For the world of ventilation

--- TECHNICAL INFO ---

In the following text you find useful information and tips, which support you with your work during the project engineering of a ventilation system.

For technical questions call our hotline service under 07720/606-266 or
send an e-mail to info@ heliosventilatoren.de.

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1. Calculation of air flow volume

The required extract or intake air volume of a room depends on the use and the contamination or odours that are created within it. A critical factor may also be the amount of heat that needs to be extracted. The calculation of the air flow volume may be done using various criteria with the following equations and tables. In some cases, several ways of calculation should be used and the higher figure taken (e.g. restaurant: no people – air changes per hour).

1.1 Calculation of air flow volume using air change rate
The air flow volume is calculated by the product of room volume and air change rate. Air change rates are based on past experience and do not take into account special pollutants.

Air changes per hour and (recommended) noise levels:

Room type	Ac/h	Max. sound power level dB(A)	Suggested method of ventilation
Assembly plants	4 - 8	60 - 70	
Auditoriums	6 - 8	35 - 40	Intake and extract
Bathrooms	5 - 7	45	
Battery rooms	5 - 10	70	Explosion proof
Car parks	5	70	Extract
Changing rooms	6 - 8	60	Extract
Cinemas and theatres	5 - 8	35/25	Intake and extract
Classroom	5 - 7	40	
Cloackrooms	4 -6	50	
Conference rooms	6 - 8	45	
Dye rooms	5 - 15	70	Explosion proof, acid proof
Foundries	8 -15	80	Extract, energy balance
Gymnasiums	4 -6	50	
Kitchen - Domestic	15 - 25	45 - 50	Extract
Kitchen - Commercial	15 - 30	50 - 60	Extract
Laboratories	8 -15	60	Extract, Explosion+, acid proof
Libraries	4 -5	35 - 40	
Laundrettes	10 -20	60 - 70	Energy balance
Living rooms	3 -6	day 40/night 30	
Meeting rooms	5 - 10	45	
Metal hardening plants	up to 80	80	Extract, energy balance
Offices	4 - 8	45	
Paint rooms	10 - 20	70	Explosion proof
Photographic printing	10 - 15	60	Extract
Plant rooms	10 - 40	60 - 80	Energy balance
Restaurants, casinos	8 - 12	45 - 55	Intake and extract
Retail shops	4 - 8	60	
Safes	3 -6	60	
Sheet metal shops	8 - 12	60	Extract, energy balance
Shower rooms	15 - 25	65 - 70	Pre-heated intake air
Spray booths	25 -50	70	Explosion proof

Swimming pools	3 - 4	50	Pre-heated intake air
Tanneries	5 -15	70	Acid protection
Toilets - Domestic	4 - 5	40	Extract
Toilets - Commercial/public	8 - 15	50	Extract
Waiting rooms	4 - 6	45	
Welding shops	10 - 20	70- 80	Spot extract systems
Workshops with low pollution	3 -6	60 - 70	
Workshops with height pollution	10 -20	60 - 70	

1.2 Calculation of air flow volume using the number of people in a room (DIN 1946 T.2):
In rooms with additional pollutants (e.g. tobacco smoke) the air flow per person has to be increased by 20 m^3/h.

Type of room	m^3/h x persons
Auditoriums	30
Canteens	30
Cinemaso	20
Classrooms	30
Common rooms	30
Conference rooms	30
Exhibition halls	20
Gymnasiums	20
Hotel rooms	30
Museums	20
Offices (open plan)	50
Offices (small)	30
Party rooms	20
Reading rooms	20
Restaurants	40
Restrooms	30
Theatres, concert halls	20
Restrooms	20

1.3 Calculation of air flow volume using maximum pollutant concentration levels (MAC value):

The MAC-value defines the maximum permitted concentration of a toxic agent. The required air flow volume is calculated by the quotient of hourly absorption of toxic agent and the difference of MAC-value and toxic agent concentration of intake air.

Extract from MAC-table (max. permitted toxic agent)

Toxic	cm^3/m^3	mg/m^3
Acetone	1000	2400
Aniline	2	8
Ammonia	50	35
Asbestos dust	-	2
Lead	-	0.1
Butane	1000	2350
Cloride	0.5	1.5
Chromate	-	0.1
Carbon monox.	30	33
CO_2	5000	9000
Formaldehyde	0.1	1.2
Hydro chloride	5	7
Hydrazine	0.1	0.13
Iodine	0.1	1
Methanole	200	260
Nicotine	0.07	0.5
NO2	5	9
Ozone	0.1	0.2
Propane	1000	1800
PVC	3	8
Quicksilver	0.01	0.1
Saltpetre	10	25
SO_2 (H_2SO_4)	2 (-)	5 (1)
Zink oxide	-	5

1.4 Calculation of air flow using the amount of humidity
The required air flow volume is calculated as follows:

$$\text{Air flow volume } (m^3/h) = \frac{\text{Amount of water(gram/hour)}}{\text{[water content of extracted air(gram water/kg air) - Water content of intake air (gram water / kg air)] x x air density(kg/m}^3\text{) at 20°C, 1013 mbar 0 1,2 kg/m}^3}$$

1.5 Calculation of air flow volume using the heat to be extracted
The required air flow volume is calculated as follows:

$$\text{Air flow volume} (m^3/h) = \frac{\text{Required heat extraction(kW) x 3600}}{\text{air density(kg/m}^3\text{) x specific heat capacity of air(kJ/kgxK) x temperature difference between intake and extract air °C}}$$

2. Noise level

The noise level of a fan must be taken into consideration when designing a ventilation system. The noise is primarily created by the fan also by ducting and other components like filters, heaters, shutters etc. if the air flow speed is too high (whistling noises). Therefore a maximum air flow speed of 7 m/s is recommended. At the same time noise transmission by fan of other components must be reduced as much as possible when installing. The maximum noise emission recommendations should not be exceeded. Reduction in noise can be achieved by installing the noise sources as far away as possible or by use of attenuators. Generally the noise level should be kept as low as possible at its source, that means selecting low noise fans.

2.1 Difference between sound power and pressure level at a distance

Distance to source	Difference
1 m	8 dB
2 m	12 dB
3 m	16 dB
4 m	20 dB

Example:
Sound power level of a fan = 70 dB(A)
Sound pressure level at 1 m (freefield conditions) = 70 dB(A) less 8 = 62 dB(A)

2.2 Sound emission levels affecting the neighbourhood
The following recommended sound levels for neighbourhoods should not be exceeded:

Area	Emission dB(a)	
	Day	Night
Industrial 100%	70	70
Industrial (mainly)	65	50
Industrial/residential	60	45
Residential (mainly)	55	40
Residential(100%)	50	35
Hospitals etc.	45	35

2.3 Noise levels for working environments

Activity	dB(a)
Intellectual concentration	55
Computer and office work	70
Others areas	85 (Maximum deviation 5 dB)
First aid, rest and recovery rooms	55

2.4 Addition of several noise sources

The increase in noise is represented in dependence of level difference of two sources of noise. The increase must be added to the higher value of two sources.

Difference in sound levels	Increase
0 dB	3,0 dB
2 dB	2,2 dB
4 dB	1,5 dB
6 dB	1,0 dB
8 dB	0,7 dB
10 dB	0,4 dB

<u>Example</u>
2 noise sources with 60 dB(A) and 64 dB(A)
Total noise level: 64 DB(A) + 1,5 dB(A) = 65,5 dB(A)

3. Pressure losses in a ventilation system

Ventilation systems consist of various different components like fan, bends, grilles, filters etc. All these components have a resistance which needs to be considered to select a suitable fan. The pressure loss $ÄP_{stat.}$ (static pressure) of the total system is calculated by adding all individual resistances. Among other things the loss of pressure depends on the air flow speed, the surface condition and the geometric shape of the component, which is in the air flow. To reduce the loss of pressure select an adequate duct cross-section, because the loss of pressure in square increases with the air flow speed. You find detailed tables with losses of pressure of components in the catalogue on page 14, as well as in the diagrams of the products. A distinction is drawn between three pressure specifications:

a. Total pressure
   Sum of static and dynamic pressure
b. Static pressure
   The pressure resistance to be overcome by the fan of the ductwork = pressure loss of the system (ducting, shaped sections, filters heaters, grilles)
c. Kinetic energy (air flow speed, i.e. cannot be used normally)

4. Performance curves

The characteristic of a fan is shown in form of a performance curve. In a performance curve the air flow volume is given in relation to a static pressure or a total pressure. The working point is the meeting point between the fan's performance curve and the system's resistance curve. The air flow volume can be determined by drawing a vertical line downwards.

System resistance curve: The pressure of a system (ducting, shaped sections, other components) changes as a square of the changing air flow volume = system's resistance. There is a stalling area or an unsuitable area on the performance curve for axial ventilators and centrifugal ventilators with forward curved impellers. That means the working point of the ventilator may not lie in this range because otherwise a reduced amount of air, strong development of noise or motor overloading is to be expected. In Helios Select these areas are taken into account and are excluded at the calculation automatically.

5. Fan performance parameters

Fans can be characterized by the following basic parameters:

Ari flow volume	[m^3/h, m^3/s]
Static pressure	[Pa]
Speed	[min^{-1}]
Shaft power	[W, kW]
Absorbed electrical power	[W, kW]
Sound power-/pressure level	[dB(a)]

The performances of geometrically similar fan type series can be calculated using the relations between fan speed, diameter and density:

a. The air flow volume rises proportionally (linearly) to increased rpm.
b. The pressure rises in square to increased rpm.
c. The required power rises to the third power to increased rpm.
d. The pressure increases proportionally to the density (or temperature) at continuous air flow volume.
e. The required power increases proportionally to the density (temperature) at continuous air flow volume.

6. IP ratings according to DIN 40050

Every electric equipment has an IP classification, which describes the protection rating. The classification consists of two digits, e.g. IP 54. The first digit describes the protection against solid objects, the second against liquids.

Rating	Short note	Definition
IP X0	Covered version	No particular protection
IP X1	Drip water protected version	Protection against drip water falling vertically
IP X3	Rain protected version	Protection against sprays of water up to 60° from vertical
IP X4	Slashing water protected version	Protection against splashing water from all directions
IP X5	Low pressure jets of water protected version	Protection against low pressure jets of water from all directions - limited ingress permitted.
IP X7	Waterproof (sealed) version	

7. Explosion proof fans – Explosion proof to regulation 94/9/EC (ATEX)

The European harmonized explosion proof regulation (94/9/EC ATEX) came into affect on 1st July 2003. Explosion proof fans for operation in or to move potentially hazardous atmospheres or substances must be in accordance with the regulation 94/9/EC and have a European Building Regulation approval and carry the CE mark. For that purpose the fans have a classification according to subsequent chart.

The fans are built in accordance with VDMA 24169 T.1 "structural explosion proof measures on fans". For certified data see motor rating plate. A motor protection device according to VDE 0165 or DIN EN 50014 and DIN EN 60079, should be fitted to achieve the required reaction time t_E.

All relevant regulations must be followed when making electrical connections. Please enquire for models with non-standard voltages, frequencies and for flameproof models to Ex d.

Classification to 94/9/EC (ATEX)

Ex	II	2G	EEx	e / de	II // IIB	T3
	Product group	Product category	Explosion proof protection to EN	Type of protection: "e" = increased safety "de" = flammable enclosure with increased safety	Gas group/sub group	Temperature class

7.1 Zone definition, Product group, Product categories

Zone definition

Explosion proof zones will be normally determined according to the implementation of the 94/9/EC and operation reliability regulation (if in doubt or for special applications, the local authorities should be consulted). Different zones have been allocated to take into account of the different degrees of risk from the concentration of flammable gas or vapour that may arise in an installation. It considers the frequency and duration of the hazardous atmosphere on each occasion. Except for mines (gas group I) six zones are specified for 3 for gas (zones 0,1 & 2) and 3 for dust (zones 20, 21 & 22).

Product groups

- Product group I: Products for use in the underground part of mines and those parts of surface installations of such mines those are likely to become endangered by firedamp and/or combustible dust.
- Product group II: For use other places likely to become hazardous by explosive atmospheres.

Types of explosion gas group II

The explosive atmospheres are either Gas vapour (G) or Dust (D) and need one of the following categories of protection

- 1- Very high level of protection
- 2- High level of protection
- 3- Normal level of protection

HELIOS explosion proof fans are suitable for product II category 2G and/or 3G for operation in zone 1 and 2.

Flammable substances	Zones IEC 60079-10	Description	Product-group	Product-category
Gases, Vapour, Fog	Zone 0	Zone in which an explosive atmosphere is continuously present, or present for long periods.	II	1G
	Zone 1	Zone in which an explosive atmosphere is likely to occur in normal operation.	II	1G or 2G
	Zone 2	Zone in which an explosive atmosphere is not likely to occur in normal operation, and if it occurs it will exist only for a short time.	II	3G, 2G or 1G
Dust	Zone 20	Zone in which an explosive atmosphere in form of a cloud of combustible dust in air is continuously present, or present for long periods.	II	1D
	Zone 21	Zone in which an explosive atmosphere in form of a cloud of combustible dust in air is likely to occur in normal operation occasionally.	II	2D oder 1D
	Zone 22	Zone in which an explosive atmosphere in form of a cloud of combustible dust in air is not likely to occur in normal operation but, if it does occur, will persist for a short period only.	II	3D

7.2 Enclosures (motor and terminal boxes): Types of protection

Classification: EEx..

- "e" - increased safety
- "d" - flameproof enclosure
- "de" - flameproof enclosure with increased safety

With fan motors with terminal boxes protection type "e " is used normally as a sub-group.

Explosion groups for enclosures

additionally divided in

- I = electrical apparatus for mines susceptible to firedamp
- II =electrical apparatus for places with a potentially explosive atmosphere, other than mines susceptible to firedamp

Protection class “e” is in suitable explosion group II and a “d” classification is required foe explosion group IIA, IIB and IIC.

The degree of danger increases from explosion group IIA to IIC. If an apparatus is suitable for group IIB, it can automatically be used for group IIA.

7.3 Ignition-, Surface temperature and Temperature class

The ignition temperature (see 7.4) is the temperature at which an ignition may occur, e.g. through contact with a hot motor surface. It depends on the nature of the gases and streams. The maximum surface temperature of an electrical appliance must always be lower than the ignition temperature of the substance used (DIN EN 50014, 4.4 and/or DIN EN 60079-10). In order to be able to indicate and to select electrical apparatus of the product group II with regard to their maximum surface temperature in a simple way, several temperature classes are distinguished. One can correspondingly assign the gases to these classes after their ignition temperature. Apparatus with higher temperature (e.g. T5) can also be used for substances classified with a lower class (e.g. T2 or T3). The temperature class, the maximum surface temperature and ignition temperature are given in the relevant tables (following table and table after 7.4). The temperature class of each fan is stated on the individual catalogue page; for certified data see motor rating plate.

Data for flammable materials for use with electrical equipment

Flammable material	Ignition temperature °C	Temperature class	Apparatus group
Acetaldehyde	140	T 4	II a
Acetone	540	T 1	II a
Acetylene	305	T 2	II C (3)
Ethane	515	T 1	II a
Ethyl acetate	460	T 1	II a
Ethyl ether	180	T 4	II B
Peroxyde production			
Ethyl alcohol	425	T 2	II A II B
Ethyl chloride	510	T 1	II a
Ethylene	425	T 2	II B
Ethyl glykole	235	T 3	- *)
Ammonia	630	T 1	II a
i-Amylacetate	380	T 2	II a
Spezial petrol	220 to 300	T 3	II a
Boiling point	> 135° C		
Benzene (pure)	555	T 1	II a
n-Butane	365	T 2	II a
n-Butyl alcohol	340	T 2	II B
Cyclohexanone	430	T 2	II a
1,2-Dichlorethane	440	T 2	II a
Diesel	220 bis 300	T 3	II a
Aviation fuel	220 bis 300	T 3	II a
n-Hexane	240	T 3	II a
Carbon monoxid	605	T 1	II a
Methane	595 (650)	T 1	II a
Methanol	455	T 1	II a

Methyl chloride	625	T 1	II a
Naphthalene	520	T 1	II a
Phenol	595	T 1	II a
Propene	470	T 1	II a
n-Propyl alcohol	405	T 2	- *)
Carbon disulfide	102	T5	II C (1)
Hydrogen sulfide	270	T3	II B
Tetralene(Tetrahydronaphthalene)	425	T 2	- *)
Toluene	535	T 1	II a
Hydrogen	560	T 1	II C (2)

* Extract from „ Selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres“ part 1, PTB Braunschweig from E.Brandes/W.Möller.

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-*) For this substance an explosion group has not yet be en determined

7.4 Ignition temperature (to VDE 0165/DIN EN 50014)

Temperature class	**Maximum surface temperature of machine**	**Ignition temperature of flammable surface**
T 1	450 °C	> 450 °C
T 2	300 °C	> 300 °C
T 3	200 °C	> 200 °C
T 4	135 °C	> 135 °C
T 5	100 °C	> 100 °C
T 6	85 °C	> 85 °C

7.5 Operation

Explosion proof motors (protection “e” increased safety) do not have thermal contacts. Rectangular explosion proof fans (type KVD..Ex), roof fans (type RD…Ex) and Axial / VAR.. fans with high power are fitted with PTC thermistors.

Speed control is permissible only with rectangular explosion proof fans (type KVD…Ex) and explosion proof roof fans (type RD…).

8. Motor protection

All 1 ph. motors are fitted with thermal contacts (TK) as standard. For some models they are wired in series with the motor windings on others there are wired to the terminal block. The majority of speed controllable 3 ph. motors (except explosion proof) have thermal contacts (TK) wired to the terminal block.

8.1 Motors with thermal contacts wired to the terminal block must

be connected to a motor protection unit (see accessories). The ports marked ‘TK’ have to be connected in accordance with the wiring diagram. If temperatures in the motor windings are too high (e.g. caused by bearing problems, obstructed impeller, inefficient cooling, too high air flow temperature, 2-phase connection) the thermal contact trips and the motor protection device isolates the fan from the supply. The fan must be restarted manually. If this happens frequently there is a fault in the system, which must be remedied. This protection offers a full protection of the motor even if speed controlled. Most HELIOS 1 ph. and 3 ph. fans have built-in thermal contacts as standard (see fan data table). For other models they can be supplied as an extra.

8.2 Motors with thermal contacts wired in series with the motor windings.

The majority of HELIOS 1 ph. fans with smaller performances have thermal contacts wired in series with the motor windings (see fan data table). They trip if the motor temperature is too high and open the electrical circuit. After having cooling down the fan will restart automatically. If thermal contacts trip this indicates a fault (e.g. stiff running, obstructions, too high air flow temperatures), which must be removed before continuing operation.

8.3 Motors with built in PTC thermistors (positive temperature coefficient)

are used for higher performances where temperatures rise quickly (e.g. under difficult working conditions). To offer a full protection each winding should be fitted with a PTC thermistor (available at special order; as standard for explosion proof rectangular fans as well as Axial and mixed-flow fans VAR with large motor powers (see product page). The thermistors are temperature sensitive elements. If a certain temperature is exceeded the electrical resistance jumps up. The thermistors must be connected to a special circuit breaker (type MSA, see accessories).

8.4 Motors without thermal protection

should be protected by a conventional circuit breaker (MCB miniature circuit breaker or RCD residual current device), which is to be wired between fan and supply (each phase must be protected). This option does not offer protection against exceedingly high air flow temperatures, insufficient motor cooling or if the fan is speed controlled. For pole-switching motors each speed should be protected separately.

9.Performance adjustment by speed control

The requirement to control the performance of a fan system is based on various factors.

- To increase the comfort.
- To adapt the system to the changing requirements within building (number of people, air quality, temperature etc.).
- To ensure an economical operation.

Speed controlling fans is the best way of adapting the performance with regards to energy consumption and noise. The required shaft power is reduced by the cubic of the speeds change. If the speed is halved the shaft power drops to one eighth of the full speed figure. How much of this reduced shaft power results in energy savings depends on the characteristic of the used motor and controller. HELIOS motors are specially designed to match the impeller’s power requirements. This guarantees optimal efficiency at full speed and when controlled.

9.1 Controllers

The controllers offered by HELIOS can control a number of fans within their rating. When selecting a controller it should be noted that in some cases using a control increases the current above the F.L.C. (see product pages).

When a motor is speed controlled using a frequency inverter it must be observed, that peak voltage passed to the motor terminals are below ≤ 1000 V and the peak voltage rise is below ≤ 500 V/µs (according to IEC 34-17). If the false inductive current exceeds 3,5 mA during normal operation, the appliance must be earth according to DIN VDE 0160/ 5.88, chapter 6.5.2.1. In case of long distance between inverter and motor, an external filter must be used on the inverter. The use of an inverter for several different motors is only possible if the an all pole sinus filter is installed between inverter and motors (to be supplied by others). It must offer protection for phases between each other and each phase and earth.

If the fan is to be speed controlled by a frequency inverter this must be stated when ordering. The use of other brand controllers might result to malfunction or defective motors. Controllers not offered or recommended by HELIOS invalidate the fan’s guarantee.

9.2 Electronic speed controllers

working on the principle of voltage reduction by cutting the phase may create electro-magnetic (humming), noise in the motor at low speed, which could be disturbing. For noise critical (sensitive) installations the use of a transformer is recommended.

9.3 Comparison of different control methods

a. Speed control
b. Bypass
c. On/off operation
d. Adjustment of impeller’s pitch angle

Regarding the required power the speed control shows advantages in comparison to other methods used in practice. HELIOS fans are speed controllable by voltage reduction, by use of frequency inverters or by pole-switching motors (2 speed).

The suitable controller range is offered on the accessory pages. Models which don’t have a controller shown must only be used at full speed. An additional advantage of speed control is the substantial reduction in noise levels. If the speed is halved the noise level drops by up to 15 dB.

In case of technical questions our hotline service under 07720 / 606-266 is at your disposal or send an e-mail to info @ heliosventilatoren.de .