Technical guide

Air curtain systems

ISO 9001

Empirical design of air curtain systems

The technique described below shows a method, based on years of empirical values, that enables a good approximation of the correct layout by considering the essential climate and inherent building parameters.

Climate parameters

Temperature
The most extreme winter temperatures can be taken from the corresponding climate zone maps. However, it is recommended that precise values (in accordance with data from meteorological offices) are used.

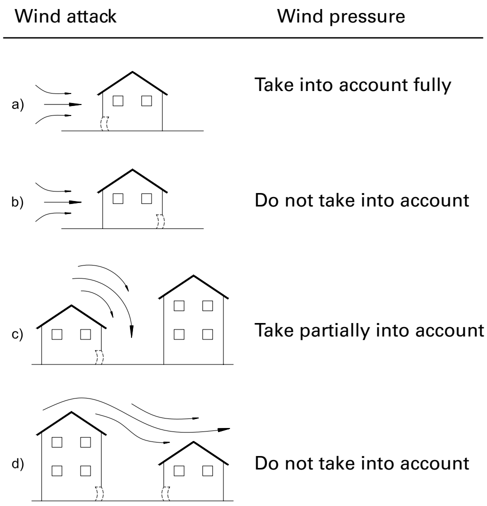
Wind pressure
For doorways (exposed side) estimated wind speeds are v_w = 3.0 - 6.5 m/s. Values that are 50% higher should be assumed for regions with strong winds (coastal areas, lowlands etc.). The influence of both the surrounding buildings and the locations of the building and doorway must be taken into consideration in accordance with **fig. 1** as follows:

a) exposed location: Wind pressure must be fully taken into consideration

b) c) d) Wind pressure can be Ignored where the doorway is fully sheilded from prevailing wind direction. However, it is recommended that a factor of 0.3 - 0.5 is assumed due to possible cross flows.

By using **fig.2** the wind-dependent pressure differential at the entrance opening Δp_w can be read off.

Fig. 1. Influence of the wind pressure on different building situations and configurations



Building parameter

The influence of the building on the pressure differential at the entrance opening is a result of:

The temperature differential of climate zones that are to be separated

The value (ρ_{out} - ρ_{in}) can be read off according to the chosen temperatures inside and outside from **fig. 3** .

Internal updraft

The internal updraft of the building is of relevance in the case of especially high buildings (industrial premises) or floors that are connected by open stairwells. When determining the pressure difference, the total height H must be taken into consideration.

Building type, door location

For an approximate determination of the pressure difference, the essential building characteristics through the reduction factor R (**fig. 4**) are taken into consideration.

Fig. 2. Pressure differential Δp_w on both sides of the opening level

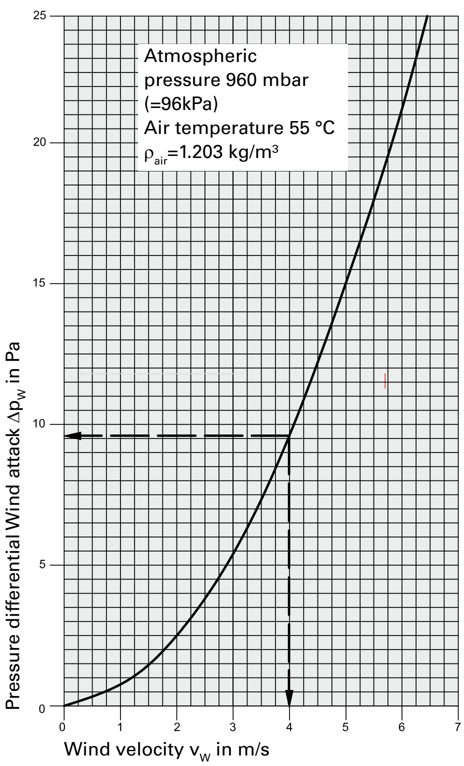
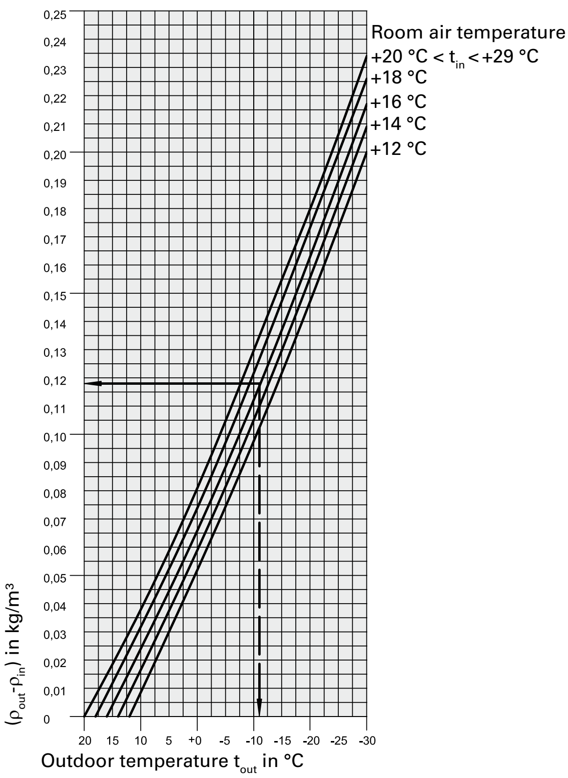


Fig. 3. Determination of (ρ_{out} - ρ_{in})

Atmospheric pressure 960 mbar (=96kPa)



Select air curtain system

To determine the air curtain system that is to be selected, first the building specific pressure difference Δp_ρ must be determined, in order to evaluate the function of the air curtain system when no wind is present.

$$\Delta p_\rho = H \cdot (\rho_{out} - \rho_{in}) \cdot g \cdot R \qquad [Pa]$$

R is the building specific reduction factor (see **fig. 4**) Subsequently, the wind speed (wind pressure), which is to be held off, is defined (Δp_w [Pa]) and the two criteria of the total pressure differential $\Delta p_{tot} = \Delta p_\rho + \Delta p_w$ to be held off are added.

Fig. 5 (comfort entrances) and **fig. 6** (industrial entrances) show the degree of efficiency of the different types of air curtains and performance sizes depending on the door/vent height and the pressure differentials that are to be withstood and enable quick and realistic construction.

Fig. 4. Building characteristics - Reduction factor R

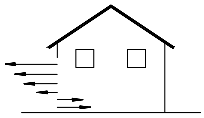
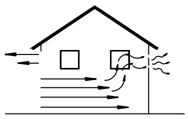
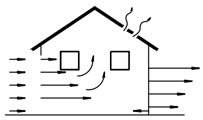
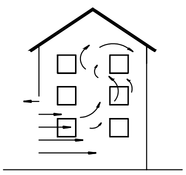
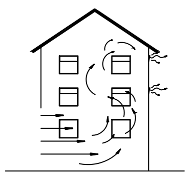
		Reduction factor R	
		with porch	without porch
	single storey building, airtight building (new building) no opposite doors	0.15	0.2
	single storey building, non-airtight building (old building) no opposite doors	0.2	0.3
	single storey building, non-airtight building opposite doors	0.4	0.5
	several open, connected floors, airtight building	0.6	0.75
	several open, connected floors, non-airtight building (open skylights etc.)	0.8	1.0

Fig. 5. Layout diagram - air curtain system at comfort entrances

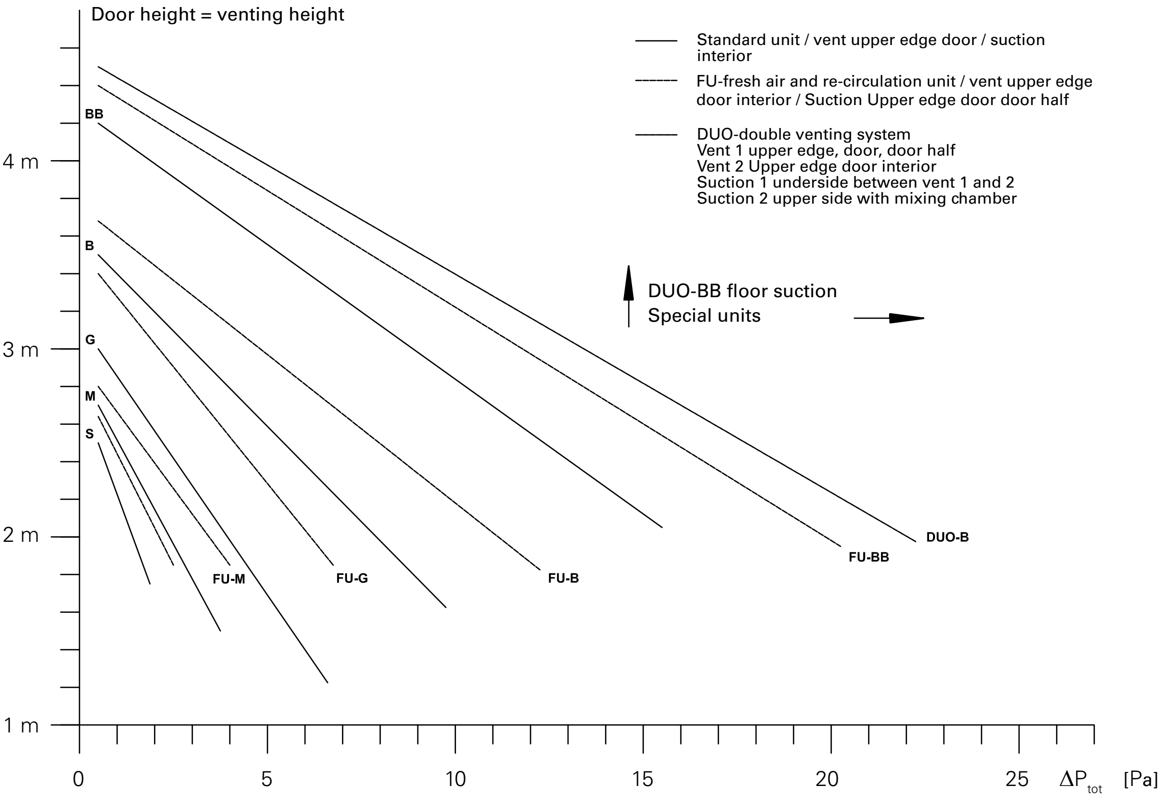
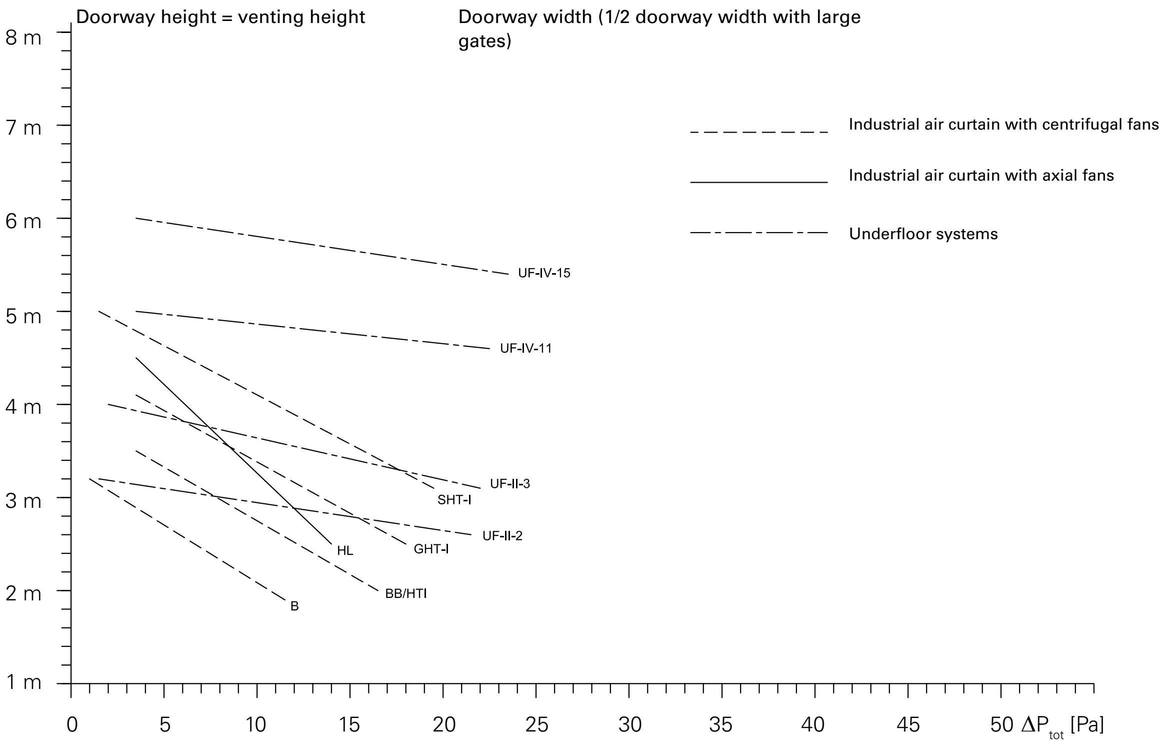


Fig. 6. Layout diagram - air curtain system at industrial doorways



Sound

What is sound?
Sound is air-pressure fluctuation that evolves when a sound source vibrates. The sound waves are produced by compression and expansion of air particles without the air in itself moving. A sound wave can have different velocities in different media. In air sound has a velocity of 340 m/s.

How is sound measured?
Sound level is measured in decibel (dB). The dB is a logarithmic unit used to describe a ratio. If the sound level is increased by 10dB, the result is twice as loud (mathematically it is exactly 6 dB, but 10dB are heard).

Two equal sound sources lead to an increase of the sound level by 3 dB. With two entrances with two air curtains in each, where all four units operate at a sound level of 50 dB, the total sound level is 56 dB. The first opening will have a total sound level of 53 dB plus an extra 3 dB from the other opening.

Points of reference – dB

0	The softest sound a person can hear
10	Normal breathing
30	Recommended max. level for bedrooms
40	Quiet office, library
50	Large office
60	Normal conversation
80	Ringing telephone
85	Noisy restaurant
110	Shouting in ear
120	The pain threshold

Fundamental concepts

Sound pressure
Pressure develops when pressure waves propagate, for example in the air. The sound pressure is measured in Pascals (Pa). To clarify sound pressure a logarithmic scale is used that is based on the difference between the actual sound pressure level and the sound pressure at the audibility threshold. The scale has the unit decibels (dB), where the audibility threshold is 0dB and the pain threshold is 120 dB.

The sound pressure decreases with the distance from the source and is also affected by the acoustics of the room.

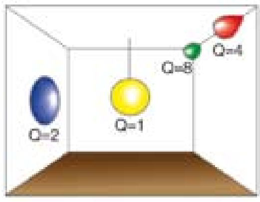
Sound power
Sound power is the energy per time unit (Watt), which the object emits. Sound power is calculated from the sound pressure and also uses a logarithmic scale. Sound power is neither dependent on the sound source nor the acoustics of the room, which therefore simplifies the comparisons of different objects.

Sound power level and sound pressure level
If the sound source emits a certain sound power level, the following will affect the sound pressure level:

1. Direction factor, Q
Specifies how the sound is distributed around the sound source. See figure below.

The distribution of sound around the sound source.

Q = 1	Middle of room
Q = 2	On wall or roof
Q = 4	Between wall and roof
Q = 8	In corner



2. Distance from sound source, r
The distance from the sound source in metres.

3. The rooms equivalent absorption area, A
The ability of a surface to absorb sound can be described by the absorption factor α , which can have a value between 0 and 1. The value 1 corresponds to a surface with complete absorption and the value 0 is a surface with complete reflection. The equivalent absorption area of a room is expressed in m². This can be calculated by multiplying the room's surface area by the surfaces' absorption factor.

Conversion between sound power and sound pressure The conversion between sound power and sound pressure is performed using the following formula $L_p = L_w + \Delta L$. ΔL is the dampening of the room and is calculated by $\Delta L = 10 \cdot \log \frac{Q}{4 \cdot p r^2} + \frac{4}{A}$.

Instead of calculating the dampening using the above mentioned formula, the following diagram can be used.

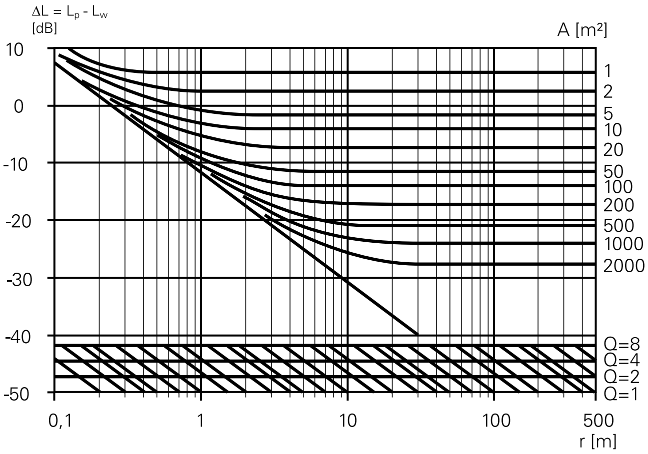


Table and diagrams for dimensioning

Basic electrical formulas

Amperage

Direct current and single-phase alternating current at cosφ=1	3-phase alternating current Y-connection	3-phase alternating current Δ-connection
$I=U/R=P/U$	$I_f=I$	$I=I_f\sqrt{3}$

Voltage

Direct current and single-phase alternating current at cosφ=1	3-phase alternating current Y-connection	3-phase alternating current Δ-connection
$U=RI$	$U=U_f\sqrt{3}$	$U_f=U$

Power

Direct current and single-phase alternating current at cosφ=1	3-phase alternating current Y-connection	3-phase alternating current Δ-connection
$P=UI$	$P=\sqrt{3}UI\cos\varphi$	$P=\sqrt{3}\,UI\cos\varphi$

U = operating voltage in volts: with direct current and 1-phase alternating current between the two conductors, with 3-phase alternating current two phases (not between phase and zero).
U_f = voltage between phase and zero in a three-phase cable.
$\sqrt{3} \cong 1.73$
I = current in ampere
I_f = current in ampere in phase wire
R = resistance in ohm
P = power in watts

Symbols for model types

= normal design (no symbols), IPX0
 = drip-proof design, IPX1
 = splash-proof design, IPX4
 = jet-proof design, IPX5

Protection classes for electrical material

IP, second figure	Protection against solid objects
0	No protection
1	Protection against solid objects ≥50 mm
2	Protection against solid objects ≥12.5 mm
3	Protection against solid objects ≥2.5 mm
4	Protection against solid objects ≥1.0 mm
5	Protection against dust
6	Dust-tight

IP, second figure	Protection against water
0	No protection
1	Protection against vertically dripping water
2	Protection against dripping water angled at max. 15°
3	Protection against sprinkled water
4	Protection against spraying with water
5	Protection against water jets
6	Protection against heavy seas
7	Protection against short-term immersion in water
8	Protection against the effects of long-term immersion in water

Dimensioning table for cables and wires

Installation wires, open or in conduit		Connection wires		
Area [mm²]	Fuse [A]	Floor space [mm²]	Continuous current [A]	Safety cutout [A]
1,5	10	0.75	6	10
2.5	16	1	10	10
4	20			
6	25	1.5	16	16
10	35	2.5	25	20
16	63	4	32	25
25	80	6	40	35
35	100	10	63	63
50	125			
70	160			
95	200			
120	250			
150	250			
185	315			
240	315			
300	400			
400	500			

Dimensioning table

Amperage at different powers and voltages

Power	Voltage [V]					
[kW]	127/1	230/1	400/1	230/3	400/3	500/3
1.0	7.85	4.34	2.50	2.51	1.46	1.16
1.1	8.65	4.78	2.75	2.76	1.59	1.27
1.2	9.45	5.22	3.00	3.02	1.73	1.39
1.3	10.2	5.65	3.25	3.27	1.88	1.50
1.4	11.0	6.09	3.50	3.52	2.02	1.62
1.5	11.8	6.52	3.75	3.77	2.17	1.73
1.6	12.6	6.96	4.00	4.02	2.31	1.85
1.7	13.4	7.39	4.25	4.27	2.46	1.96
1.8	14.2	7.83	4.50	4.52	2.60	2.08
1.9	15.0	8.26	4.75	4.78	2.75	2.20
2.0	15.8	8.70	5.00	5.03	2.89	2.31
2.2	17.3	9.67	5.50	5.53	3.18	2.54
2.3	18.1	10.0	5.75	5.78	3.32	2.66
2.4	18.9	10.4	6.00	6.03	3.47	2.77
2.6	20.5	11.3	6.50	6.53	3.76	3.01
2.8	22.0	12.2	7.00	7.03	4.05	3.24
3.0	23.6	13.0	7.50	7.54	4.34	3.47
3.2	25.2	13.9	8.00	8.04	4.62	3.70
3.4	26.8	14.8	8.50	8.54	4.91	3.93
3.6	28.4	15.7	9.00	0.05	5.20	4.15
3.8	29.9	16.5	9.50	9.55	5.49	4.39
4.0	31.15	17.4	10.0	10.05	5.78	4.62
4.5	35.4	19.6	11.25	11.31	6.50	5.20
5.0	39.4	21.7	12.50	12.57	7.23	5.78
5.5	43.3	23.9	13.75	13.82	7.95	6.36
6.0	47.3	26.1	15.0	15.1	8.67	6.94
6.5	51.2	28.3	16.25	16.3	9.39	7.51
7.0	55.0	30.4	17.50	17.6	10.1	8.09
7.5	59.0	32.6	18.75	18.8	10.8	8.67
8.0	63.0	34.8	20.0	20.1	11.6	9.25
8.5	67.0	37.0	21.25	21.4	12.3	9.83
9.0	71.0	39.1	22.5	22.6	13.0	10.4
9.5	75.0	41.3	23.75	23.9	13.7	11.0
10.0	78.5	43.5	25.0	25.1	14.5	11.6

For power outputs between 0.1 and 1 kW, the amperage read is multiplied by 0.1. For power outputs between 10 and 100 kW, the amperage read is multiplied by 10.

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