Thermozone® Technology
Optimized air curtains

Thirty years of air curtain development in the demanding Scandinavian climate has given us a unique platform to create air curtains with optimal door protection. Thanks to the Thermozone technology, the performance can be precisely adjusted to obtain an air curtain with efficient separation that is also comfortable to pass through.

Thermozone air curtains are optimized in:
- Airflow geometry
- Performance
- Sound level

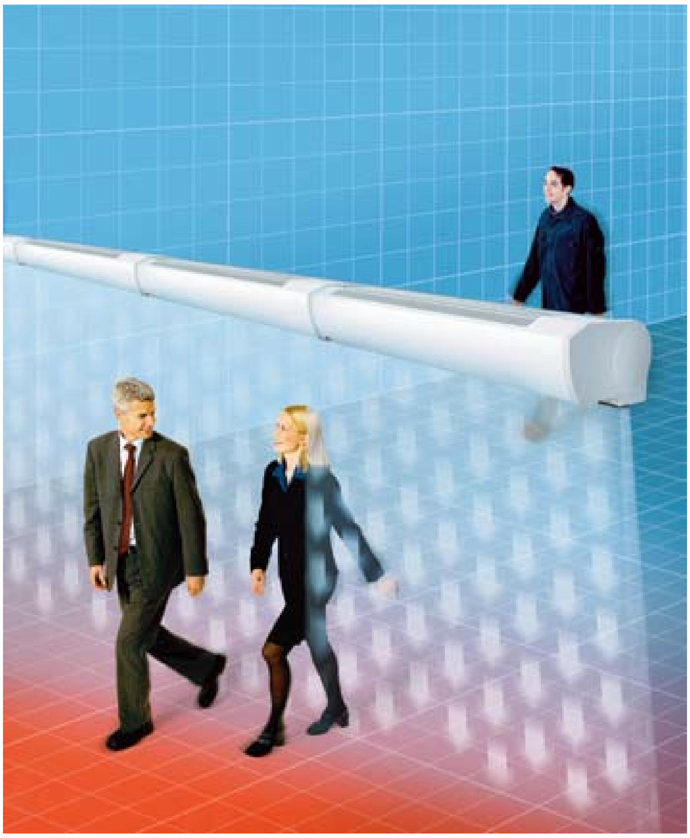
Airflow geometry
Based on fifty years' experience of fan technology we have developed air curtains with the lowest possible sound levels and turbulence – without compromising efficiency. Our highly skilled technicians, considerable experience, and one of Europe's most modern air and sound laboratories have all contributed to what we consider to be the optimal combination of all the components in an air curtain.

Performance
Impulse and air velocity are very important factors when talking about air curtain performance. The same impulse can be obtained in different ways and a higher impulse does not necessarily mean that the air curtain is more efficient.

There are different theories on this subject but we maintain that we have found the balance between air volume and velocity that provides optimal efficiency. Furthermore, high speed causes high sound levels and turbulence and large air volumes require a lot of heat.

Sound level
Frico focuses strongly on sound levels and we work constantly on improvements. The kind of fans we use and the overall optimisation in air flow geometry also result in optimized sound levels. Sound is an important environmental factor, equally as important as good light, fresh air and ergonomics. Awareness of and demands for lower sound levels are increasing. At Frico we take responsibility for this and limit the effects our products have on overall sound levels. Read more about sound on page 244.

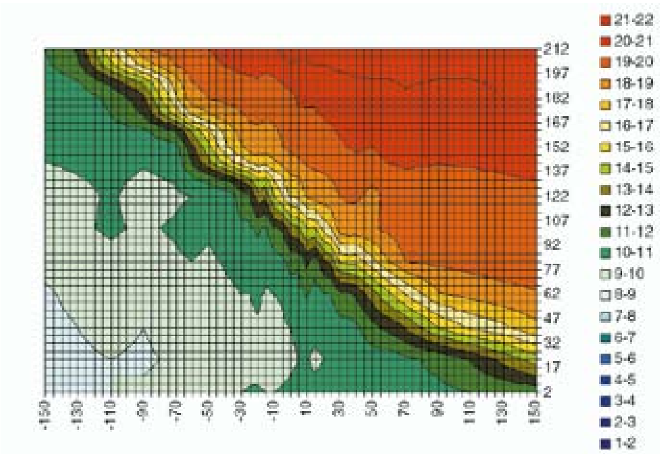
On the following pages you can read more about tests that illustrate Thermozone technology.



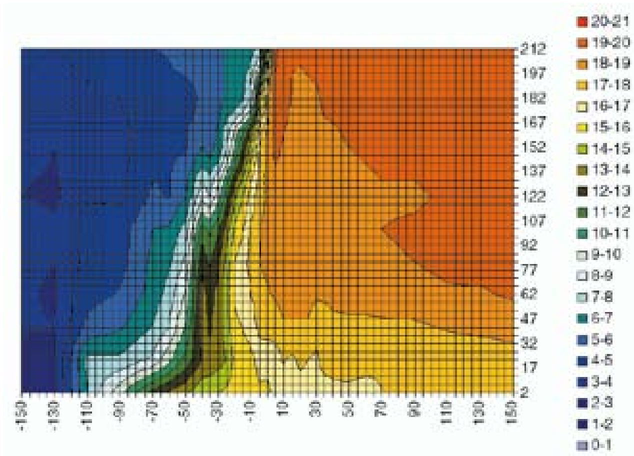
The invisible door

The simulated environment was a cold storage area in a food store where dairy products are held. The area had a direct connection with normal room temperature. By carrying out a set of tests at different conditions and by measuring the temperature at different points in the air stream, the following charts were generated, showing how the airflow can effect the temperature in the different areas around the opening.

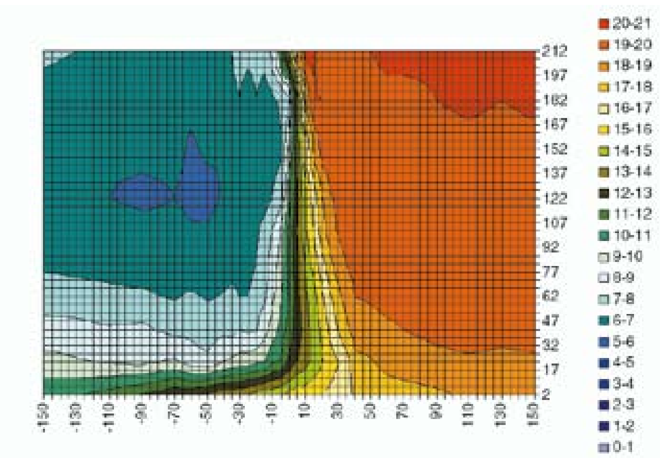
The dark red colour shows room temperature and the darkest blue colour the lowest cold-storage temperature. The value on the x-axis indicates the distance in centimetres from the unit, the value on the y-axis indicates the distance in centimetres from the floor. To the right of each diagram is a key to the colours/ temperature relationship.



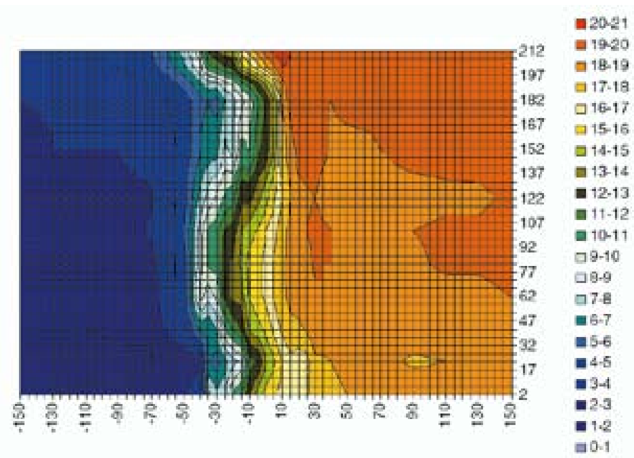
Opening without air curtain
In an opening without protection you can see how the cold air escapes through the opening, resulting in a significant amount of warm air ingress.



Opening with an air curtain set at the wrong angle
If the angle is too small, warm air will blow in to the cold storage and result in increased internal temperature and subsequent energy loss.



Opening with an air curtain, velocity too high
The airflow is an important factor in achieving a good result with an air curtain. Excessive velocity will result in energy loss and an increase in the cold storage temperature.



Opening with a correctly adjusted air curtain
With the air curtain correctly set-up a sharp separation is made between the temperature zones.

The test was carried out using Thermozone ADA Cool, model ADAC120, by Malmö Technical University, Sweden.

Performance

Separating climate zones where only the temperature differs is relatively easy. Handling an opening that is exposed in terms of wind and pressure differences i.e. unbalanced ventilation (read more on pages 190-191) is more difficult. Our aim is to counteract these problems by achieving the optimal balance between air volume and air velocity. Not only does this balance make the air curtain more efficient, but it also provides other advantages such as a comfortable indoor climate with less noise and turbulence. Energy costs are reduced at the same time.

There are different theories on this subject, but supported by our tests, we maintain that we have found the balance that provides optimal efficiency combined with low energy consumption. High velocities require a lot of energy to build up the necessary pressure. Large air volumes also require a lot of energy.

Impulse and air velocity are important factors when talking about air curtain performance. The impulse is the mass flow (air volume x density) multiplied by the velocity and it can be created in different ways. A unit with high air velocity and a small airflow can have the same impulse as a unit with low air velocity and a large airflow.

If airflow and air velocity are optimized the air curtain can perform better than units with higher impulse or higher air velocity. The air velocity profiles shown in the catalogue are based on measurements done in a laboratory environment with a hot-wire probe instrument, using recognised test methods, the figures represent peak levels.

Performance test

Frico has developed a method for testing the performance of air curtains. The test described below was carried out as a full scale test. The idea is to compare the air volume that passes through a door with and without an air curtain. The testing facility used is described in Fig. 1. The two rooms correspond to outdoor and indoor environments. There are two ducts equipped with airflow measuring devices between the two rooms. An axial fan is mounted in the end of each duct. The air curtain is installed above the opening.

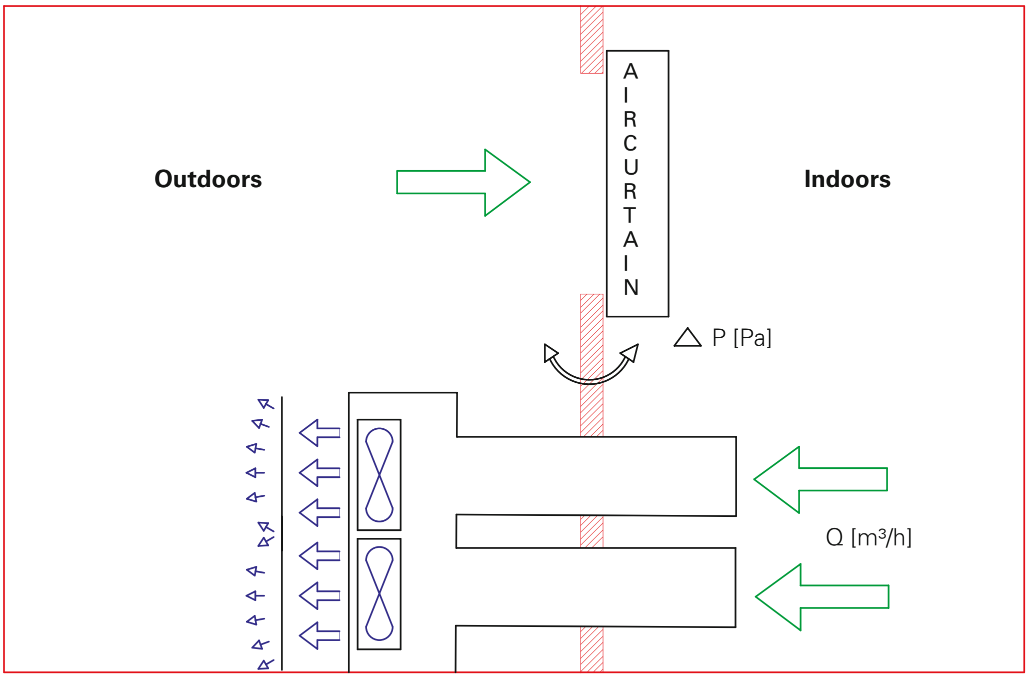


Fig. 1 Testing facility

When the fans are running airflow is created from the indoor to the outdoor environment and the exact same air volume passes through the ducts as through the opening. This creates a pressure difference ((DP) between the two rooms. The fans start at a low speed which is gradually increased. In the meantime information on airflow and pressure differences is stored in a computer. A curve is created from the data and this is shown in Fig. 2 below. The opening is measured with and without an air curtain. The result is two curves on which the airflow at a certain pressure difference can be compared.

Example: At 3 Pa the airflow through the opening without an air curtain is 4 m^3/s and 1,6 m^3/s with an air curtain. The difference in airflow shows the efficiency of the air curtain. In this case there is (4-1,6)/4*100 = 60% less flow with an air curtain than without.

This makes it possible to compare the performance of different products under the same circumstances. Fig. 3 shows the result of tests of units constructed on different principles. Type 1 has high air velocity and small airflow, type 2 has medium air velocity, a large airflow and a Thermozone with optimized air velocity and airflow. The Thermozone is more efficient than the type 2 unit even though it has 13% lower impulse.

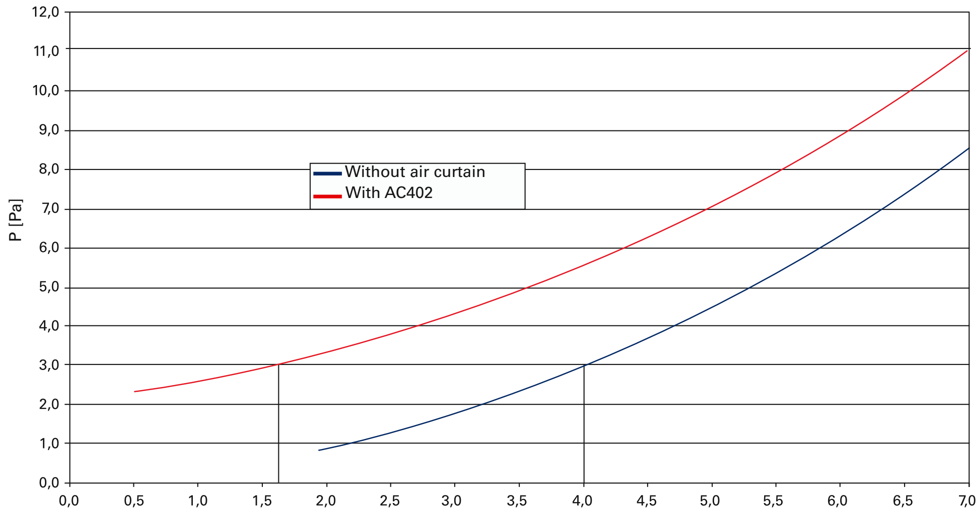


Fig. 2. Airflow through the opening, with and without air curtain at different pressures

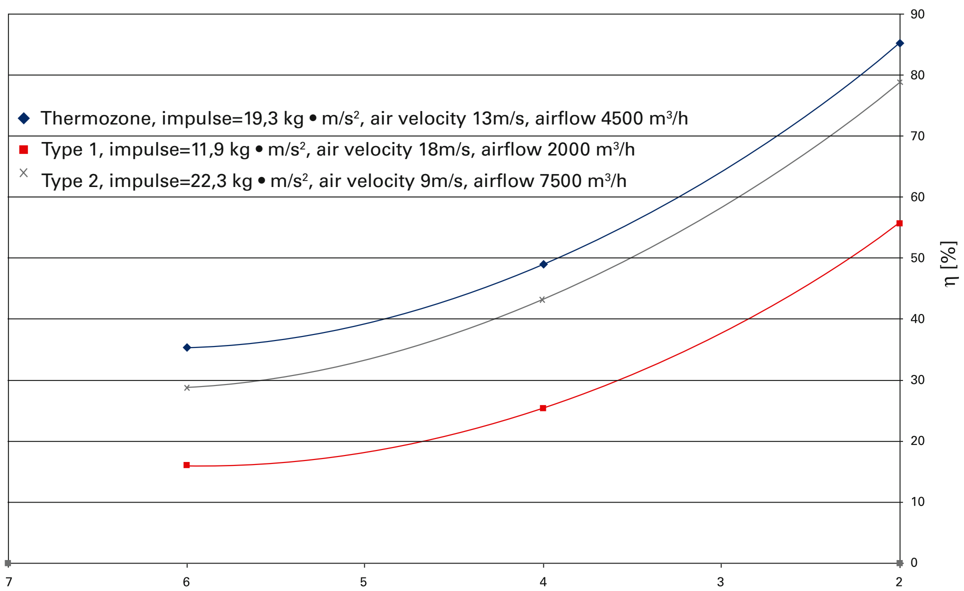


Fig. 3. Air curtains mounted on 3 metres height, efficiency at different pressures

Sound

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.

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

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), where the threshold of hearing is 0 dB and the threshold of pain 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 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).

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.

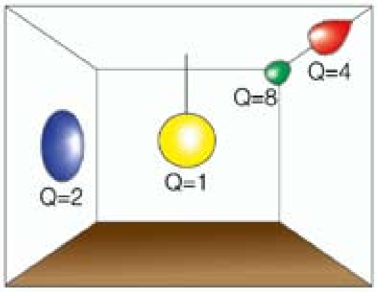
2. Distance from sound source

   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 m^2. 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.



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