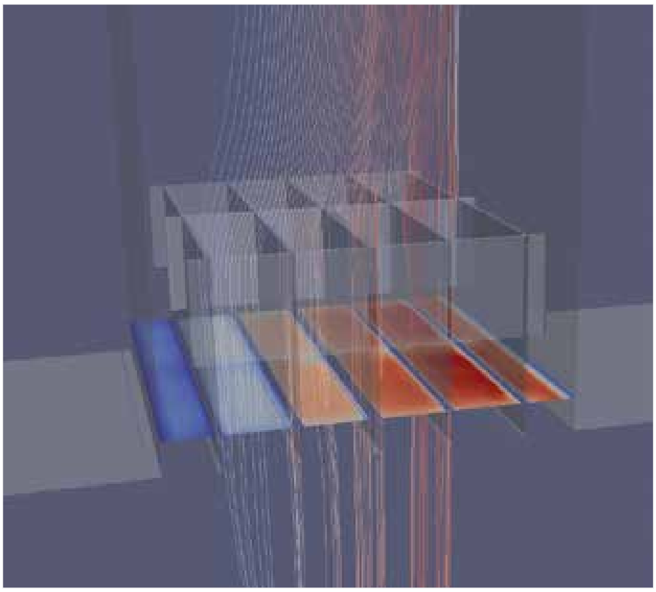
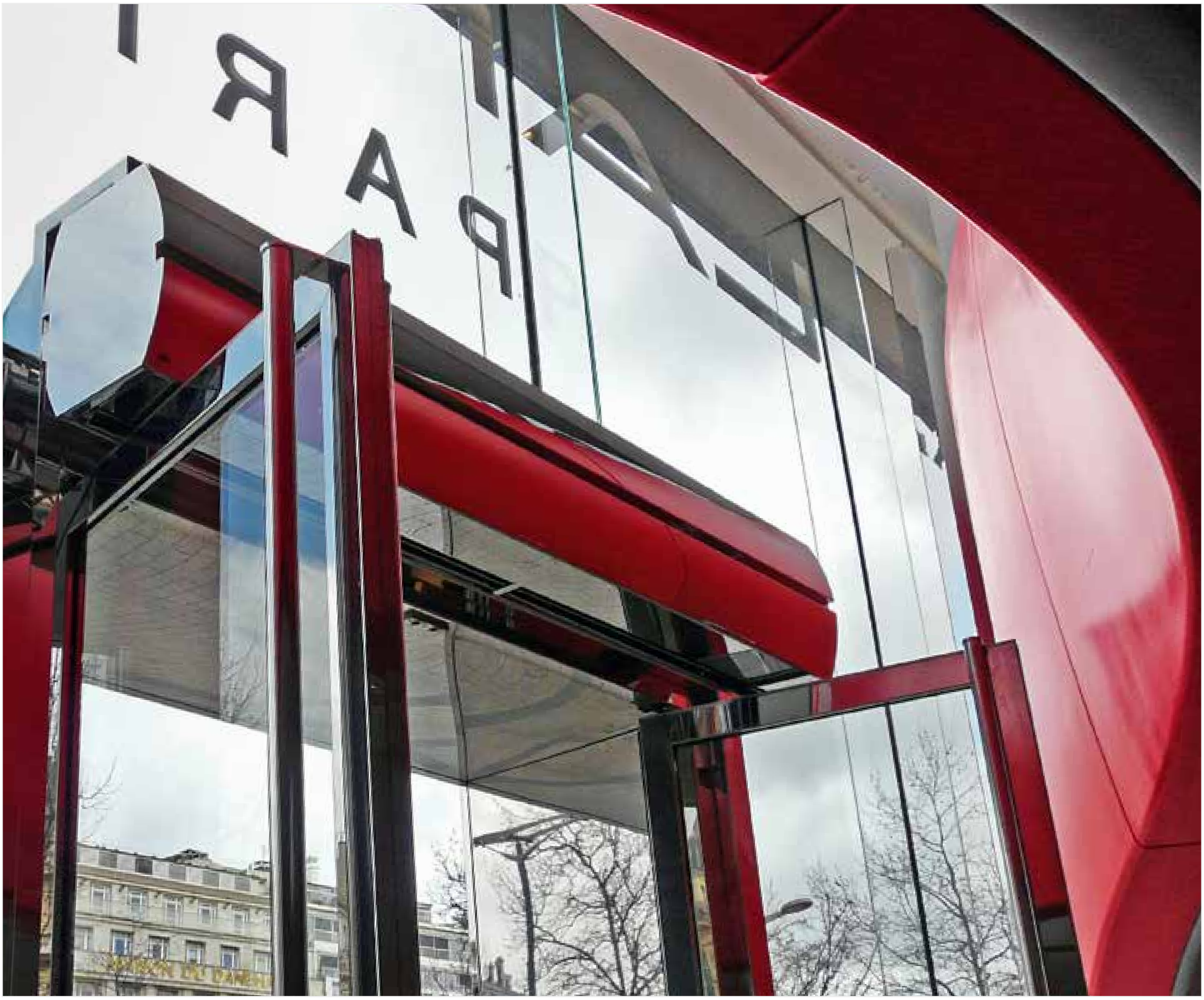
Technical handbook





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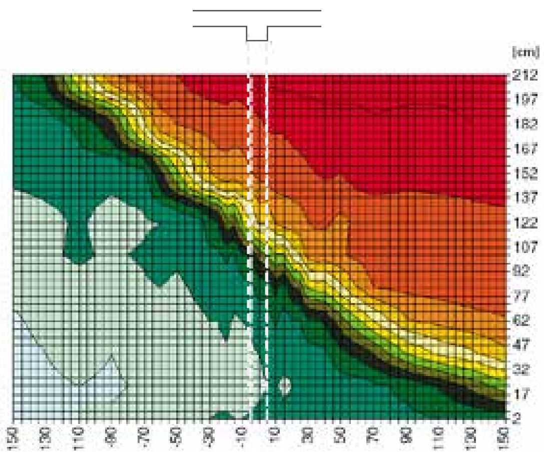
The invisible door

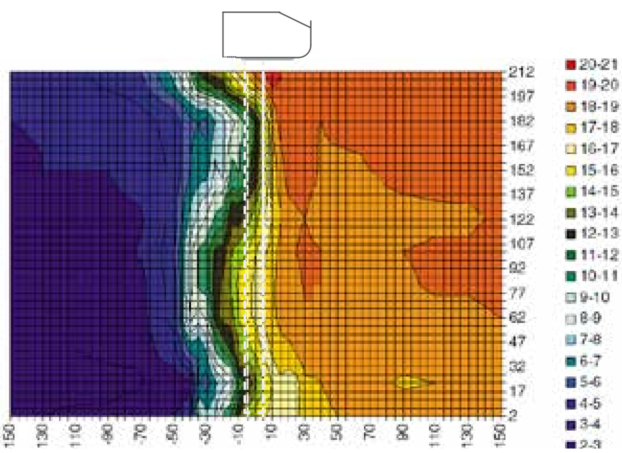
An open door is inviting and easy to pass through, but it also means a poor working environment and energy loss. An air curtain creates a comfortable environment and minimizes energy loss. Frico air curtains effectively separate indoors from outdoors, hot from cold.

Air curtains create an air barrier between hot and cold, both to prevent cold outdoor air from entering, while the heated air is kept inside, and to protect air conditioned premises and refrigerated rooms.

A correctly installed air curtain reduces draughts, creates a comfortable indoor environment and reduces energy losses at doors and doorways.



Air flows out of an unprotected opening.



With a correctly set air curtain there is a sharp separation between the different temperature zones.

Why is there a draught from an opening?

The amount of air that flows out through an open door depends on differences in pressure between the indoor and outdoor air.

This pressure differential is dependent on three factors:

- Different temperatures indoors and outdoors
- Different pressures indoors and outdoors
- Incoming wind speed at the door opening

Simply put; if the conditions on one side of the door differ in any way from those on the other side, then there will be a draught from the door opening. Air flows out through an open door to equalize the differences in pressure and temperature. In heated premises this means that hot air flows out and cold air flows in. Wind blowing towards the door also affects the airflow.

Temperature differential outdoor/indoor

Warm indoor air has a lower density and is lighter than cold outdoor air. Therefore there is a pressure differential at the door opening. The cold air flows in through the lower part of the opening and pushes the hot air through the upper section. The size of the airflow depends on the temperature differential between outdoor and indoor air. The air exchange is thus dependent on thermal pressure differentials. If the indoor and outdoor temperatures are known, then the density of the outdoor and indoor air can be determined and making it possible to calculate the pressure differential and airflow through the opening.

The airflow (Q_T) can be calculated using the following equation:

$$Q_T = \frac{W}{3} \bullet H^{1.5} \bullet C_d \bullet \sqrt{g \bullet \frac{\Delta\rho}{\rho_m}}$$

Opening			
	Q_T	=	airflow, temperature [m³/s]
	W	=	door width [m]
	H	=	door height [m]
	C_d	=	flow coefficient 0.6 - 0.9
	g	=	gravity coefficient (9.81 m/s²)
	$\Delta\rho$	=	the air masses' density differential
	ρ_m	=	the air masses' average density

Pressure differentials indoor/outdoor

In order for an air curtain to work well, it is important that there is not too great an overpressure or negative pressure in the premises.

Nearly all ventilation systems are mechanically adjusted and are based on the prevailing conditions when they were set. When the external conditions are changed, for example by variations in temperature, air pressure, wind influence and humidity, the balance is disturbed and replaced by positive or negative pressure (usually negative pressure).

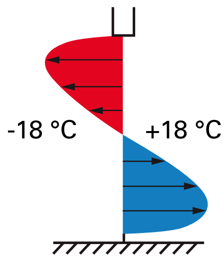
An air curtain can withstand a maximum of 5 Pa, depending on the conditions. But even small differences in pressure can significantly affect the efficiency of the air curtain.

The pressure differential between a building and its surroundings can be equalized using balanced ventilation, which increases comfort and reduces energy costs. Balanced ventilation can be achieved by pressure regulation via the ventilation system, but the most efficient way is to continuously measure the pressure differential between indoors and outdoors and use it to control the ventilation flow. Contact Frico for more information.

Airflow dependent on pressure differential (Q_P) can be calculated using the following equation:

$$Q_P = W \bullet H \bullet \sqrt{\frac{\Delta P \bullet 2}{\rho}} \bullet C_d$$
$$(\Delta P \leq 5\text{ Pa})$$

Opening			
	Q_P	=	airflow, pressure [m³/s]
	W	=	door width [m]
	H	=	door height [m]
	ΔP	=	pressure differential
	ρ	=	air density
	C_d	=	flow coefficient 0.6 - 0.9



Airflow caused by thermal pressure differentials.

Wind stress

When the wind blows towards an opening, air flows through the opening. The airflow is assumed to be evenly distributed across the whole door opening. The airflow is then proportional to the wind speed horizontally against the door opening. (After the pressure build up the airflow is limited to what escapes through leaks in the building.) A wind speed of 3 m/s corresponds to a load pressure of 5 Pa.

The air flow (Q_v) can be calculated using the following equation:

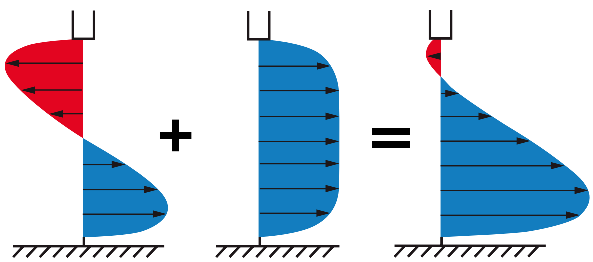
$$Q_v = W \bullet H \bullet C_v \bullet v$$

Opening	Q_v	=	airflow, wind [m³/s]
	W	=	door width [m]
	H	=	door height [m]
	v	=	wind speed
	C_v	=	wind direction coefficient = 0.5 - 0.6 if perpendicular wind load towards the opening 0.25 - 0.36 if diagonal wind load towards the opening

The total airflow

The total airflow through open doors is the sum of the flow caused by temperature and pressure differentials and wind stresses.

$$Q_{tot} = Q_T + Q_V + Q_P$$



The total airflow is the sum of the flows caused by temperature and pressure differentials and wind stresses.

Important to remember

- If there is negative pressure in the building, the efficiency of the air curtain is considerably reduced. The ventilation should therefore be balanced. An air curtain cannot prevent a deficit in the amount of air that is due to unbalanced ventilation (negative pressure).
- If an opening is exposed to wind it affects the efficiency of the air curtain. An air curtain can withstand a wind speed of up to 3 m/s, depending on the conditions. In an existing opening that is exposed to greater wind loads you may supplement with more heating to improve the comfort.
- Where there are high wind stresses it is appropriate to supplement the air curtain with a revolving door or an air lock, ideally with the openings offset in relation to each other.
- The design of the building affects the function of the air curtain. In large buildings that are strongly affected by wind, premises with staircases where the chimney effect occurs and premises with draughts, more powerful curtains are required.
- Normally the air curtain unit is placed on the inside of the opening to the premises it should protect. When used to protect cold storage or a freezer room, the unit must be mounted on the warm side.
- The air curtains must be as close to the opening as possible and cover the full width of the opening.
- The direction and speed of the airflow should be adjusted to the conditions in the opening. Wind pressure and negative pressure affect the function of air curtains and try to bend the air stream inwards. The air stream should therefore be directed outwards to withstand the load.

Technical handbook

Optimized air curtains

Separating climate zones is relatively easy if it is only the temperatures that differ. Handling an opening that is exposed to wind, pressure differentials and unbalanced ventilation is more difficult. Frico air curtains reduce the problems by creating an air barrier with the perfect balance between air volume and air velocity and a high uniformity of the air beam.

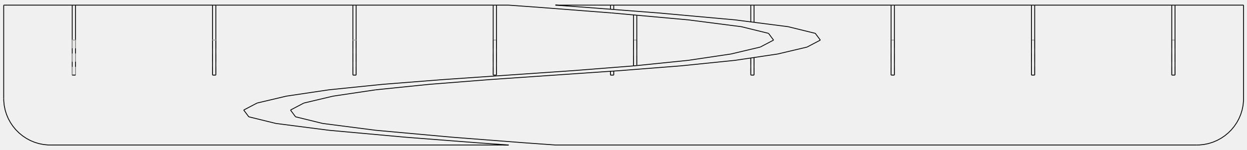
Frico has been developing air curtains for the demanding Scandinavian climate for 45 years. Our experience and knowledge has resulted in Thermozone technology, the theoretical foundation that we base the development of our air curtains on.

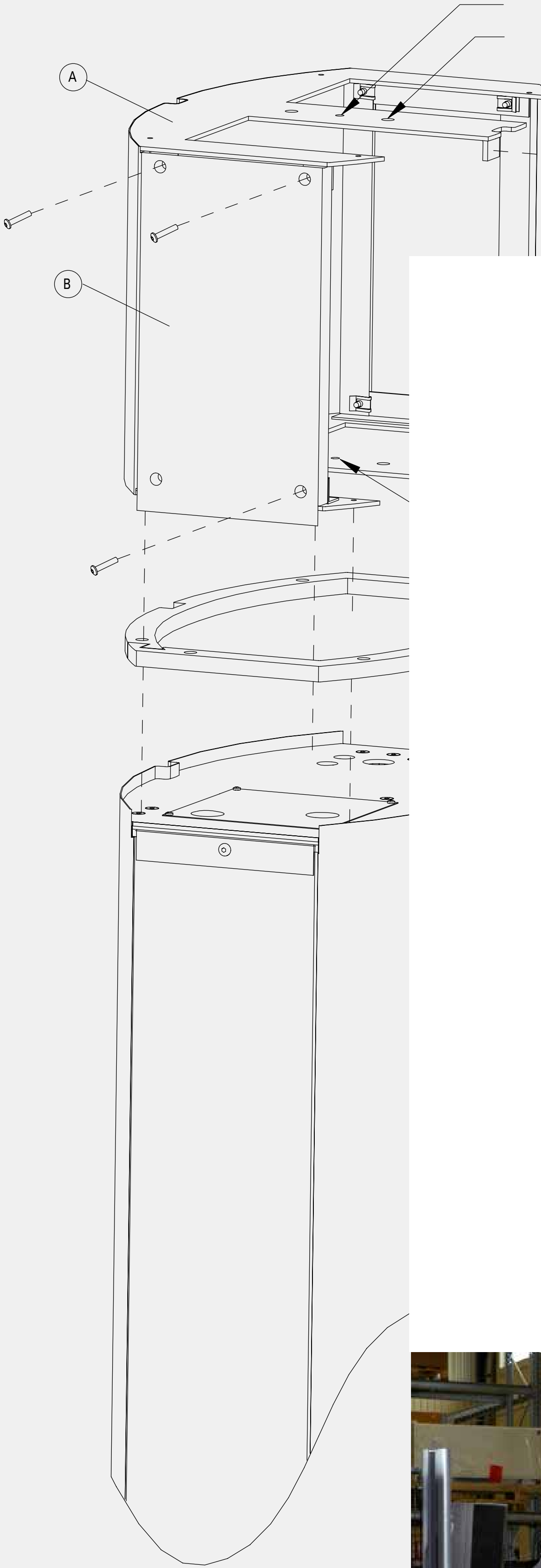
Thermozone technology gives optimum curtain effect with perfect balance between air volume and air velocity and a high uniformity of the air beam. This balance does not just make the air curtain more effective but also has other advantages. The indoor climate is more comfortable if the sound level and the turbulence are reduced and the energy costs are lower.

Air curtains with Thermozone technology have optimized performance and minimized sound levels.

Read more about Thermozone technology on the following pages.

THERMOZONE®
TECHNOLOGY





Right from the start and the whole way

When we start to develop a new product the most important factors are performance and sound level. The designers test their way forward step by step to find a level with optimum performance and the lowest sound level.

The turbulence in the unit must be minimized to prevent high pressure drops and high energy consumption and to give as low a sound level as possible. To minimize the turbulence, the designers follow the path of the air from the intake grille to the outlet. The shape of the fan housing is very important for the performance of the fan and the fan's capacity to increase the pressure. The air must be directed to and from the fans in a natural way and finally leave the unit through the important outlet grille. The width and design of the outlet is very important. The throw is at its most effective when the flow of air leaving the air curtain is laminar and homogenous throughout the width of the outlet.

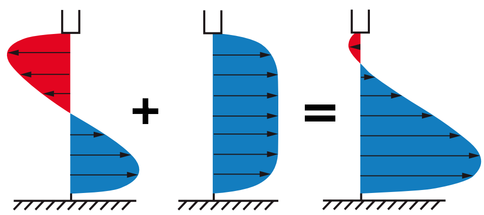
From the very beginning of development, consideration is taken to make the product easy to assemble, install and service.

The designers are involved in the product the whole way through to manufacture and launch to ensure that the design functions in production terms and that it meets our customers' wishes.

Technical handbook

Optimized performance

Independent tests show that a correctly installed air curtain can reduce energy losses at an open door by up to 80%. A correctly installed air curtain covers the width and height of the opening and is adapted for the stresses that it is exposed to.



The opening is affected by the differences in temperature, pressure and wind stress. The effect is greatest at floor level.

Protects the whole door opening

A correctly installed air curtain creates an air barrier that covers the whole opening and is adapted for the stresses that it is exposed to. In addition to the air volume from the air curtain, when dimensioning you must set requirements for the air velocity and the uniformity of the air beam at the floor level. Because it is at the floor level the stress is greatest. You then know that you have an air barrier that reaches the whole way down and gives the best possible protection.

By setting requirements for the air velocity and uniformity of the air beam at floor level, you have an air curtain that covers the whole door opening.

...not just where it is least needed

Many people evaluate air curtains based on the air volume that they produce without considering the length of the air barrier. The air volume is measured closest to the unit, where the stresses are smallest. If you choose an air curtain based purely on air volume you may get an air curtain that only gives good protection close to the outlet.

If you choose an air curtain based purely on air volume you may get an air curtain that only gives good protection close to the outlet, where the impact on the door opening is less.

Air barrier power = impulse

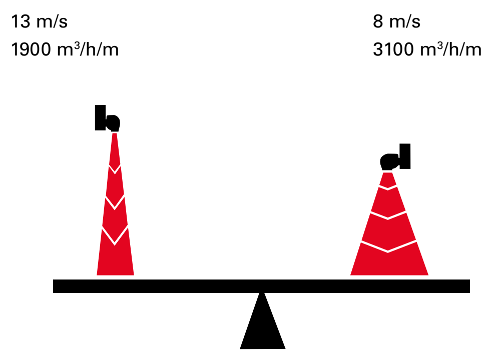
To evaluate an air curtain's performance the term impulse is used, which describes what force an air barrier has.

Impulse = air volume x density x air velocity

$$[kgm/s^2] = [m^3/s] \times [kg/m^3] \times [m/s]$$

The unit for impulse is [kgm/s²], that is Newton (N), the SI unit for force. The impulse can be achieved in different ways. A product with high air velocity and small airflow can have the same impulse as a product with low air velocity and large airflow.

The impulse must be sufficiently large the whole way down to the floor in order to obtain an effective air barrier across the whole opening. It is therefore important to take air velocity into consideration when dimensioning.

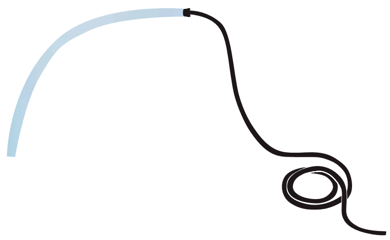


A product with high air velocity and small airflow can have the same impulse as a product with low air velocity and large airflow.

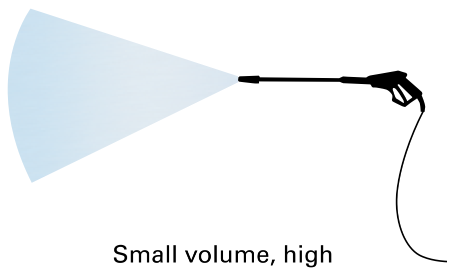
Balance between air volume and air velocity

Thermozone technology creates a balance between air volume and air velocity that gives optimum performance. The design of the outlet is a key factor in achieving this balance. To explain it we usually use the analogy of a hose pipe, because airflow is physically similar to water flow. With a hose pipe without a nozzle (large water volume and low pressure) you cannot reach far because the velocity of the water leaving the hose is too low. If you connect the hose to a pressure washer (low water volume and high pressure) the water leaves the pressure washer at high speed, but still does not reach further than a few metres, because of the turbulence created in the water flow by the high pressure washer. If you then connect the hose to a nozzle, the water volume and pressure can be adjusted and the range of the water jet can be optimized and reach a long way.

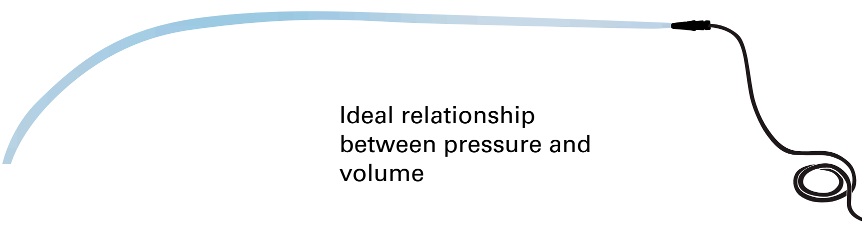
The performance is reduced in the same way in air curtains with low air velocity and large airflow or high air velocity and small airflow. They don't reach the floor. Large air volumes also require more heating and unnecessarily large amounts of energy. Thermozone technology creates a balance between air volume and air velocity that saves energy by using the minimum amount of air and gives optimal efficiency over the whole door opening.



Large volume, low pressure



Small volume, high pressure



Ideal relationship between pressure and volume

High uniformity of the air velocity profile

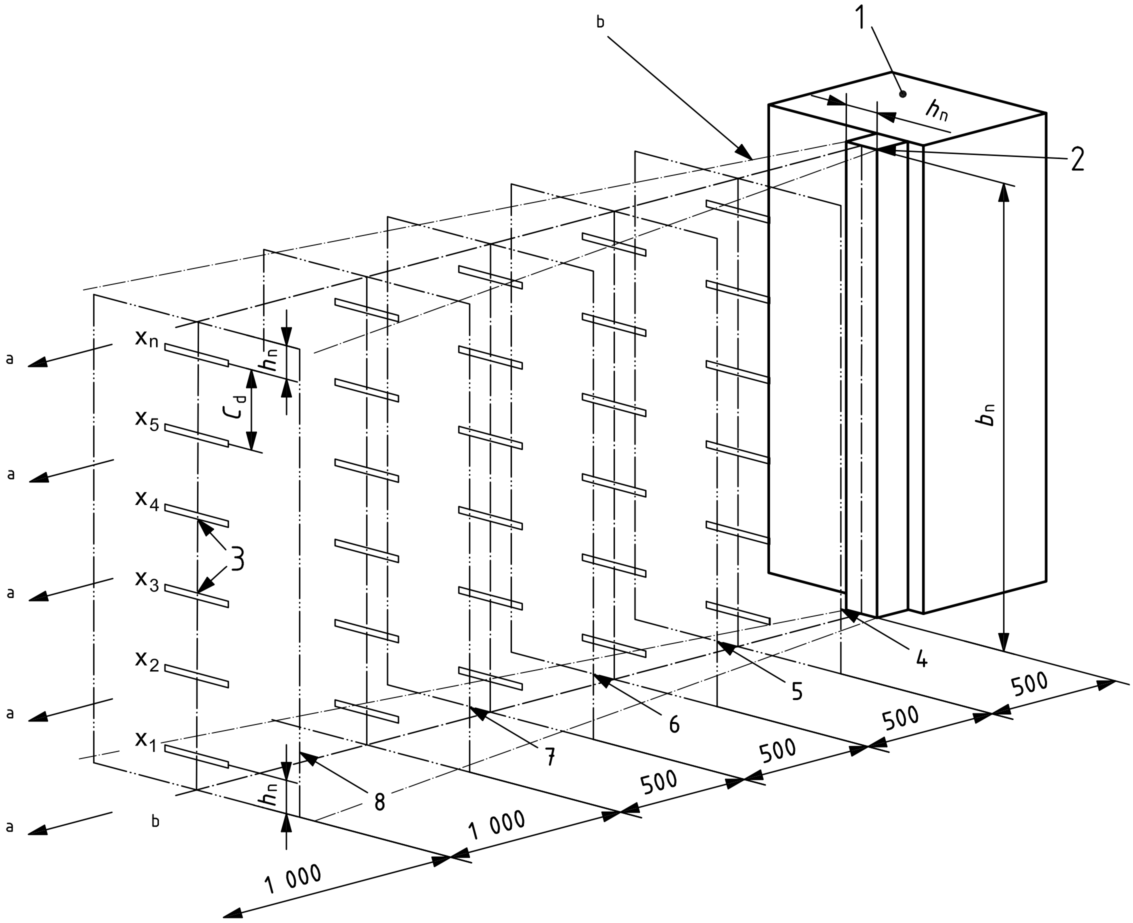
Uniformity displays the velocity profile throughout the width of the profile. The uniformity of the air beam is important in order to achieve optimal performance. An air beam with high uniformity ensures good coverage of the total width of the opening.

How to measure

Uniformity of the air beam is measured by comparing air velocity at different positions throughout the width of the air curtain and is expressed in percentage. A uniformity of 100% implies the air beam has the same velocity throughout the entire width of the air curtain.

Why high uniformity is important

The strength of the air beam is determined on its lowest velocity at the floor level. An air beam with low uniformity will therefore need additional air in order to ensure minimum velocity is reached over the entire opening. More air in the air beam areas of high velocity creates turbulence, which has negative influence on the comfort. An air beam with high uniformity strikes the floor simultaneously with the same velocity over the whole opening, which minimize turbulence and maintains the strength of the air beam.



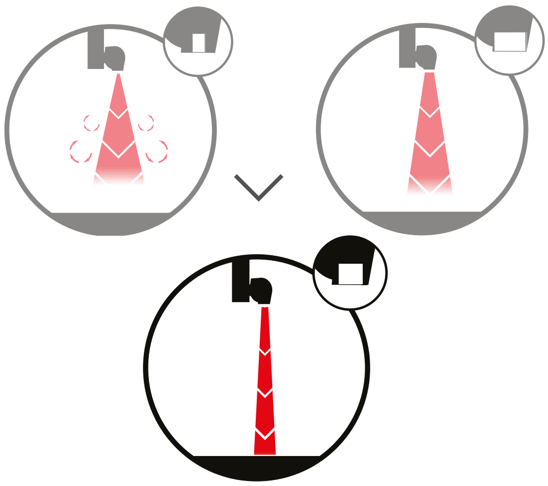
Optimized airflow geometry

The designs of the outlet and the inside of the unit are key factors in creating an air barrier that protects efficiently and has a minimal sound level.

1

Depth of the outlet

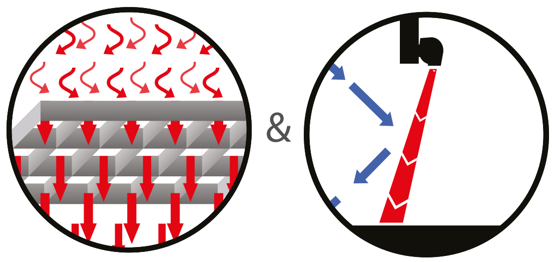
At any given air volume, it is the depth of the outlet that determines the air velocity. Too small an outlet creates turbulence because of an air velocity which is too high, this shortens the throw length. If the outlet is too deep it reduces the air velocity and shortens the length. In Frico air curtains the throw length is optimized via the depth of the outlet.



2

Outlet grille

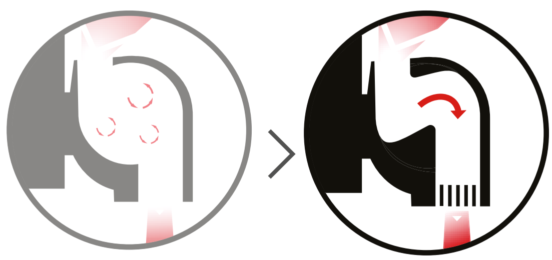
Height, width and fin distance all play a part in the design of the outlet grille, so that the air is directed and turbulence minimized. The result is a uniform air stream and an effective air barrier. Frico's outlet grilles make it easy to direct the air to resist pressure loads in the opening, so that energy losses are minimized.



3

Minimized turbulence

Turbulence inside the air curtain gives higher pressure drops resulting in higher energy consumption and less uniformity of the air beam. In Frico air curtains the turbulence is minimized and the energy consumption is limited.

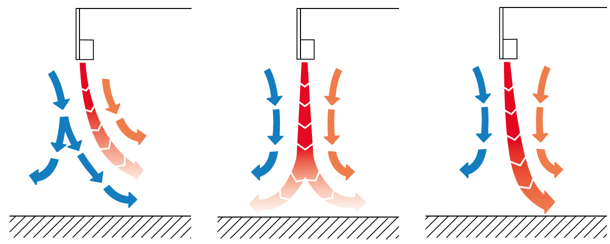


Technical handbook

Create maximum protection at floor level

Too low air velocity at floor level gives a curtain that cannot withstand stresses. Too high velocity gives turbulence that reduces the protective capacity of the air barrier and also has loud sound levels.

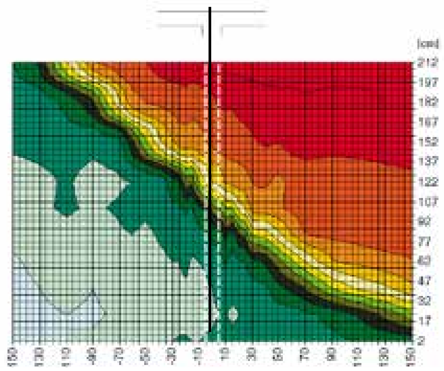
An air beam with correct velocity and high uniformity gives the best protection. Thermozone technology gives the most effective air barrier by ensuring that the air stream reaches the floor and at optimal velocity and uniformity. Thermozone technology solves the problem with the minimum amount of air.



Test - protective effect

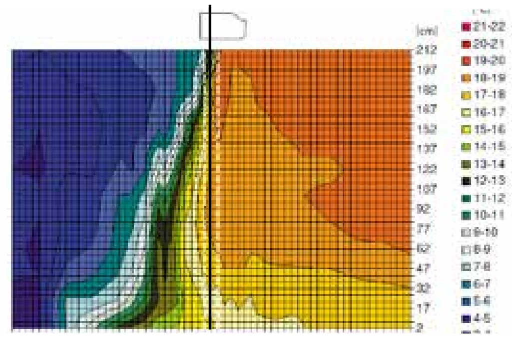
The environment replicated in this test is a dairy section directly attached to a room with normal room temperatue. Different operating cases were studied in a cross-sectional temperature measurement and the values were compiled in a diagram showing how the air streams affect the temperature in the areas around the opening.

The clear red colour shows normal room temperature and the darkest blue colour shows the cold storage temperature. The values on the X-axis state the distance in centimetres from the unit, the values on the Y-axis state the distance in centimetres from the floor.



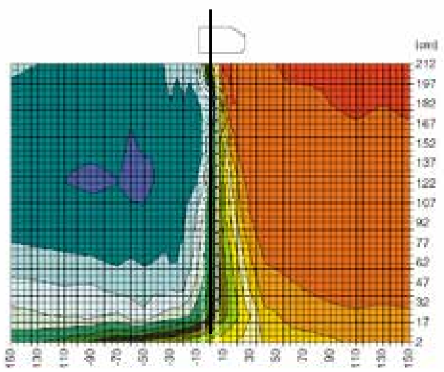
Opening without air curtain

In an unprotected opening the cold air flows out and the cold storage room becomes much too warm.



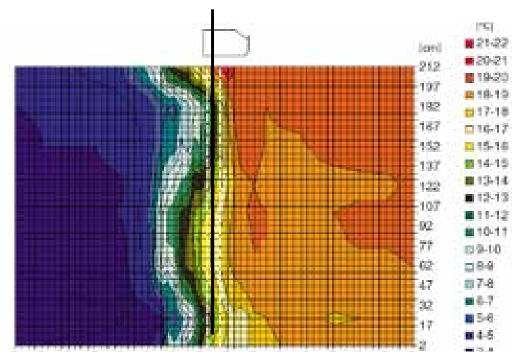
Opening with air curtain, wrong angle

If the angle is too small the hot air is blown into the cold storage room.



Opening with air curtain, too high speed

Excessive speed creates turbulence, which causes energy loss and increases the cold storage temperature.



Opening with correctly adjusted air curtain

With a correctly set air curtain unit there is a sharp separation between the different temperature zones.

The test was made with ADA Cool, model ADAC120, and carried out by technicians from Malmö University.

Dimensioning

Frico has supplied air curtains for over 40 years and our experience of dimensioning can be illustrated in a diagram.

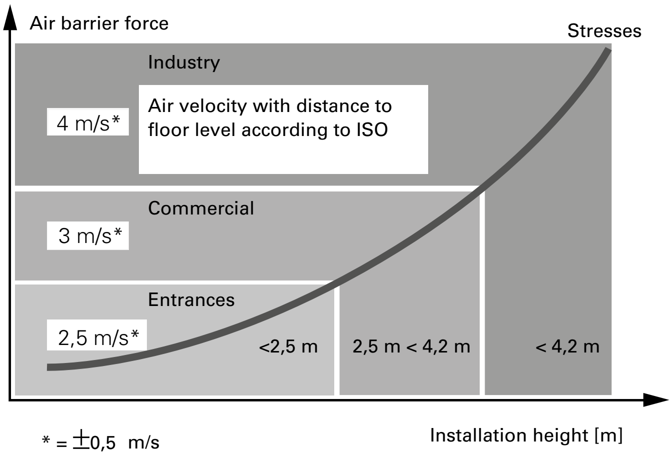
The relationship between the size of the door and how powerful the air curtain needs to be is not linear. The higher the door the greater the force required. We have chosen to use the distance to the floor as reference, together with the air velocity and the air beam uniformity measured in accordance with ISO 27327-1.

For an installation height less than 2.5 metres it is usually appropriate to select an air curtain with the capacity to deliver approx 2.5 m/s in a laboratory environment at a distance equal to the installation height. For other heights, see the diagram. In addition, the uniformity of the air beam should be ≥90% to ensure low turbulence and maximum strength of the air beam.

Please note that the air velocity at dimensioning is not the velocity the air should have at floor level in an actual installation, but the capacity the unit needs to be able to compensate for the wind loads and pressure differentials occurring in an actual doorway.

In many cases there are other factors to refer to, see the section "Important to remember" earlier in the handbook.

The air stream direction and velocity must be adjusted at installation to obtain an air curtain that works optimally. Read more about adjustment later in the handbook.

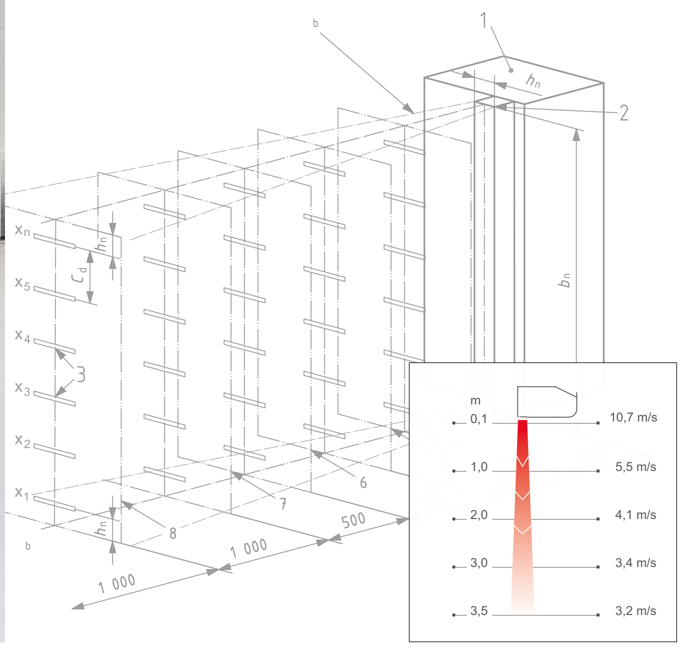


ISO measurements at our laboratory in Skinnskatteberg, which is one of the most advanced in heating and ventilation in Europe.

Air barrier velocity and uniformity

There is an ISO standard to measure the air barrier velocity and uniformity (ISO 27327-1 Laboratory methods of testing for aerodynamic performance rating).

Frico measures all air curtains according to the ISO standard, the result is in the air velocity profile of the relevant product.

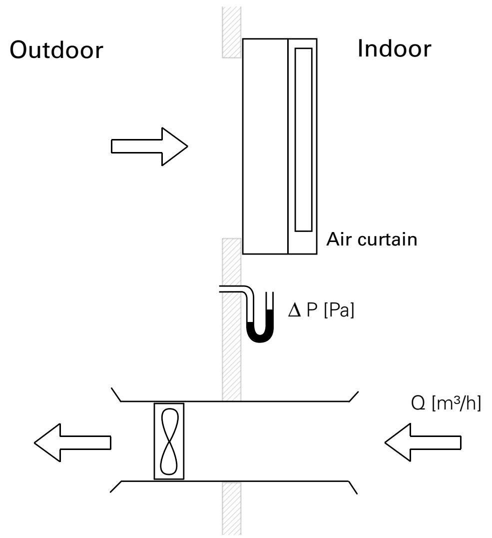


Air velocity profile PA3500

Tests - performance

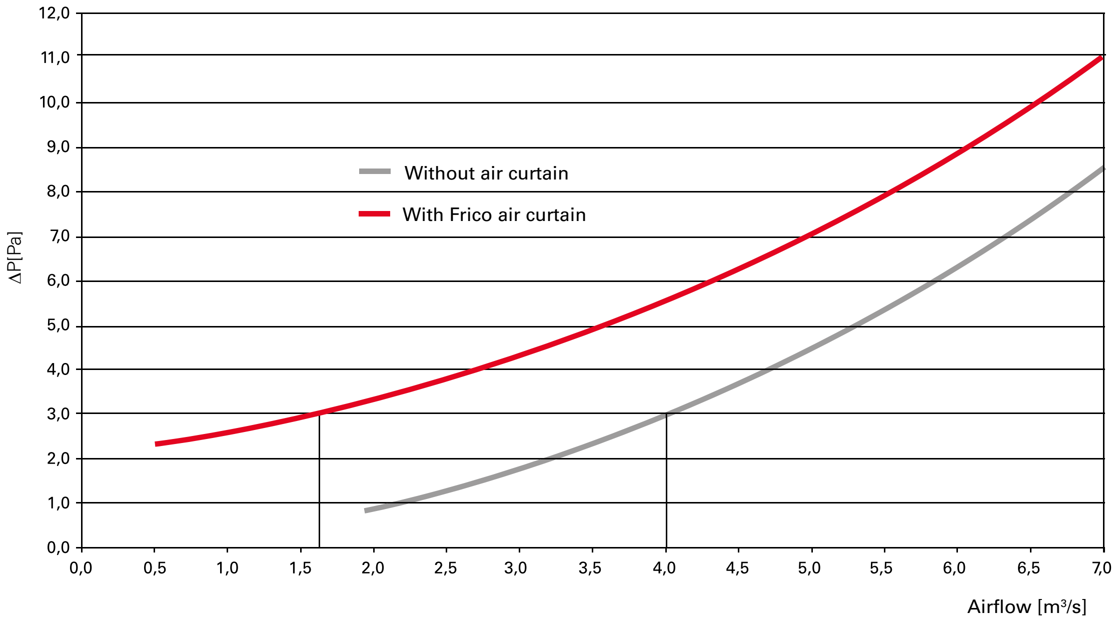
Air curtain efficiency

Frico has developed a method to test air curtain performance. The test is full scale. The idea is to measure the volume of air that passes through a door with an air curtain is installed in comparison to a door without an air curtain. In the test all stresses are converted to a pressure evenly distributed across the door.



The test installation consists of two rooms that correspond to indoors and outdoors. A powerful fan with equipment to measure airflow is located between the rooms. The air curtain is installed above the opening. When the fan is run an airflow is created from one room to the other, exactly the same volume of air passes through the fan as through the opening. This gives rise to a pressure differential (ΔP) between the two rooms. The fan starts to run at low speed that then slowly increases. Information about airflow and pressure differential is stored on computer. This data is then used to create a curve, see diagram 1.

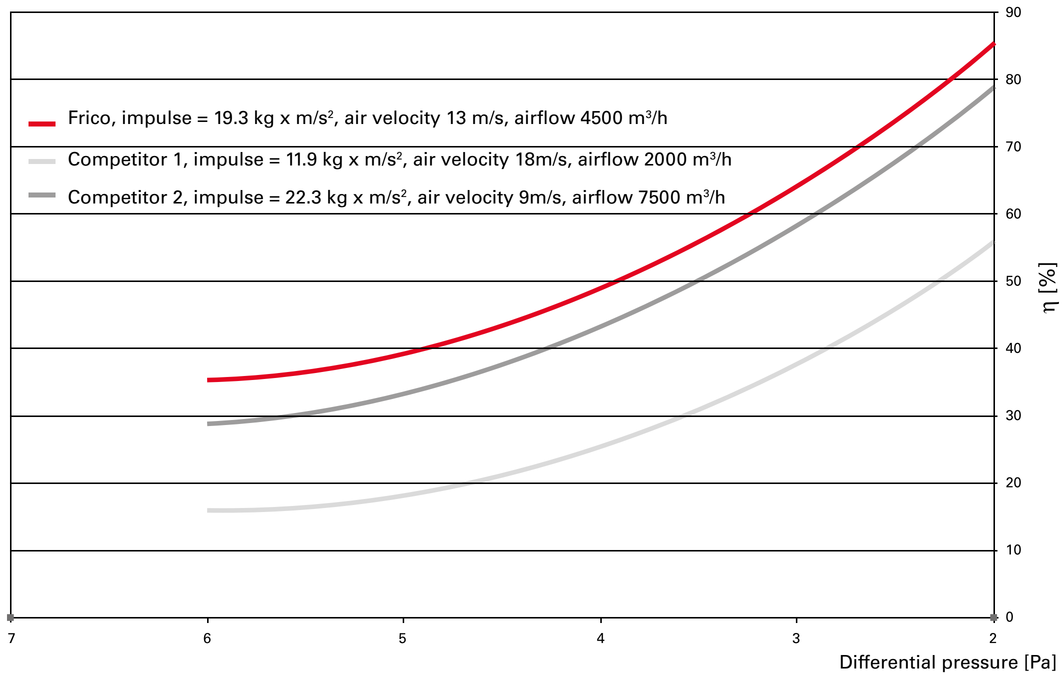
Diagram 1: Airflow through the opening with and without air curtain at different differential pressures.



Pressure and flow over the opening are measured with and without the air curtain. The result is two curves where the airflow at a particular pressure differential can be compared.

Example: At 3 Pa the airflow through the opening without the air curtain is 4 m³/s and with the air curtain is 1.6 m³/s. The difference in the airflow shows the perfomance of the air curtain. In this case it is (4–1.6)/4 ×100 = 60% less flow with the air curtain compared to without.

Diagram 2: Air curtains mounted at a height of 3 metres, measured efficiency at different differential pressures.



This also makes it possible to compare the performance of different products under the same conditions. Diagram 2 shows the result of testing three air curtain units that have been designed using different basic concepts. Competitor 1 has a high air velocity and small air flow and competitor 2 has a medium air velocity and large air flow.

The air curtain from Frico has an optimized air velocity and airflow that makes it more efficient than competitor 2 despite (22.3-19.3)/22.3 = approx 13% lower impulse.

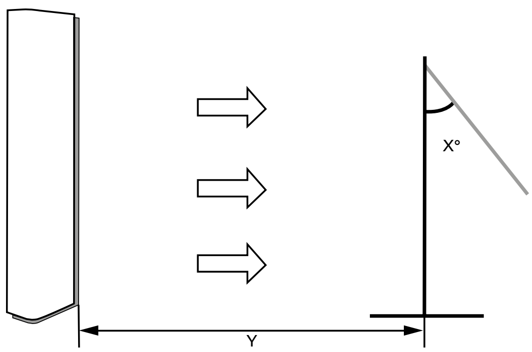
Tests - performance

Impulse at the floor

A practical test of different air curtains at floor level can be carried out by comparing the air throw length and power using a wind board.

To directly compare the throw length and power of different air curtains you can position them equidistantly on either side of a wind board and see which way the board moves.

At the same air volume, air curtains from Frico give a stronger impulse at ground level than competitors, which means greater protection. Frico air curtains maintain the impulse the whole way to the floor, which gives a lower operating cost, because the same strength of air barrier can be achieved using lower air volume.



The angle X indicates the air barrier force (impulse).

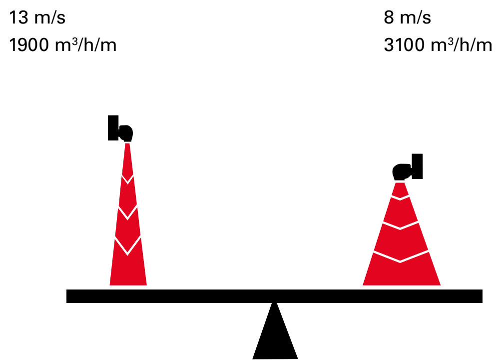
Y = corresponds to the distance to the floor

Impulse = air volume x density x air velocity

Large air volumes cost

Low air velocity can be compensated for by higher air volume to reach the floor. Large air volumes require more heating and therefore cost more. As shown by above test, Frico air curtains can give the same strength to the air barrier at floor level with lower air volume.

Calculation of output on an air curtain from Frico and an air curtain with low air velocity and large airflow shows that, in this example, Frico air curtain consumes 40% less than the competitors', but achieves the same impulse.



A product with high air velocity and small airflow can have the same impulse as a product with low air velocity and large airflow.

Conditions:

Same impulse
Desired temperature increase: 15 °C
Room temperature: 20 °C
Opening width: 2 m

T = 20 °C =>ρ = 1,2

Competitor (3100 m³/h/m, 8 m/s)
$P = Q \bullet \Delta T \bullet \rho \bullet c_p = 2 \bullet 3100/3600 \bullet 15 \bullet 1.2 \bullet 1$ = approx 31 kW

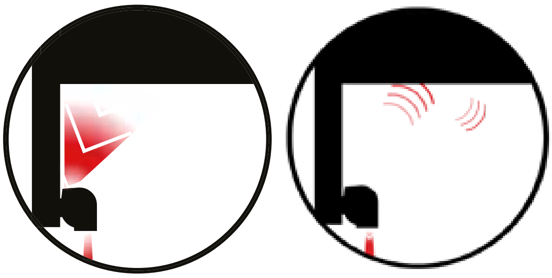
Frico (1900 m³/h/m, 13 m/s)
$P = Q \bullet \Delta T \bullet \rho \bullet c_p = 2 \bullet 1900/3600 \bullet 15 \bullet 1.2 \bullet 1$ = approx 19 kW

Minimized sound level

Sound is important for indoor comfort. At Frico we place great importance on the sound levels of our products. The fans we use together with our optimized air flow geometry provides a low sound level.

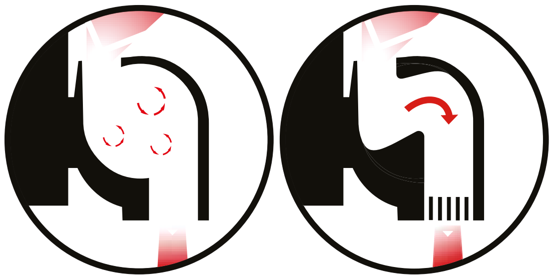
Air intake on the top

With the air intake placed on the top of the air curtain, the sound level experienced is minimized because the walls and ceilings absorb some of the sound before it spreads.



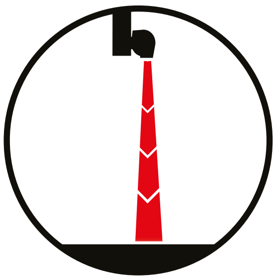
Turbulence - no thanks

Turbulence inside the air curtain causes higher levels of sound. In Frico air curtains turbulence is minimized and the sound level is limited.



Optimized amount of air

The sound level originating from the outlet depends on the air volume, a greater air volume increases the sound level. Optimum airflow in combination with the outlet grille gives a controlled air stream with less air volume and lower sound level.



Sound facts

Sound is an important environmental factor, equally important as good light, fresh air and ergonomics. What we usually call the sound level of a product is actually the sound pressure level. The sound pressure level includes the distance to the sound source, the position of the sound source and acoustics of the room. This means that a silent product is essential, but the whole environment needs to be considered to achieve a comfortable sound level.

What is sound?

Sound is caused by air pressure fluctuations that evolve when a sound source vibrates. The sound waves that are produced are condensation and dillusion of air particles without the air in itself moving. A sound wave can have different velocities in different media. In air the 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 10 dB, the result is twice as loud (matematically it is 6 dB, but the way we hear it, it is 10 dB).

It is also useful to know that two equally strong sound sources give an added sound level of 3 dB. Assume you have two entrances with two air curtains in each entrance, all four units with a sound level of 50 dB. The total sound level will then be 56 dB. The first opening will have a total sound level of 53 dB plus an extra 3 dB from the other opening.

Fundamental concepts

Sound pressure

Pressure develops when pressure waves move, for example in the air. The sound pressure is measured in Pascals (Pa). To clarify sound pressure a logarithmic scale is used which is based on the differences between the actual sound pressure level and the sound pressure at the threshold of hearing. The scale has the units decibels (dB(A)), where the threshold of hearing is 0 dB(A) and the threshold of pain is 120 dB(A).

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. Just like sound pressure, a logarithmic scale in decibels (dB(A)) is used to specify the sound power. Sound power is not dependent on the sound source nor the acoustics of the room, which therefore simplifies the comparisons of different objects.

Frequency

A sound source's periodical oscillation is its frequency. Frequency is measured as the number of oscillations per second, where one oscillation per second is 1 Hertz (Hz).

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 threshold of pain

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.

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

3. The rooms equivalent absorption area
The ability for a surface to absorb sound can be expressed as an absorption factor, α, which has a value between 0 and 1. The value 1 corresponding to a fully absorbing surface and the value 0 to a fully reflective surface. 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.

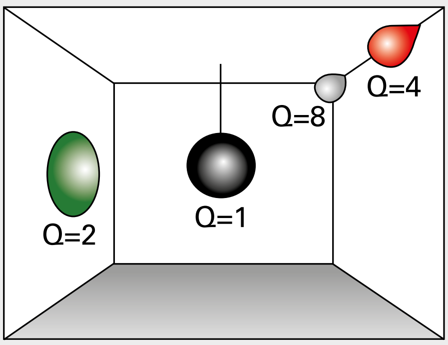
With these known factors it is possible to calculate the sound pressure if the sound power level is known.

Testing - sound

Our test facility for air and sound is among the most modern in Europe. We regularly carry out tests and measurements during the development of new products, but also to improve existing products. The measurements are carried out according to the AMCA and ISO standards.

This picture shows our acoustic chamber, where we measure the sound levels of our products. The acoustic chamber consists of a sound chamber standing on powerful springs with a background noise that is lower than can be detected by the human ear.

The sound levels of our products are stated for each product. Our sound measurements are carried out according to the international standards ISO27327-2 and ISO3741. The distance to the product is 5 m, directional factor 2 and the equivalent absorption area is 200 m².



The distribution of sound around the sound source.

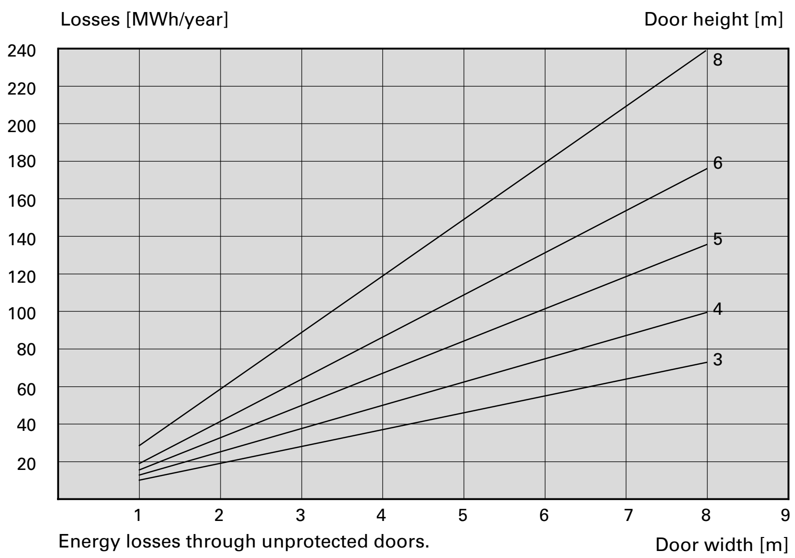
Q = 1	Middle of room
Q = 2	On wall or roof
Q = 4	Between wall and roof
Q = 8	In corner

Energy saving with air curtains

The diagram below illustrates how large energy losses can be from a door without air curtains as protection.

Conditions:

Large premises	
Average yearly temperature	6,5 °C
Annual average wind speed υ_{10}	4 m/s
Opening times	1 hour/day



Energy losses through unprotected doors.

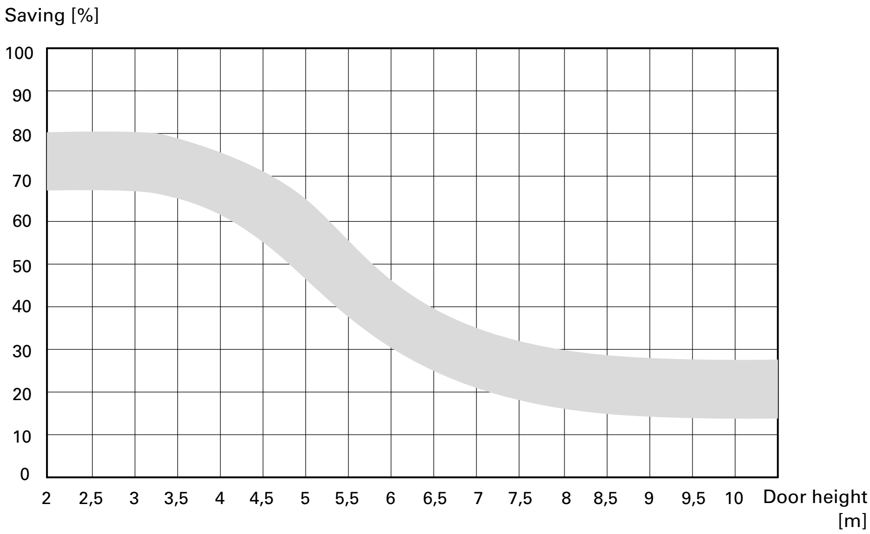
Calculation of energy savings

Door height	5	
Door width	4	
Number of days per week in operation	5	days
Time open during a day	1	hour
Average time open per opening	5	minutes
Dim. indoor temperature	18	°C
Dim. outdoor temperature	-18	°C
Average yearly temperature	5	°C
Wind speed	4	
Room volume	6400	

We will compare energy loss through an open, unprotected door with a similar door where air curtains have been installed. The calculation should only be viewed as an estimate. Calculation of energy savings is not an exact science. It is difficult to determine the impact of cross draughts, building seal, chimney effect, wind speed and direction. But what we can see is that there will be high energy losses if an opening is left completely unprotected.

If we compare the values from the diagram on the previous page with the diagram below, we can see that the air curtain eliminates up to 65 % of the air exchange through the door.

Energy loss, unprotected door: 69 MWh/year
Energy loss, curtain protected door: 24 MWh/year
Energy saving: 45 MWh/year



Estimated possible savings (efficiency) in doors of different heights. The comparison applies to doors protected by an air curtain compared to the equivalent without protection.

Contact us at Frico for advice

You are very welcome to contact us if you want to discuss the requirements for your doors. With some information from you we can give an estimate of the possible energy savings. See the following checklist with useful parameters.

Adjustment

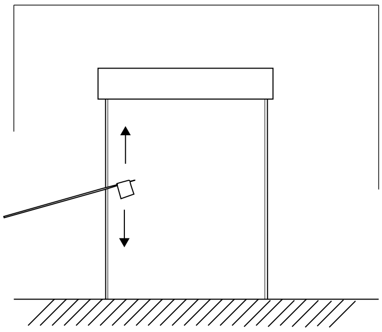
The direction and velocity of the air stream must be adjusted as follows to obtain optimum function from the air curtain. If the air velocity is too high, turbulence will occur which reduces the protective effect and the comfort inside the door. If velocity is too low, the barrier does not reach the floor and cannot protect the opening.

Cold storage and freezer rooms

Adjustment can be made using an anemometer. An alternative method is to attach a piece of thin paper on a rod. By moving it up and down the doorway it's easy to see how the air stream behaves. Start with middle speed and with the minimum unit angled outwards towards the hot side. Change to a higher or lower speed and try different angles (3 positions - 5, 10, 15 °) so that it neither blows inwards or outwards, but it may blow slightly towards the warm side.

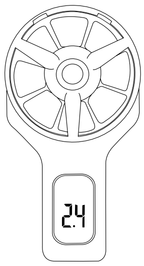
Entrances and doorways

External influences are greater at entrances and doorways, but an anemometer or simple adjustment tool can be used to give an indication that the installation is correct. The adjustment tool (or anemometer) is placed slightly further in than with a cold storage or freezer room. Initially the angle should be adjusted (5-15° outward) and then the fan speed adjusted until the inward air stream is minimal.



A small adjustment tool consisting of a simple stand and a free hanging piece of tissue paper is placed near the door inside the premises.

Tip! There are films showing adjustment at www.frico.se/adjust.



Example of anemometer.

Correct air velocity

The air velocity at dimensioning must be correct for the installation environment and height (see diagram under Dimensioning, earlier in the handbook). In an installation outside the laboratory environment, the air velocity at floor level will be affected by wind loads and pressure differentials. Our dimensioning recommendations (for air velocity at floor level) are made to withstand normal wind and pressure differences in a real environment. It is essential that the air curtain is correctly adjusted for the specific opening and the air velocity then adapted to how the conditions change over time.

Adjustment adapts your installation

Stresses vary between different installations and adjustment ensures that the air curtain functions perfectly in your particular installation.

Controls take care of the rest

Adjustment is usually carried out once when commissioning, if and when the external influences change, the controls automatically compensate.

Controls

How efficient an air curtain is and how much energy can be saved depends to a large part on the control system. Many factors that affect the air curtain vary over time. The variations can be long term, for example seasonal, or more temporary, for example when the sun goes behind clouds, the premises fills with people or when a door is opened.

SIRe Control system

Most of our air curtains have an integrated intelligent control, SIRe, which automatically manages the air curtain operation, both in summer and winter. The control system can optimize either comfort, energy saving or a combination of these. SIRe is a smart and well designed, low voltage control system available in three different levels with different functionalities.

Basic

Basic includes basic functions covering manual control of fans and automatic heating with thermostats.

Competent

Competent is an automatic solution for daily air curtain operation.

The included door contact makes it possible to adapt operation of the air curtain to whether the door is open or closed. If the door is open the air curtain operates at high speed. When the door is closed the air curtain runs at low speed, but if there is no heating requirement the air curtain switches off. The air curtain can also be integrated with a heating system and be used for heating. In this way other heating costs can be reduced.

From function level Competent and upwards, a calendar function is included. For example, by reducing the temperature at night and weekends energy savings are possible. Each degree of room temperature reduction can save at least 5% of the total heating cost of the premises inside the door.

It is also possible to choose the functionality between the air curtain operating best for doors that are always open or for doors that are frequently opened and closed.

A common error is to turn the temperature up to max when it is cold, which results in over temperature which in turn impacts on comfort and energy consumption. With Competent it is possible to limit the range of room temperature setting.

Advanced

Advanced is a fully automatic solution for air curtain operation including all functions from Competent as well as further smart functions.

Advanced also includes the possibility of choosing between Eco mode or Comfort mode. Comfort mode prioritises comfort. Eco mode limits the outlet temperature and the energy consumption can be reduced by up to 35%.

Advanced measures the outdoor temperature allowing the air curtain to be one step ahead. The fan speed and temperature are always correct and assure optimal protection. The colder it is outdoors the higher the fan speed and vice versa in the summer. The automatic control, including the door contact, ensures that the air curtain operates when it should; you do not have to remember to switch it on. Many people forget that the air curtain is also of benefit when it is hot outdoors and don't switch the curtains on if it is manual, but cooling air is even more expensive than heating it.

When a water heated unit is controlled the return water temperature can be restricted. With a sensor on the return pipe more of the energy in the pipe can be utilised and the system that produces the heat - a heat pump or a district heating system - is significantly more efficient at a lower return temperature. In many cases you also pay a lower tariff if you can keep the return temperature down.

BMS

The air curtain operation can also be controlled via an overall control system. The air curtain can receive signals for fans and heating with voltage signal 0–10 V, but it also possible to control all functions and receive all indications via gateway Modbus RTU (RS485). Functionality for BMS is in Competent (on/off/fan speed and alarm function) and in Advanced (complete control with indication and via gateway).

Simple installation

The different components are supplied together and are easy to assemble. The system self-checks that everything is correct and that it functions. Thanks to the preset default settings it is easy to start air curtain operation as soon as the system is in place.
Read more on the product pages in the catalogue.

Other controls

Frico offer a wide selection of control panels, speed controls, door switches and thermostats for our other air curtains. Some of our air curtains have integrated controls. See product pages.

Valve systems

Water heated units must always be supplemented with valves. When heating is not required, the valve restricts the water flow and only a small amount is allowed through so that there is always hot water in the heating coil. This is to be able to provide quick heat supply when a door is opened but also to provide a degree of frost protection. Without valves the unit gives off maximum heat energy as long as the fan is running, which means energy loss.

Select the correct valve system for units with SIRe

Which valve system should be selected is related to the level of SIRe control (Basic, Competent or Advanced) and what information is available about available pressure and desired output.

In Basic and Competent the valves are controlled on/off and in Advanced a modulating actuator is used that controls the valve.

In order to select the correct valve size it is necessary to know what water flow is desired and what available pressure the pump in the pipe system can deliver to the valve. It is often difficult to know the available pressure and it varies with changes to the system, therefore it is often advantageous to select a pressure independent valve that compensates for variable pressure. Specifications about the Frico valve systems are found in the Water control chapter. There are diagrams and tables for valves on our website to help you make a precise selection.

Valve systems VLSP and VOT are used for SIRe Basic and Competent. Valve systems VLP and VMT are used for SIRe Advanced.

Valve systems for SIRe Basic and Competent

VLSP, pressure independent valve system on/off

Two way pressure independent control and adjustment valve with on/off actuator, shut-off valve and bypass. DN15/20/25/32. 230V. Controls heat supply on/off. The valve is pressure independent and ensures that the flow to the unit is correct even if the differential pressure in the rest of the pipe system changes, which contributes to stable and accurate control.

Valve size

To select the valve size the water flow must be known and available pressure must always lie in the range 15 – 350 kPa (DN15/20) and 23 – 350 kPa (DN25/32).

Select the smallest possible valve size that can achieve the desired flow. A valve setting between 6-8 is recommended.

In the example in the table a flow of 900 l/h is desired. VLSP20 is a suitable choice. If you instead had selected VLSP25 the valve setting would have been between 3 and 4, which would have given worse characteristics and an unnecessarily large valve.

The valve will compensate for variations in the pipe system, so that the desired water flow is maintained.

q_{max}

	1	2	3	4	5	6	7	8	9	10
DN15LF	44	71	97	123	148	170	190	210	227	245
DN15	88	150	200	248	295	340	380	420	450	470
DN20	210	335	460	575	680	780	890	990	1080	1150
DN25	370	610	830	1050	1270	1490	1720	1870	2050	2150
DN32	800	1220	1620	2060	2450	2790	3080	3350	3550	3700

q_{max} = l/h

Example of the tables for VLSP, which display the flow for different settings.

VOT, three way control valve and actuator on/off

The 3-way control valve controls the water flow in combination with the actuator. Used when the adjustment, shut off and bypass valves and the differential pressure control are supplied in another way. Controls heat supply on/off. If a two way valve is required instead of the 3-way control valve included, the third valve opening can be easily plugged (not included).

On markets where there are requirements for a constant return flow (3-way control valve) this is a suitable choice.

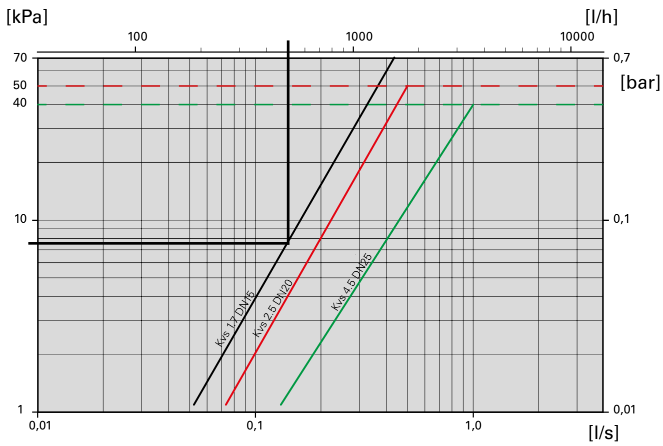
Valve size

To select the valve size both the water flow and pressure drop across the valve need to be known.

Select the valve size so that the pressure drop across the valve provides the required water volume.

In the example in the diagram, a flow of 500 l/h and a pressure drop of 7.5 kPa is required. VOT15 should be selected.

If you do not know the available pressure you can make an estimate, for example 10 kPa, and select the valve based on that; but if the actual pressure is higher than 10 kPa the water flow will be higher than required and vice versa.



Example of diagram for VOT, which displays the pressure drop for different flows.

Valve systems for SIRe Advanced

VLP, pressure independent and modulating valve system

Two way pressure independent control and adjustment valve with modulating actuator and shut-off valve. DN15/20/25/32. 24V. Controls the heat supply steplessly, modulates and gives the right heating. The actuator is set to always release a small flow with SIRe Advanced. The valve is pressure independent and ensures that the flow to the unit is correct even if the differential pressure in the rest of the pipe system changes, which contributes to stable and accurate control.

Valve size

To select the valve size the water flow must be known and available pressure must always lie in the range 15 – 350 kPa (DN15/20) and 23 – 350 kPa (DN25/32).

Select the smallest possible valve size that can achieve the desired flow. A valve setting between 6-8 is recommended.

In the example in the table a flow of 900 l/h is desired. VLP20 is a suitable choice. If instead you had selected VLP25 the valve setting would have been between 3 and 4, which would have given worse circuit characteristics and an unnecessarily large valve.

The valve will compensate for variations in the pipe system, so that the desired water flow is maintained.

q_{max}

	1	2	3	4	5	6	7	8	9	10
DN15LF	44	71	97	123	148	170	190	210	227	245
DN15	88	150	200	248	295	340	380	420	450	470
DN20	210	335	460	575	680	780	890	990	1080	1150
DN25	370	610	830	1050	1270	1490	1720	1870	2050	2150
DN32	800	1220	1620	2060	2450	2790	3080	3350	3550	3700

q_{max} = l/h

Example of the tables for VLP, which display the flow for different settings.

VMT, three way control valve and modulating actuator

The 3-way control valve controls the water flow in combination with the actuator. Used when the adjustment and shut off valves and the differential pressure control are supplied in another way. Controls the heat supply steplessly, modulates and gives the right heating. The actuator is set to always release a small flow with SIRe Advanced. If a two way valve is required instead of the 3-way control valve included, the third valve opening can be easily plugged (not included).

On markets where there are requirements for a constant return flow (3-way control valve) this is a suitable choice.

Valve size

To select the valve size both water flow and available pressure need to be known.

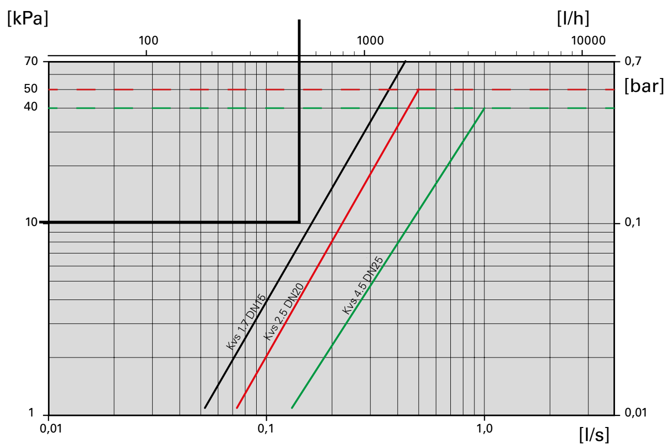
Select the size of the valve, where the pressure drop over the valve is at least as large as the pressure drop over the heating coil.

In the example, if you want a flow of 500 l/h, that is 0.14 l/s, the pressure drop must be at least 7.4 kPa (see table on previous page). VMT15 is therefore a suitable choice.

For modulated valves it is very important that the regulating valve is the correct size and has authority over the heating coil to prevent oscillation in the radiated heating output.

Too large a valve will give a large change in radiated output even at small adjustments.

Too small a pressure drop across the valve compared to the pressure drop in the coil affects the accuracy of the valve and therefore also increases the risk of oscillations.

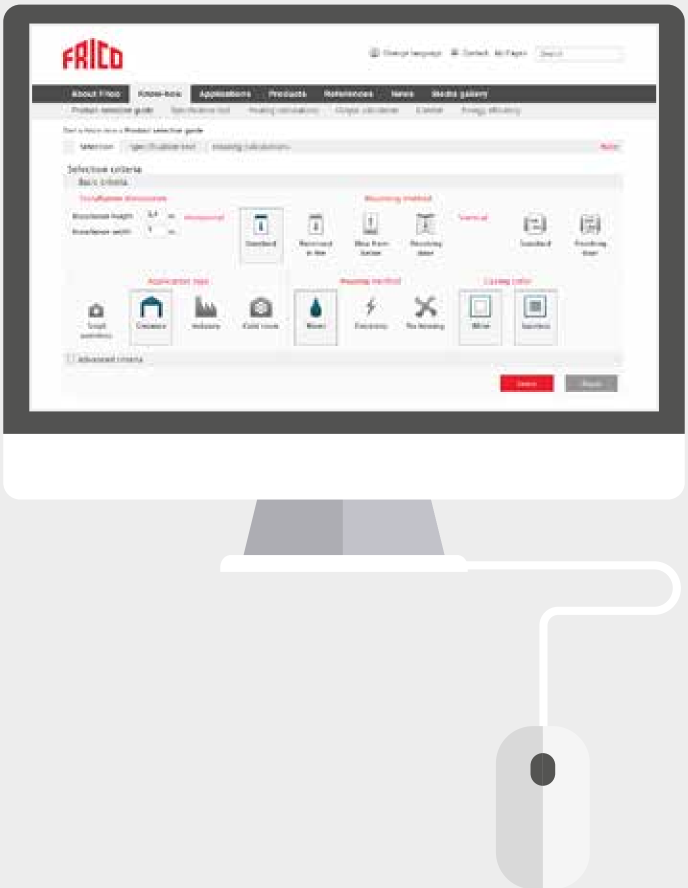


Example of diagram for VMT, which displays the pressure drop for different flows.

Just a click away

Smart tools

Information about all our products can be found on our website. There are also smart tools to help find the right product, make heating calculations and create specification texts.



Product selection guide
The product selection guide has a basic and an advanced level. What level is used depends on how much information is available about the installation. The product selection program should be used to get an idea of what products are suitable.

Specification text
Using this tool you can choose accessories for a selected product, make heating calculations and receive all the technical data in a specification sheet.

Heating calculations
Heating calculations can also be used as a separate tool. Calculations can be made in order to easily compare different water temperatures, fan settings etc.

Tables for dimensioning

Basic electrical formulas

Amperage

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

Voltage

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

Output

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

U = operating voltage in volts: with DC and singlephase AC between the two conductors, with 3-phase AC two phases (not between phase and zero).
U_f = voltage between phase and zero in a 3-phase cable.
$\sqrt{3} \cong 1.73$
I = amperage in ampere
I_f = amperage in ampere in phase wire
R = resistance in ohm
P = output in watt

Symbols for model types

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

Enclosure classes for electrical materials

IP, first 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 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 immersion in water
8	Protection against the effects of long-term immersion in water

Dimensioning table for cables and wiring

Installation wires, open or in conduit		Connection wires		
Area [mm²]	Fuse [A]	Area [mm²]	Continuous current [A]	Fuse [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

Current load at different outputs 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	9,04	5,20	4,15
3,8	29,9	16,5	9,50	9,55	5,49	4,39
4,0	31,1	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

At outputs between 0.1 and 1 kW the read off current load is multiplied by 0.1. At outputs between 10 and 100 kW the read off current load is multiplied by 10.