
- operation temperature: -40 ÷ +90°C
- casing heat transfer coefficient K= 0.62 W/m2K **CLASS** T2 Acc. EN 1886
- thermal bridges coefficient: **CLASS** TB2 Acc. EN 1886
- mechanical strength of casing: -2500Pa ÷ 2500Pa < 2mm **CLASS** 2A Acc. EN 1886
- casing tightness: -400Pa – 0.41 l/sm2 **CLASS** B Acc. EN 1886 +700Pa – 0.58 l/sm2 **CLASS** B Acc. EN 1886

Panels:
- panel thickness: 40mm
- metal sheet thickness: 0,5mm
- thermal conductivity PPU λ= 0,022 W/mK
- casing fire rating: non-flammable material (NRO)
- moisture absorption: 0,04%
- PPU density: ρ= 42kg/m^3
- panel weight: m= 10kg/m^2

Anticorrosive protection:
- 275g/m^2 galvanized zinc (Zn) coating
- external protection coating material/thickness: polyester / 25μm

Compliance with standards: EN1886.

VS 21÷650



- Non-skeleton construction made on the basis of 'sandwich' type panels formed in 'C' shape and reinforced with an inner frame system.
- Panels construction:
  - external material: zinc coated steel sheet S280GD+Z275 covered with anticorrosive coating;
  - insulation: polyurethane foam;
  - internal material: zinc coated steel sheet S280GD+Z275.
- Casing mounted on a steel frame enables easy transport, ceiling suspension and floor mounting.
- Access to the unit: from the side.

Unit designed for both indoor and outdoor installation.

Casing:
- operation temperature: -40 ÷ +90°C
- casing heat transfer coefficient K= 0.62 W/m2K **CLASS** T2 Acc. EN 1886
- thermal bridges coefficient: **CLASS** TB2 Acc. EN 1886
- mechanical strength of casing: -2500Pa ÷ 2500Pa < 2mm **CLASS** 2A Acc. EN 1886
- casing tightness: -400Pa – 0.41 l/sm2 **CLASS** B Acc. EN 1886 +700Pa – 0.58 l/sm2 **CLASS** B Acc. EN 1886

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- panel thickness: 40mm
- metal sheet thiskness: 0,5mm
- thermal conductivity PPU λ= 0,022 W/mK
- casing fire rating: non-flammable material (NRO)
- moisture absorption: 0,04%
- PPU density: ρ= 42kg/m^3
- panel weight: m= 10kg/m^2

Anticorrosive protection:
- 275g/m^2 galvanized zinc (Zn) coating
- external protection coating material/thickness: polyester / 25μm

Compliance with standards: EN1886.

ADVANTAGES

- energy loss reduction – no thermal bridges
- elimination of moisture condensation phenomenon
- high rigidity of construction
- labyrinth modules connection – elimination of air leakages

- elimination of moisture absorption
- insulation material with a very long decomposition period
- smooth internal surfaces of the casing – easy to maintain hygiene
- light inspection panels - easy handling

- high resistance to external atmospheric factors
- high resistance to mechanical factors

- energy loss reduction – no thermal bridges
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- high rigidity of the construction
- labyrinth modules connection – elimination of air leakages

- elimination of moisture absorption
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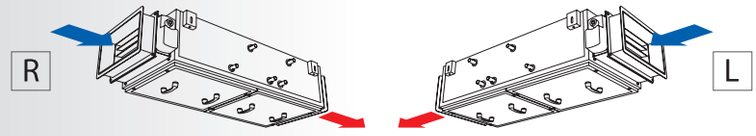
- smooth internal surfaces of the casing – easy to maintain hygiene
- light inspection panels - easy handling

- high resistance to external atmospheric factors
- high resistance to mechanical factors

Teaching aids

Access side: VS 10÷15

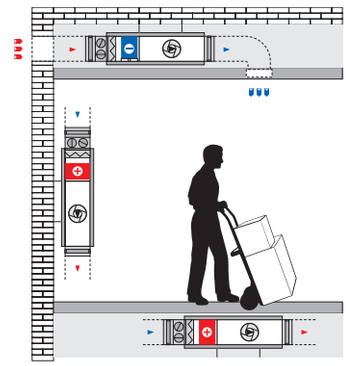


Right hand access side Left hand access side

Installation of: VS 10÷15

Suspended VENTUS AHUs, due to their small dimensions and low weight, are ideal for installation in the structural areas of buildings (suspended ceilings, raised floors) directly in the ventilation duct system.

VS 10÷15 AHUs can also be installed vertically by specific air processing units (filter, fan, water heater, silencer).



Non-skeleton technology

In the construction of VTS AHUs a modern 'non-skeleton' technology is applied. The casing made of homogenous laminar panel in 'C' shape contains appropriate sub-assemblies carrying out a desired air handling process. This kind of construction in connection with a labyrinth system of modules connection constitutes a perfectly tight system similar in its construction to a vacuum flask. As a result both the number of thermal bridges (elimination of energy loss and moisture condensation phenomena) as well as air leakages have been reduced.

VENTUS AHUs – non-skeleton casing Frame constructions

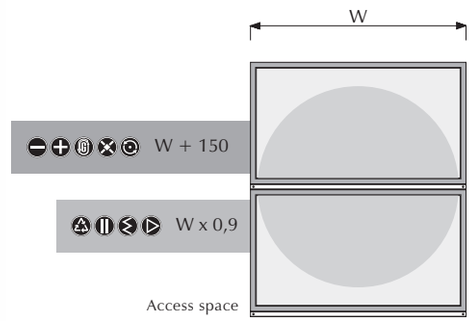
Access side: VS 21÷650

Right hand access side Left hand access side

Device location

The AHU should be located in such a way so as to enable connection of related systems (ventilation ducts, piping, cable trays) without getting in the way of inspection panels. For efficient installation, operation and maintenance of the AHU, the minimum distances between the access side and fixed structural components of the installation location (walls, supports, pipelines, etc.) should be kept.

The access space can be built up with systems, pipelines, support structures only in a way which permits easy disassembly and assembly during maintenance.



Access space

FILTERS

Pre-filters

Function and application	Construction

Flat filters

G4 type

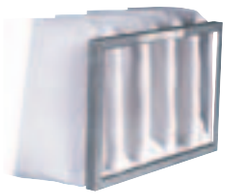
VS 10÷650

- Ventilation and air conditioning systems for rooms with average requirements of air purity as the final filter.
- Ventilation and air conditioning systems with high purity requirements as a pre-filter in front of higher efficiency filters. Possible applications:
  - hotels;
  - restaurants;
  - cinemas;
  - theatres;
  - department stores;
  - concert halls.

- pleated filter material encased in a wire mesh installed in a steel frame 50mm thick
- filter material made of polyester fiber fabric

Assembly: system of guide rails enabling quick and easy replacement of filters.

Preliminary bag filters



G4/F5 type

VS 21÷650

- Ventilation and air conditioning systems for rooms with average requirements of air purity as the final filter.
- Ventilation and air conditioning systems with high purity requirements as a pre-filter before higher efficiency filters. Possible applications:
  - hotels;
  - restaurants;
  - cinemas;
  - theatres;
  - department stores;
  - concert halls.

- filtration bags 300mm long installed in a steel frame 25mm thick
- filter material made of polyester fiber fabric
- vertical arrangement of filtration bags

Assembly: system of guide rails enabling quick and easy replacement of filters.

Secondary filters

Function and application	Construction

Secondary bag filters

F7 type

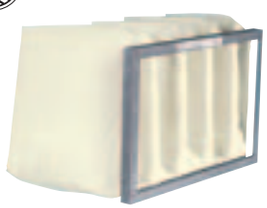
VS 21÷650

- Ventilation and air conditioning systems for rooms with high requirements of air purity as the final filter:
  - hospitals;
  - pharmaceuticals;
  - food industry;
  - varnishing chambers;
  - dehumidification chambers.

- filtration bags 600mm long installed in a steel frame 25mm thick
- filter material made of polyester fiber fabric
- vertical arrangement of filtration bags

Assembly: system of guide rails enabling quick and easy replacement of filters.

Secondary bag filters



F9 type

VS 21÷650

- Ventilation and air conditioning systems for clean rooms as the final filtration stage.
- Ventilation and air conditioning systems for clean rooms as the pre-filter stage for activated carbon filters:
  - production of electronic components,
  - production of optical components,
  - sterile operating theatres,
  - pharmaceutical clean rooms.

- filtration bags 600mm long installed in a steel frame 25mm thick
- filter material made of polyester fiber fabric
- vertical arrangement of filtration bags

Assembly: system of guide rails enabling quick and easy replacement of filters.

Operation parameters

- average filtration ratio A_m=92%
- max. pressure difference: Δp=150Pa
- max. air velocity: v=4,2m/s
- filter bypass leakage F9 - tightness **CLASS B (acc. EN 1886)**
- ambient temperature: max. 70°C / 100%

Protection: The permitted level of filter contamination may be signaled by the pressure differential control (an optional element).

Compliance with standards: EN779.

- average filtration ratio A_m=90%
- max. pressure difference:
  G4 - Δp=150Pa
  F5 - Δp=250Pa
- max. air velocity: v=4,6m/s
- filter bypass leakage F9 - tightness **CLASS B(acc. EN 1886)**
- ambient temperature: max. 70°C / 100%

Protection: the permitted level of filter contamination may be signaled by the pressure differential control (an optional element).

Compliance with standards: EN779.

Operation parameters

- average filtration ratio E_m= 80÷85%
- max. pressure difference: Δp=250Pa
- max. air velocity: v=3,6m/s
- filter bypass leakage F9 - tightness **CLASS B (acc. EN 1886)**
- ambient temperature: max. 70°C / 100%

Protection: The permitted level of filter contamination may be signaled by the pressure differential control (an optional element).

Compliance with standards: EN779.

- average filtration ratio E_m=90÷95%
- recommended filter change: Δp=350Pa
- max. air velocity: v=3,6m/s
- filter bypass leakage F9 - tightness **CLASS B (acc. EN 1886)**
- ambient temperature: max. 70°C / 100%

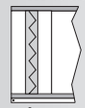
Protection: The permitted level of filter contamination may be signaled by the pressure differential control (an optional element).

Compliance with standards: EN779.

Teaching aids

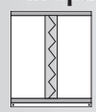
Filter configurations

- in base units:

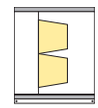

G4 flat filter
ref. VS 10÷650 AHUs


G4/F5 bag filter
ref. VS 21÷650 AHUs

- in optional functions – ref. VS 21÷650 AHUs


G4 flat filter


G4/F5 bag filter

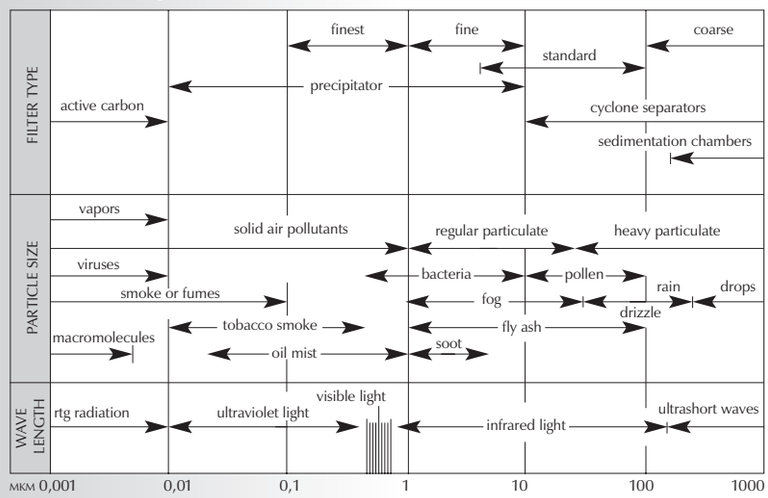

F7/F9 bag filter

Filters' dimensions in optional functions are demonstrated on page 53 and on the bookmark including optional functions.

Classification of filters used

PN-B-76003:1996	Class	B_2	C		Q
	initial efficiency	>75% (gravimetric filtration method)	<85% (gravimetric filtration method)		–
	Average filtration efficiency	>90% (gravimetric filtration method)	>95% (gravimetric filtration method)		>85% (paraffin oil mist method)
ASHRAE St.52.2;1999	Class	MERV 6,6-7, 7-8, 6-8	MERV 8-9, 9-10	MERV 13-14	MERV 15
EN 779:1992 greenDIN 24184	Class	G4	F5	F7	F9
	Class	EU4	EU5	EU7	EU9
DIN 24185 EUROVENT 4/5	average effectiveness for particulate	90%≤A_m	40%≤E_m ≤60%	80%≤E_m ≤90%	95≤E_m
Initial pressure of a clean filter [Pa]		30-60	50-80	100-200	150-250
Maximum allowed pressure drop [Pa]		150	250		350

Sizes of some particulate in the air



Recknagel, Sprenger source

Average particulate content in air

Technological area or process		Average concentration [mg/m^3]	Most frequent particle size [mm]	Upper Limit of the size of particles [mm]
Non-urban areas	During rain	0,05	0,8	4
	During dry periods	0,10	2,0	25
Large urban area	Residential area	0,10	7,0	60
	Industrial area	0,30-0,5	20	100
	Industrial facilities	1,0-3,0	60	1000
	Habitats	1-2	-	-
	Department stores	2-5	-	-
	Workshops	1-10	-	-
	Cement factories	100-200	-	-
	Air in mines	100-300	-	-
Coke fired furnace flue gases	Hand loaded	10-50	-	-
	Mechanically loaded	100-200	-	-
	Furnace flue gases	1000-15000	-	-

Recknagel, Sprenger source

Exchangers

Heaters

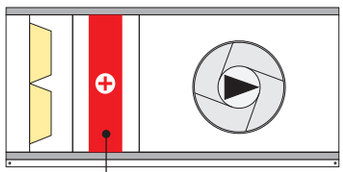
Water heater

Function and application

- Heating of the air supplied to the room.
- Heating of the air after the dehumidification process.

Used if a heating water system is available (local boiler or municipal heating system).

WCL type



Water heater

Construction

- copper pipes with aluminium plate fins (Cu/Al)
- distance between fins:
  VS 10÷15 - 2,1mm
  VS 21÷650 - 2,5mm
- fin thickness: 0,1mm (Al)
- pipe wall thickness: 0,37mm
- pipe diameter:
  VS 10÷15 – ⅜″
  VS 21÷650 – ½″
- collector diameter:

VS	DN	Material	Connection
10,15	20	brass	thread R3/4″
21 30,40 (≤4R)	25	brass	thread R1″
30,40 55,75 (≤4R) 100,120,150 (2R)	32	brass	thread R11/4″
55 (6R,8R) 75,100,120,150 (4R) 180 (2R)	50	steel	thread R2″
120 ÷ 650	80	steel	thread R3″
180 ÷ 400 (8R) 500 ÷ 650 (≥2R)	2x80	steel	thread 2xR3″

- number of heater rows: 2÷8
- connections of exchanger are equipped with drain and vent

The connectors are on the tending side of the AHU.
Connecting the exchanger to the power supply in a cocurrent system results in reduction of the heating capacity by between 10 and 20%.

Electrical heater

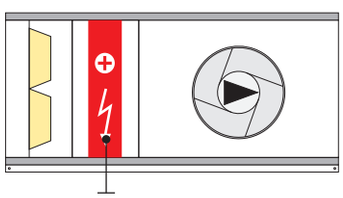
Function and application

- Heating of the air supplied to the room.
- Heating of the air after the dehumidification process.

Used when heating water is not available or in case of lower heating powers.

HE type

VS 10÷400



Electrical heater

Construction

- a complex of resistance heating elements made of Cr-Ni-Fr alloy, power: 6 kW/400V, each
- casing: frame made of zinc-coated steel
- terminal strip
- as standard, the heater is equipped with an overheat protection thermostat

If the device is staged together with a control system, the heater is integrated with a control module.
The wires are connected to the terminal strip of the exchanger on the AHU access side.
Desired power can be obtained by means of the system of smooth regulation (HE module as an optional control element) or gradual regulation (a diagram of connections available in the manual).

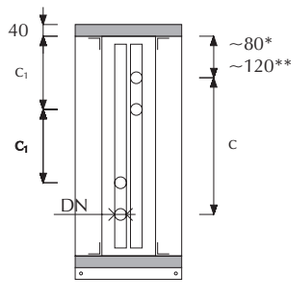
Operation parameters

- max. temp. of the liquid: up to 150°C (with the system control up to 140°C)
- max. operation pressure of the liquid: 1.6 MPa = 16 bar (tested 21 bar)
- max. allowed air velocity: v = 4,6 m/s
- max. glycol content: 50%
- heating capacity - available in technical specification (CCOL)
- fluid pressure drop and fluid flow rate - available in technical specification (CCOL)
- air gaps between the exchanger frame and the AHU casing: < 2 m

Protection: Allowed minimum air temperature after the exchanger is monitored by the anti-freeze thermostat (an optional element).

Geometry of water heaters' collectors

VS	C [mm]	C_1[mm]
10	115	x
15	140	x
21	164	x
30	294	x
40	294	x
55	347	x
75	459	x
100	554	x
120	586	x
150	681	x
180	872	380
230	872	379
300	1189	478
400	1380	554
500	1412	553
650	1888	711



* VS 10÷40
** VS 55÷650

Exchanger is connected to the hot water supply by means of the top or bottom connector depending on the access side of the AHU in order to enable counter-current air flow with reference to liquid flow in the cooler – universal design of exchanger: right/left.

Compliance with standards: EN 305, EN 1216, EN 13053.

- max. allowed air velocity: v = 5 m/s
- max. allowed ambient temperature around heating elements: 65°C
- airs gaps between the exchanger frame and AHU casing: < 2 mm
- heating elements joined in groups: power: 18kW each

Capacity range for specific sizes of AHUs

VS	P_{el} [kW]
10	18
15	36
21	36
30	54
40	72
55	90
75	90
100	108
120	108
150	108
180	108
230	108
300	108
400	108
500	x
650	x

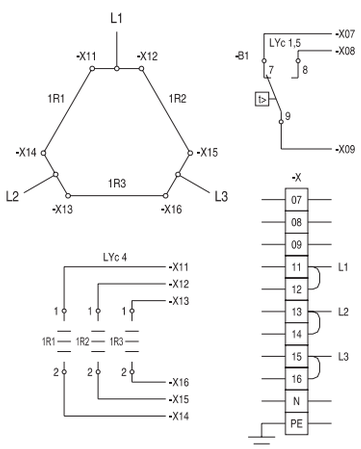


Fig. Diagram illustrating connections of heating elements

Teaching aids

Water heater capacity

Heating capacity of water heater for heating the air flow rate V [m^3/h] from temperature at point 1 to temperature at point 2 (x=const.)

Water heater capacity (liquid)

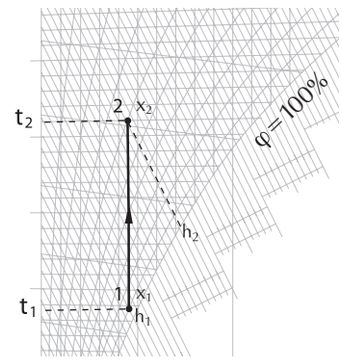
$Q = M_w \cdot c_{pw}(t_{w1}-t_{w2})$ [kW]

t_{w1} [°C] – water temperature before the heater
t_{w2} [°C] – water temperature after the heater
M_w [kg/s] – water flow rate
c_{pw} = 4,19 kJ/kgK – specific heat of water

Water heater thermal capacity (air)

$Q = V/3600 \cdot \rho_p \cdot c_p(t_2-t_1)$ [kW]*

V [m^3/h] – air flow rate
t_1 [°C] – air temperature before the heater
t_2 [°C] – air temperature after the heater
ρ_p [kg/m^3] – air density (1,2 kg/m^3 for 20°C)
c_p [kJ/kgK] = 1,005 – specific heat of dry air
* estimated value



$t_2 > t_1$
$x_2 = x_1$

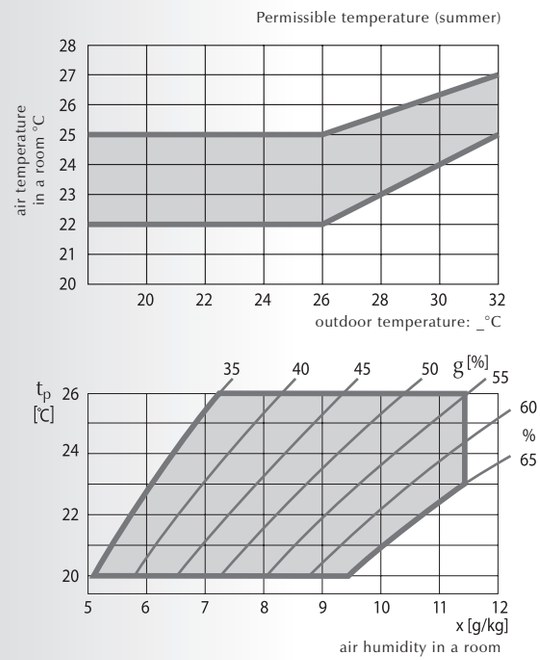
or/and

$Q = V/3600 \cdot \rho_p \cdot (h_2-h_1)$ [kW]

V [m^3/h] – air flow rate
h_1 [kJ/kg] – enthalpy of air before the heater
h_2 [kJ/kg] – enthalpy of air after the heater
ρ_p [kg/m^3] – air density (1,2 kg/m^3 for 20°C)

Temperature and humidity in a room

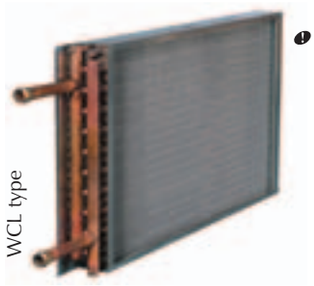
The human body continuously emits heat, the amount of which depends on the level of physical activity. In order to assess the amount of the heat a unit called MET is used. When people are idle the coefficient is 58W from each sqm of the surface of human body. We would like to remind you that an 'average' person has a body surface of 1.8 sqm.
Since indoor air must receive the heat emitted by people the air temperature in the room is a parameter determining the state of heat comfort.
Most often it can be assumed that the optimum temperature is: for winter 20-22°C, for summer 22-24°C. The relative humidity limits are from 35 to 65% (see graph).



Source: EN ISO 7730, ASHRAE 55.

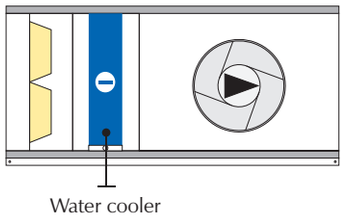
Coolers

Water cooler



- Cooling of the air supplied to the room.
- Air dehumidification during summer.

Exchanger used in complex air conditioning systems – several or even more units powered from one source of chilledwater system (chiller) or in case of using a unit with a relatively high cooling capacity.



- copper pipes with aluminium plate fins (Cu/Al)
- in pitch distance between fins:
  VS 10÷15 - 2,1mm
  VS 21÷650 - 2,5mm
- fin thickness: 0,1mm (Al)
- pipe wall thickness: 0,37mm
- pipe diameter:
  VS 10÷15 – 3/8″
  VS 21÷650 – ½″
- Collector diameter:

VS	DN	Material	Connection
10,15	20	brass	thread R3/4″
21 30,40 (≤4R)	25	brass	thread R1″
30,40 55,75 (≤4R) 100,120,150 (2R)	32	brass	thread R11/4″
55 (6R,8R) 75,100,120,150 (4R) 180 (2R)	50	steel	thread R2″
120 ÷ 650	80	steel	thread R3″
180 ÷ 400 (8R) 500 ÷ 650 (≥2R)	2x80	steel	thread 2xR3″

- number of cooler rows: 2÷8
- drain pan (made of stainless steel)
- connectors of the exchanger are equipped with the drain and vent

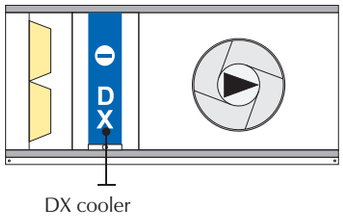
The connectors are on the access side of the AHU.

Connecting the exchanger to the chilled water supply in a paralell flow fashion results in reduction of the cooling capacity by up to 10-20%.

Direct evaporation cooler

- Cooling of air supplied to the room.
- Air dehumidification during summer.

Used for lower cooling capacity systems in comparison to water coolers (compressor units) in single air conditioning systems.



- copper pipes with aluminium plate fins (Cu/Al)
- drain pan (made of stainless steel)
- options:
  - mono-section exchanger <100kW
  - double-section exchanger >50kW
- fin pitch distance between fins:
  VS 10÷15 - 2,1mm
  VS 21÷650 - 2,5mm
- fin thickness: 0,1mm (Al)
- pipe wall thickness: 0,37mm
- pipe diameter:
  VS 10÷15 – 3/8″
  VS 21÷650 – ½″
- collector diameter:

VS	D_{in}	D_{out}
10÷30	5/8″	Ø28
40÷650	CCOL	

- number of cooler rows: 2÷6

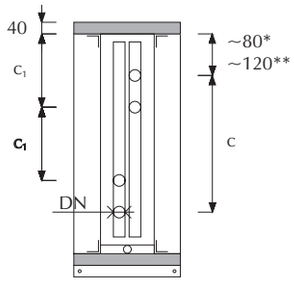
The connectors are on the access side of the AHU.

Operation parameters

- min. liquid temperature for chilled water: +2°C
- max. operaiton pressure of the liquid: 1.6 MPa = 16 bar (tested 21 bar)
- max. glycol content: 50%
- max. air velocity: v=2,8m/s
- cooling capacity - available in technical specification (CCOL)
- fluid pressure drop and fluid flow rate - available in technical specification (CCOL)
- air gap between the exchanger frame and AHU casing: < 2 mm

Geometry of water coolers' collectors

VS	C [mm]	C_1[mm]
10	115	x
15	140	x
21	164	x
30	294	x
40	294	x
55	347	x
75	459	x
100	554	x
120	586	x
150	681	x
180	872	380
230	872	379
300	1189	478
400	1380	554
500	1412	553
650	1888	711



* VS 10÷40
** VS 55÷650

Exchanger is connected to the chilled water supply by means of the top or bottom connector depending on the access side of the AHU in order to enable counter-current air flow with reference to liquid flow in the cooler – universal design of exchanger: right/left.

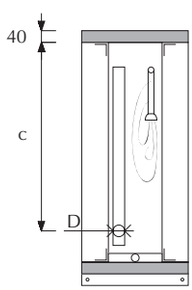
Compliance with standards: EN 305, EN 1216, EN 13053.

- min. cooling agent evaporation temperature: +3°C
- max. operaiton pressure of the liquid: 2.2 MPa = 22 bar (tested 29 bar)
- max. allowed air velocity: v = 2.8m/s
- cooling capacity - available in technical specification (CCOL)
- air gaps between the exchanger frame and AHU casing: < 2 mm

The exchanger can be selected for a wide range refrigerants (R12, R22, R134a, R407c...).

Geometry of DX coolers' collectors

VS	C [mm]
10	195
15	195
21	244
30	374
40	374
55	467
75	586
100	684
120	718
150	817
180	1017
230	1021
300	1315
400	1543
500	1538
650	2014



Compliance with standards: EN 305, EN 1216, EN 13053.

Teaching aids

Cooling capacity

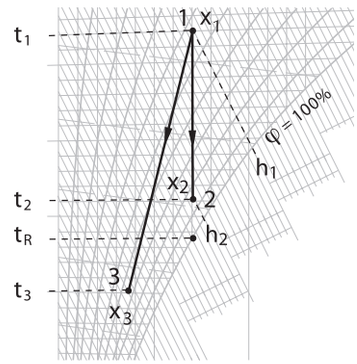
Cooling capacity for cooling air flow V [m^3/h] from the temperature at point 1 to the temperature at point 2 (x=const) or to the temperature at point 3 (x= var)

'Dry' cooling (alteration 1-2)

$Q = V/3600 \cdot \rho_p \cdot (h_1-h_2)$ [kW]; $x_1=x_2$, w=0

V [m^3/h] - air flow capacity
h_1 [kJ/kg] – enthalpy of air flow before the cooler
h_2, h_3 [kJ/kg] – enthalpy of air flow after the cooler
ρ_p [kg/m^3] – air density (1,2 kg/m^3 for 20°C)

$t_2<t_1$
$x_2=x_1$



t_1 [°C] - air temperature before the cooler
t_2, t_3 [°C] - air temperature behind cooler

'Wet' cooling (alteration 1-3)

$Q = V/3600 \cdot \rho_p \cdot (h_1-h_3)$ [kW]
$W = V/3600 \cdot \rho_p \cdot (x_1-x_3)$ [kg/s]

V [m^3/h] - air flow capacity
W [kg/s] - amount of condensed moisture
x_1 [kg/kg] – amount of moisture before the cooler
x_2, x_3 [kg/kg] – amount of moisture after the cooler
h_1 [kJ/kg] – enthalpy of air before the cooler
h_2, h_3 [kJ/kg] – enthalpy of air behind the coolerρ_p [kg/m^3] – air density (1,2 kg/m^3 for 20°C)

$t_3<t_1$
$x_3<x_1$

Air comfort parameters

Category	Design conditions		Air velocity
	winter t/%	summer t/%	m/s
catering and entertainment			
cafeterias	21-23°C / 20-30%	26°C / 50%	0,25 m/s
restaurants		22-26°C / 50-55%	at 1,8 m above the floor
bars		22-26°C / 50-60%	
night clubs		22-26°C / 50-60%	
kitchens	21-24°C	25-28°C	
offices	21-23°C / 20-30%	21-26°C / 50-60%	0,13-0,23 m/s
libraries and museums	18-24°C / 40-55%	18-24°C / 40-55%	below 0,13 m/s
telecommunication			
technical rooms	22-26°C / 40-50%	22-26°C / 50%	0,13-0,15 m/s above the floor
telephone exchanger	21-23°C / 40-50%	22-26°C / 45-55%	0,13-0,15 m/s above the floor
radio and TV studios	23-26°C / 40-50%	22-26°C / 45-60%	below 0,13 m/s at 3,7 m above the floor
transport centers			
airports	21-23°C / 20-30%	23-26°C / 50-60%	0,13-0,15 m/s at 1,8 m above the floor
seaports	21-23°C / 20-30%	23-26°C / 50-60%	0,13-0,15 m/s at 1,8 m above the floor
bus terminals	21-23°C / 20-20%	23-26°C	0,13-0,15 m/s at 1,8 m above the floor
garages	4-13°C	26-38°C	0,13-0,38 m/s
warehouses	outdoor air parameters depend on a housed material		

Source: ASHRAE 55.

Physical activity of a person

Activity	MET	[W]
lying or sleeping	0,8	84
sitting still	1,0	105
activities carried out in a sitting position (office, house, laboratory, school)	1,2	125
a rested person standing	1,2	125
activities not requiring too much effort (shopping, laboratory, light industry)	1,6	160
activities requiring average amount of effort in standing position (shop assistant, household activities, work on a machine)	2,0	205
activities requiring much effort (hard work on a machine, work at a garage for a longer period of time)	3,0	300

Source: ASHRAE 55.

Energy recovery

Regeneration

Non- hydroscopic rotary exchanger

Function and application

- Indirect energy recovery (sensible heat) accumulated in the exhaust air flow and its transfer to the counter current supply air flow.
- Indirect recovery of latent heat (moisture) when the rotor surface temperature on the side of the exhaust air is lower than the supply air dew-point temperature.
- Energy recovery without total separation of the supply and exhaust air flows (air leakages of 2 ÷ 5%).
- Application in block Supply-exhaust AHUs.

Construction

- rotor 400-500mm thick installed on a shaft with bearing and built in steel construction frame
- rotor filling: a spiral built of two alternating layers of flat and corrugated aluminium sheets 0.07mm thick creating ducts of hydraulic diameter D=1.6mm
- variable rotary speed drive system enabling max. exchanger efficiency and regulation of energy recovery level
- purge sector reducing the penetration of 'dirty' exhaust air into the supply air to the minimum
- brush seals placed on the rotor's perimeter and the dividing line providing additional protection against air leakages

- ***If there is a risk of moisture freezing on the exchanger rotor the process control system reduces the r.p.m. which results in heating the surfaces covered with frost.***

Type: AIR - AIR

vertical system: VS 21÷650

Recuperation

Cross-flow exchanger

Function and application

- Indirect energy recovery (sensible heat) accumulated in the stream of exhaust air and its transfer to the ventilation air supplied to the rooms.
- Heat recovery at very high separation of the streams of supplied and exhaust air (99.9%).
- Application in block supply-exhaust AHUs.

Construction

- a system of crosswise formed 0.12÷0.2mm thick aluminium plates, between which separated streams of supply and exhaust air flow in an alternating crosswise pattern
- internal by-pass duct (VS-21÷650) with installed air damper which allows to divert air flow outside the exchanger "window":
  - disabling energy recovery function
  - function of the exchanger's anti-freeze protection
- drop eliminator with a drain pan

Type: AIR - AIR

horizontal system: VS 10÷15
vertical system: VS 21÷650

Glycol system

Function and application

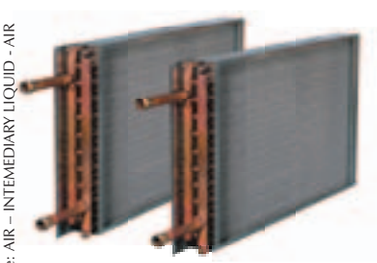
- Indirect energy recovery (sensible heat) with a total (100%) separation of supply and exhaust air flows.
- System applied when there is a necessity to separate (even at significant distances) supply from exhaust AHUs.

Construction

- system of two exchangers – placed in the exhaust air flow, which takes over the heat (cooler) and transfers it through an intermediate agent (water and glycol solution) to an exchanger, mounted in the supply air flow (heater)
- construction of exchangers included in the recovery system is similar to the construction of water VTS exchangers
- number of rows: 8

- ***Glycol installation system with a circulating pump and control system is not included in VTS offer.***
- ***The connectors are placed on the access side of the AHU.***
- ***Exchanger is connected to the liquid supply by means of the top or bottom connector depending on the access side of the AHU in order to enable counter-current air flow with reference to liquid flow in the exchanger – universal exchanger right/left type.***
- ***Connecting the exchanger to the liquid supply in a paralell flow fashion system results in reduction of the cooling by up to 20%.***

Type: AIR – INTEMEDIARY LIQUID - AIR



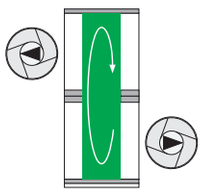
VS 21÷650

Operation parameters

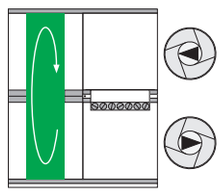
- efficiency up to 85% (depends on the temperature differences between the air streams, moisture and ratio of air flows) – exchanger class A acc. EN 13053
- exchanger tightness for nominal operation parameters: 97%
- max. permissible air flow speed: 5,2m/s
- rotor rotational speed: 10rpm
- life of bearings:
  L_{10}= 50000h / L_{50}=250000h (<VS-120)
  L_{10}= 25000h / L_{50}=125000h (> VS-120)
- recommended max. pressure drop: 450Pa
- ambient temperature: -40÷70°C

Cooperation between the exchanger and the fan unit

Basic configurations



Configuration for a unit cooperating with an internal mixing box



Compliance with standards: EN 308, EN 13053.

Teaching aids

Total heat recovery efficiency (sensible and latent heat)

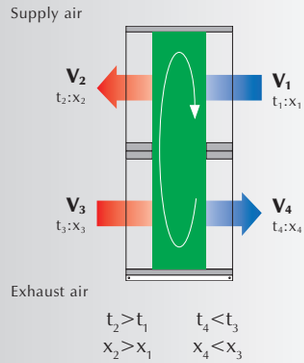
$$\eta_c = \frac{(h_2-h_1)}{(h_3-h_1)}$$

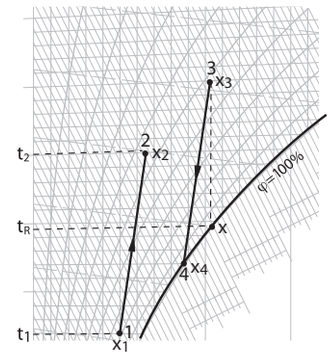
Enthalpy and temperature of the supply air:
h_1 [kJ/kg], t_1 [°C] – before the exchanger
h_2 [kJ/kg], t_2 [°C] – behind the exchanger

Heat recovery sensible efficiency (sensible heat)

$$\eta_t = \frac{(t_2-t_1)}{(t_3-t_1)}$$

Exhaust air enthalpy and temperature:
h_3 [kJ/kg], t_3 [°C] – before the exchanger
h_4 [kJ/kg], t_4 [°C] – behind the exchanger

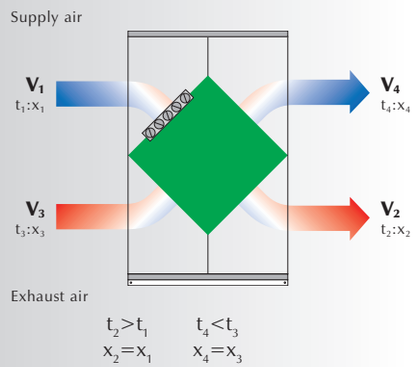


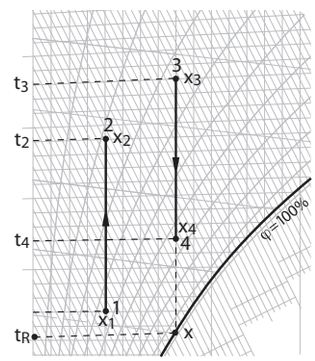


Operation parameters

- efficiency up to 70% (depends on the temperature differences between the air streams, moisture and ratio of air streams) – exchanger class B acc. EN 13053
- exchanger tightness for nominal operation parameters: 99.9%
- max. permissible air flow speed: 3.8m/s
- recommended max. pressure drop: 450Pa
- max. difference between air flow pressures of supply and exhaust air: 1500Pa
- ambient temperature: -40÷80°C

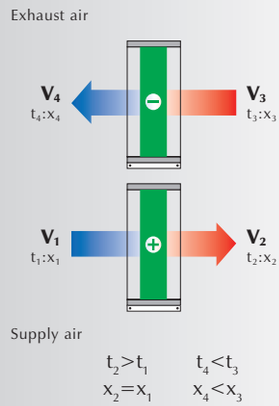
Compliance with standards: EN 308, EN 13053.

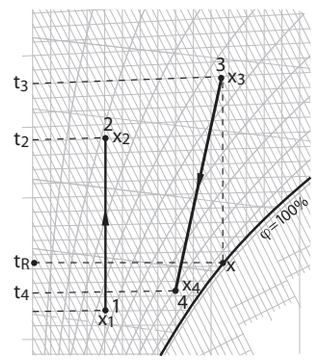




- efficiency up to 45% - exchanger class C acc. EN 13053
- max. permissible air flow speed:
  "heater": v=2,8m/s
  "cooler": v=2,8m/s
- max. operation pressure of the agent: 1.6MPa=16 bar (tested 21 bar)
- min. agent temperature depends on the glycol concentration
- glycol content: max. 50%
- pressure drop on the exchangers/agent flow available in technical specification (CCOL)

Compliance with standards: EN 779, EN 13053.





Fan units

	Function and application	Construction

PLUG fan unit with a direct drive

SWSI type

VS 21÷150

- Low and medium pressure ventilation and air conditioning systems, with total pressures of up to 2200 Pa.
- Single-draw centrifugal fan without casing with impeller's blades curved backwards.

- the fan and motor unit is placed on a common frame isolated from the AHU structure by rubber vibration isolators
- drive type: direct – the fan impeller is installed on the motor shaft
- TEFC type motors (Totally Enclosed Fan Cooled)
- one speed motors complying with the IEC standard
- frequency converter (a standard element of the fan unit)

PLUG fan unit with belt drive

SWSI type

VS 180÷650

- Low and medium pressure and air conditioning systems with total pressures up to 2000 Pa.
- Single-draw centrifugal fan without casing with impeller's blades curved backwards.

- fan and motor unit are installed on a common frame isolated from the AHU structure by rubber vibration isolators
- drive type: indirect – belt drive
- taper-lock type belt pulleys are seated on sleeves which are easy to adjust, assemble and disassemble and makes it possible to use on a wide range of pulleys (so called gear ratios)
- TEFC type motors (Totally Enclosed Fan Cooled)
- one speed motors complying with the IEC standard

230V Fan unit

DWDI type

VS 10

- Low and medium pressure ventilation and air conditioning systems, with total pressures of up to 750 Pa.
- Single-draw centrifugal fan without casing with impeller's blades curved forwards.

- integrated fan and motor unit is placed on a common frame
- unit isolated from the AHU structure by rubber vibration isolators
- drive type: direct
- TEFC type motors (Totally Enclosed Fan Cooled)
- one speed motors complying with the IEC standard
- rotation speed controller (a standard element of the fan unit)

230V Fan unit

SWSI type

VS 15

- Low and medium pressure ventilation and air conditioning systems, with total pressures of up to 800 Pa.
- Single-draw centrifugal fan without casing with impeller's blades curved forwards.

- integrated fan and motor unit is placed on a common frame
- unit isolated from the AHU structure by rubber vibration insulators
- drive type: direct
- TEFC type motors (Totally Enclosed Fan Cooled)
- one speed motors complying with the IEC standard
- rotation speed controller (a standard element of the fan unit)

Operation parameters

- voltage rating: 3x400V AC
- motor rpm.: 1440 rpm, 2860 rpm
- protection type: PTC
- motor winding insulation class F: life (co-operation with exchanger)
- life-span of bearings: L10 = 20000h / L50 = 100000h
- level of protection: IP 55
- ambient temperature: 60°C

Technical specification of frequency converters: p. 74.
Protection: operation of the fan unit may be monitored by a pressure differential switch (optional element).

Compliance with standards: EN 1886, EN 25136, ISO 5801, AMCA standard 210.

- voltage rating: 3x400V AC
- motor rpm.: 1440 rpm, 2860 rpm
- protection type: PTC
- motor winding insulation class: F (co-operation with exchanger)
- life-span of bearings: L10 = 20000h / L50 = 100000h
- level of protection: IP 55
- ambient temperature: 60°C

Protection: operation of the fan unit may be monitored by a pressure differential switch (optional element).

Compliance with standards: EN 1886, EN 25136,ISO 5801, AMCA standard 210.

- voltage rating: 1x230V AC (in=7.7 A)
- motor rpm.: 2700 rpm
- nom. motor power: P=1kW
- motor winding insulation class: B
- life-span of bearings: L_{10}= 20000h / L_{50}=100000h
- level of protection: IP54
- ambient temperature: 40°C

Compliance with standards: EN 1886, EN 25136, ISO 5801, AMCA standard 210.

Technical specification of rotation speed controller: p. 76.

- rated voltage: 1x230V AC (In=7,6A)
- motor rpm.: 1160 rpm
- nom. motor power: P=1,75kW
- protection type: TK
- motor winding insulation class: F
- life-span of bearings: L_{10}= 20000h / L_{50}=100000h
- level of protection: IP20
- ambient temperature: 40°C

Compliance with standards: EN 1886, EN 25136, ISO 5801, AMCA standard 210.

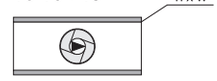
Technical specification of rotation speed controller: p.76.

Teaching aids

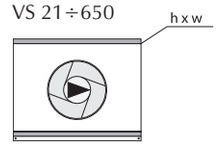
AHU outlet configurations - PLUG centrifugal fan

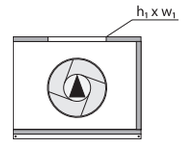
VS	► h x w [mm]	▲ h_1 x w_1 [mm]
10	220 x 500	-
15	250 x 660	-
21	313 x 821	250 x 660
30	440 x 821	313 x 821
40	440 x 1028	440 x 821
55	575 x 1199	440 x 1028
75	695 x 1340	575 x 1199
100	795 x 1520	795 x 1520
120	832 x 1751	795 x 1520
150	933 x 1945	933 x 1945
180	1137 x 1945	933 x 1945
230	1137 x 2353	933 x 1945
300	1436 x 2445	1199 x 1945
400	1669 x 2945	1199 x 2650
500	1669 x 3445	1199 x 3150
650	2146 x 3557	1520 x 3250

VS 10÷15



VS 21÷650





SFP – common indicator of the ventilation system capacity

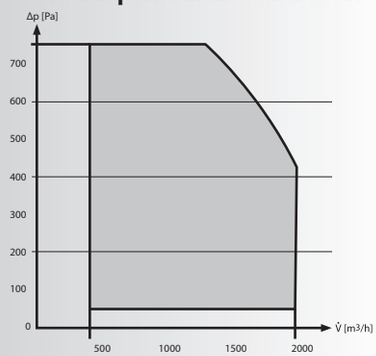
SFP (Specific Fan Power) indicates the relation of electrical energy consumption to the amount of supplied and/or exhaust air through mechanical ventilation unit within a given time limit. It is the only parameter which reflects characteristics of air flow in an AHU as well as the one in the whole network with one value only.

$$SFP = \frac{P_{el\_nawiew} + P_{el\_wywiew}}{\dot{V}_{max}} \ [kW/m^3/s]$$

For calculations in the case of supply-exhaust AHUs a greater value of air flow capacity for supply or exhaust air should be assumed.

The analyses of ventilation systems' energetic capacity indicate that values between 1.8 and 2.3 m/s are optimum linear air flow speeds in a ventilation unit cross section.

VS 10 fan performance characteristics



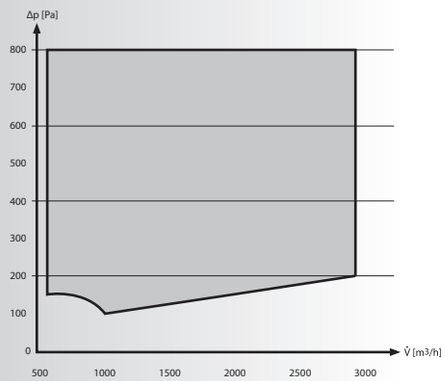
Change of fan's capacity in relation to change of rotary speed

$$\frac{V_2}{V_1} = \frac{n_2}{n_1}$$

Change of fan's accumulation in relation to change of rotary speed

$$\frac{\Delta P_2}{\Delta P_1} = \left(\frac{n_2}{n_1}\right)^2$$

VS 15 fan performance characteristics



Demand for fan power in relation to change of rotary speed

$$\frac{P_2}{P_1} = \left(\frac{n_2}{n_1}\right)^3$$

Mixing box, Silencer

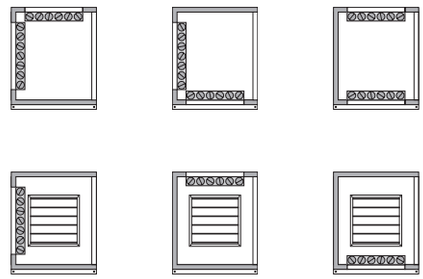
Recirculation

Mixing box

Function and application	Construction
● Direct energy recovery (sensible heat, latent heat) as a result of mixing two streams of air – the external air with a part of the exhaust air. ● AHU operation in fast heating mode for units equipped with an internal mixing box. ● ***In case of high concentration of toxic substances in a room using the recirculation function is forbidden.*** ● ***The recirculation function constitutes an optional element of a unit's equipment.*** ● ***The function available for the VS 21÷650 size.***	● mixing box is equipped with an appropriate double system of inlets/outlets armed with air throttles regulating the proportional share of the external air to the exhaust one (the recirculation air) ● configurations of inlets/outlets:

M type

VS 21÷650



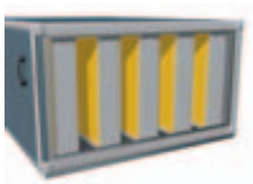
● ***Dimensions of inlets/outlets: p. 53 or the bookmark.***

Silencing

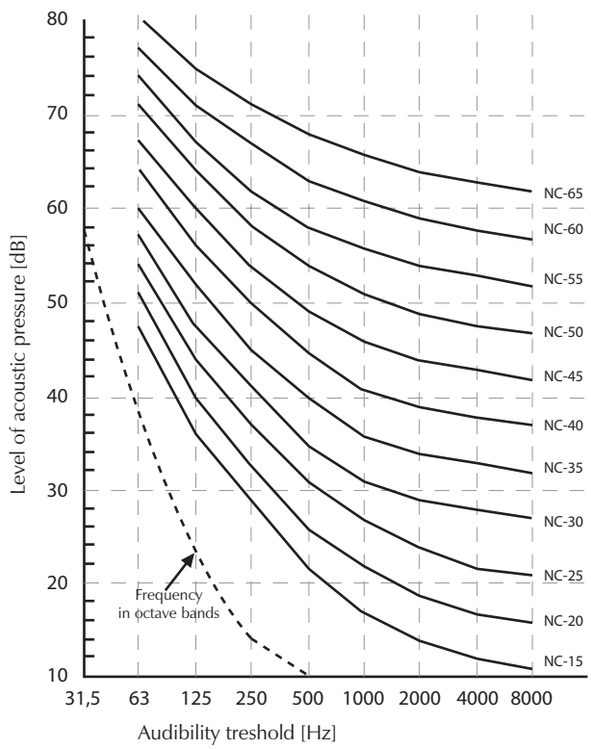
Silencers

Function and application	Construction
● Reduction of the level of acoustic power and in consequence acoustic pressure (noise) from the draw and discharge side of the ventilation or air conditioning AHU, generated by the fan unit. ● ***Silencing function constitutes an optional element of a unit's equipment.***	● 140 mm thick silencing elements (plates) internal filling is made of sound absorbing and incombustible mineral wool of 60 and 60 kg/m³ density, respectively ● plates' casing: plastic frame ● the outer surface of the elements is covered with a thin unwoven fabric ("veil"), which prevents mineral wool particles from getting into the supply air flow ● number of plates per silencer: 2-13 (depending on the size of a specific AHU)

SLCR type



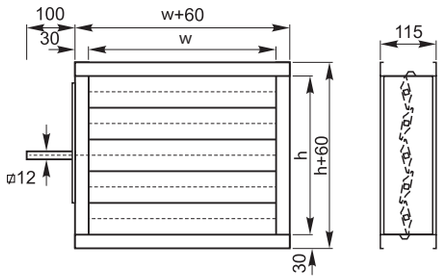
NC curve distribution (Noise criteria)



Operation parameters

- efficiency up to 90% - exchanger class A acc. EN 13053
- operation temperature: -40 ÷ +70°C

Compliance with standards: EN 13053.



Operation parameters

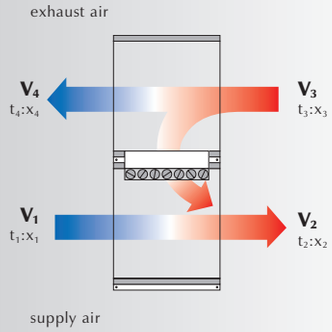
- maximum air velocity: v=5m/s
- operation conditions: -40 ÷ +70°C

Compliance with standards: EN ISO 7235:2005.

Silencing values for *VENTUS* AHU silencers

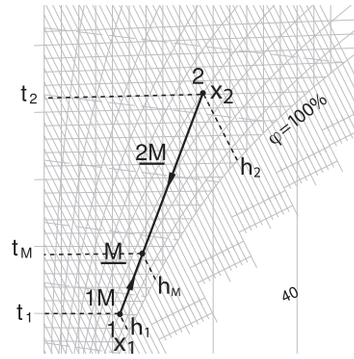
VS	Frequency [Hz]						
	125	250	500	1000	2000	4000	8000
10	6,3	9,4	15,7	18,8	20,1	20,4	20,0
15	6,8	10,2	17,0	20,4	21,7	22,0	21,5
21	10,6	16,0	26,7	32,0	34,1	34,7	33,9
30	8,7	13,0	21,7	26,1	27,8	28,2	27,6
40	10,0	15,0	24,9	30,0	32,0	32,5	31,8
55	9,4	14,1	23,5	28,1	30,0	30,4	29,9
75	9,0	13,5	22,4	26,9	28,7	29,1	28,6
100	8,9	13,4	22,3	26,8	28,6	29,1	28,5
120	9,5	14,3	23,8	28,6	30,5	31,0	30,3
150	9,5	14,2	23,7	28,5	30,3	30,8	30,2
180	8,4	12,6	21,0	25,2	26,9	27,3	26,8
230	9,5	14,2	23,7	28,4	30,3	30,8	30,1
300	11,4	17,1	28,3	34,0	36,3	36,9	36,0
400	11,7	17,4	29,0	34,9	37,2	37,8	36,9
500	12,8	19,3	32,1	38,5	41,1	41,7	40,9
650	11,2	16,8	28,0	33,6	35,8	36,4	35,7

Teaching aids



$$\frac{V_1}{V_2} = \frac{\overline{2M}}{\overline{1M}} = \frac{h_2 - h_M}{h_M - h_1} = \frac{x_2 - x_M}{x_M - x_1}$$

$$\frac{V_1}{V} = \frac{\overline{2M}}{\overline{12}} \qquad \frac{V_2}{V} = \frac{\overline{1M}}{\overline{12}}$$



t [°C] - air temperature
w [kg/kg] - amount of moisture in the air
h [kJ/kg] - enthalpy of air
V [m³/h] - air flow

Level of acoustic power

The acoustic power level, which is an objective value describing the source of noise in acoustic terms, is used for acoustic calculations (it is neither dependent of the distance of the sound source nor the room type).

Level of acoustic pressure

The measure of acoustic pressure of sound in relation to reference pressure amounting to
$p_o = 2 \cdot 10^{-5}$ Pa (audibility threshold):

$L_p = 20 \log (p/p_o)$ [dB]

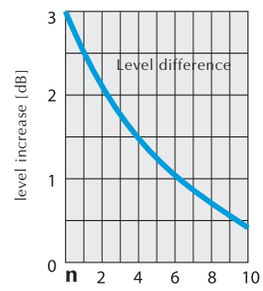
Acoustic pressure as a value perceived by human ear depends on the sound source and room type. Therefore the figures provided in technical specifications of equipment describe only an approximate value of the level of acoustic pressure.

Two and more sound sources

Summation of noise level from identical sound sources :

$L_s = L + 10 \lg n$ [dB(A)]

Where n –number of sources
L_s - total sound level
L - sound level of individual sources



For two sources (n=2) with identical acoustic power the sound level rises by 2 dB(A) at n=10 increase by 10 dB(A). For summation of two sources with different sound levels, the level of the louder source must be increased according to the chart depending on the level difference between the two sources. For more sound sources all sound sources should be totaled one by one.

The letter "A" added to the acoustic pressure level unit [dB(A)] - shows that the indicated noise level takes into account the reaction of human middle ear to sounds of different frequencies. It is known that low frequencies of the same acoustic pressure are more tolerable to humans than high frequencies, which is shown by the "A" curve.

Optional elements

Function and application	Construction

Air damper

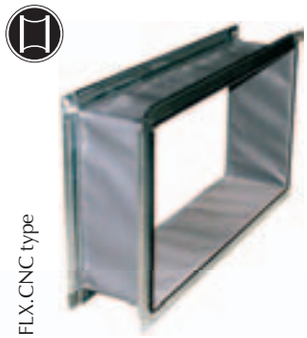
A.DAMP type

- Cutting off the air flow through AHU.
- Control of air flow through AHU.
- Control of air mixing rate in the supply and exhaust AHU system.
- Protection of cross-flow exchanger - by-pass type air damper.

- aluminium blades protected with rubber seals on the edges
- aluminum frame
- driven by plastic gears installed inside aluminium frame-work
- damper is equipped with a square pin adjusted for cooperation with an actuator (dampers with hydraulic diameters greater than 4m^2 have two pins coupled with a connector)

Assembly:
- outside AHU's casing;
- mixing box: inside AHU's casing.

Flexible connection

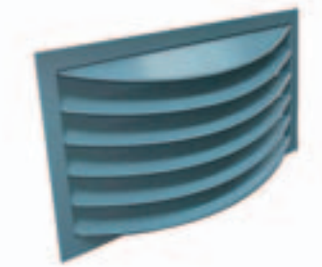


FLX.CNC type

- Protection of the ventilation system (ducts) against transmission of vibrations from the ventilation or air conditioning AHU.
- Compensation of axial symmetry of ventilation ducts in relation to the AHU's axis.

- flange: 1mm thick and 30mm wide zinc-coated steel
- flexible material: polyester fabric covered with PVC
- PE are equipped with ground load in order to equalize potentials

Air intake, Air terminal, Drip cap



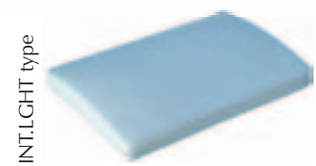
VS 21÷650

- Protection of the ventilation or air conditioning AHU against the effects of outdoor factors (water, sand) for outdoor systems.

Each of these components can operate as an independent option.

- air intake: 1mm thick zinc-coated metal sheet covered with an additional polymer coating
- air terminal: 1mm thick zinc-coated metal sheet covered with an additional polymer coating
- drip cap: 1mm thick aluminium section

Lighting



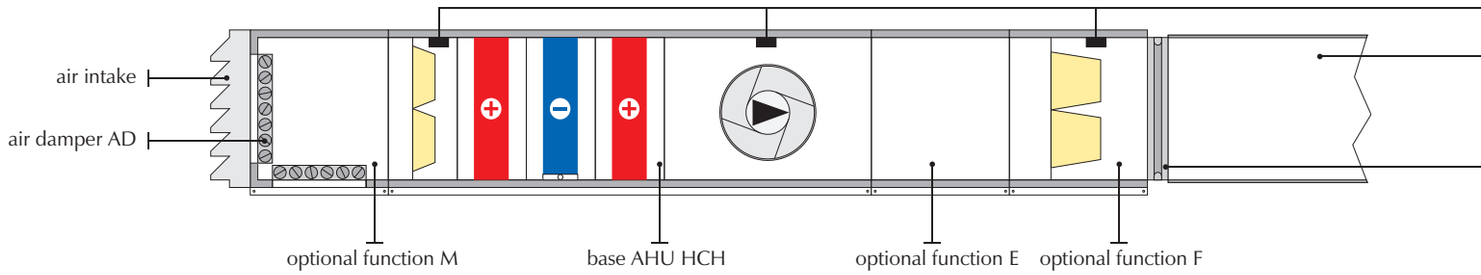
INT.LGHT type

VS 21÷650

- AHU inspection and maintenance.

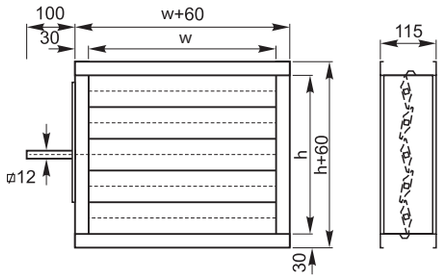
- casing
- glow tube

Installation: filtration area, fan area.



Operation parameters

- leakages behind the closed blades: 50m³/h/m² – at pressure difference of 100Pa
- ambient temperature: -40 ÷ +70 °C



- pressure strength of material in accordance with DIN24194
- position of operation: span 110mm
- ambient temperature: -40 ÷ +70 °C

- zinc coating mass 275g/m²
- material/ external protection coating thickness: polyester/25μm
- ambient temperature: -40 ÷ +70°C

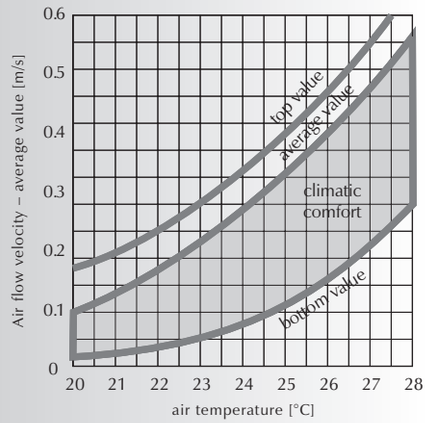
- power supply voltage: 230V AC
- power: 11W
- protection class: IP54
- ambient temperature: 0 ÷ +70°C

lighting

ventilation duct

flexible connection FC

Teaching aids



Air flow velocity in a populated area

Usually in a populated area (up to 1.8m above the floor and at 0.15m intervals from all surfaces of the room) at 24°C the recommended velocity of air flow is 0,15 m/s. You can approximately determine air velocity in the room using the chart. Use the standards for more accurate calculations.

Source: EN ISO 7730, ASHRAE 55.

Type of room	Multiple of air replacement [h^{-1}]
Auditorium	6 ÷ 8
Bank	2 ÷ 3
Bar	10 ÷ 15
Library	3 ÷ 5
Department store	3 ÷ 6
Garage	4 ÷ 6
Cinema, theatre	4 ÷ 6
Theatre	0 ÷ 0
Classroom	3 ÷ 5
Kitchen	10 ÷ 30
Physical laboratory	5 ÷ 15
Warehouse	4 ÷ 6
Swimming pool	3 ÷ 4
Hotel room	4 ÷ 8
Office room	3 ÷ 8
Utility room	1 ÷ 2
Retail premises	4 ÷ 8
Laundry	10 ÷ 15
Restaurant	8 ÷ 12
Conference room	6 ÷ 8
Server room	5 ÷ 10
Shop	6 ÷ 8
Cloakroom	4 ÷ 6
Mechanical workshop	3 ÷ 6

Calculating the amount of ventilation air considering the required multiple of replacement

$V = n \cdot V_p$ [m³/h]

V_p – [m³] – cubic capacity of the room
n – [h^{-1}] – required multiple of replacement in the room

You need to remember that the method of determining the amount of ventilation air based on the replaced multiple is a simplified method not considering the thermal load of the room, the number of persons or concentration of pollutants. The values in the table based on the DIN 1946, ASHRAE standard should be treated as approximate.

Calculation of the amount of ventilation air depending on the number of people

$V = n \cdot V_i$ [m³/h]

V_i - [m³/h] – amount of the outdoor air (so called hygienic minimum) per person
n – number of persons

Usually the value of Vi is assumed from 20 to 60 m³/h per person, depending on the type of a room. In any case, the amount of air calculated in this way is at the same time the minimum amount of outdoor air that must be supplied to the room.

Source: DIN 1946, ASHRAE standard.

Type of room	V_i	
	recommended	minimum
Theatres, movie theatres, conference room (no smoking)	40 m³/h per person	20 m³/h per person
Restaurants, cafes (smoking allowed)	60 m³/h per person	40 m³/h per person