

FIRST EDITION



 **EUROVENT**

---

# AIR CURTAINS GUIDEBOOK

MARCH 2016

[www.eurovent.eu](http://www.eurovent.eu)

# TABLE OF CONTENTS

## 1. INTRODUCTION

1.1	Background	4
1.2	Purpose of this report	4
1.3	What is an air curtain?	5
1.4	What are the key benefits of using an air curtain?	6

## 2. APPLICATIONS

2.1	Commercial/Comfort	7
2.2	Industrial	9
2.3	Cold storage	10
2.4	Specialist applications	11

## 3. THEORY IN BRIEF

3.1	Heat losses	12
3.1.1	Mechanical ventilation	12
3.1.2	Natural ventilation	12
3.1.3	Natural convection	13
3.2	Energy use and expenditure	13

## 4. OPTIONS

4.1	Types of air curtains	14
4.1.1	Recirculating	14
4.1.2	Non-recirculating	15



4.2	Airflow properties	15
4.2.1	Generation of the air stream	16
4.2.2	Air volume control	16
4.3	Supply air treatment	16
4.3.1	Electric heating	17
4.3.2	Hydronic coil	17
4.3.3	Direct expansion heat pump coil	18
4.3.4	Indirect and direct gas fired	19
4.3.5	Hybrid	19
4.4	Control Options	20
4.5	Filtering	20

## 5. SELECTION, INSTALLATION AND MAINTENANCE

5.1	Site assessment and Air Curtain Units Installation	22
5.2	Air curtain installation 'Quick Check'	24
5.2.1	How far away is the air curtain from the door horizontally?	24
5.2.2	How far away is the air curtain from the door vertically?	25
5.2.3	Does the air curtain cover the entire width of the door opening?	26
5.3	Air curtain maintenance	26

## 6. EUROPE'S AIR CURTAIN INDUSTRY



# 1. INTRODUCTION

## 1.1 BACKGROUND

In 2012<sup>1</sup> the European Union consumed 17% of global energy demand with the building sector (residential, commercial and government buildings) accounting for 61%<sup>2</sup> of primary energy consumption. The most significant usage of energy within buildings are applications used for space heating and space cooling (39%), water heating (12%), and lighting (12%) which equates to 63% of total building energy consumption. In commercial buildings, air infiltration as a result of the unintentional introduction of outside air into the building through cracks in the building envelope and across entrances, can account for up to 18% of total building heat losses. By using appropriately designed air curtain technologies in all non-residential buildings it is possible to make significant reductions in the demand of energy from buildings for heating and cooling applications; particularly in the case of retail stores, supermarkets, hospitals, airports and many more buildings with frequently opening doors. Conservative estimates made by Eurovent, based on its extensive experience of the market and the technology, have concluded that a potential EU28 energy saving of up to 7,824 GWh per year could be made by specifying the use of appropriately designed air curtains across all of the non-residential buildings in each member state<sup>4</sup>. To put that figure into context, it equates to eliminating the need for the electrical power produced by 1.3 nuclear power stations.<sup>1</sup>

## 1.2 PURPOSE OF THIS REPORT

The information presented in this report has been designed to inform decision-makers at all levels about the benefits associated with using air curtain solutions. It identifies typical applications where this technology can be used and guides the reader through the process of selecting, installing and maintaining an appropriate, safe and efficient system for the end user.

---

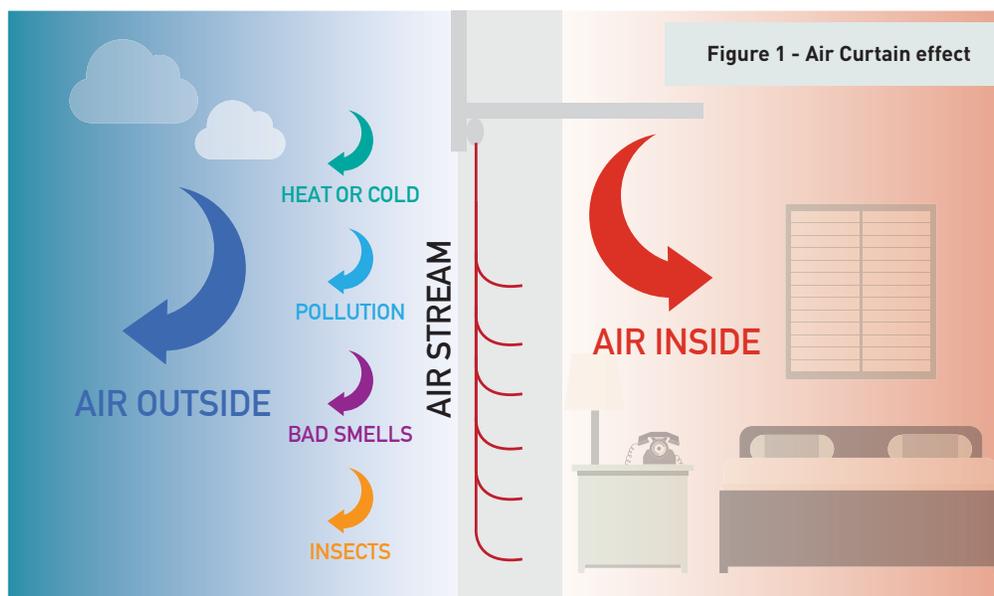
SEE BACKPAGE FOR FULL LIST OF SOURCES



## 1.3 WHAT IS AN AIR CURTAIN?

An air curtain is a product which creates a uniform stream of directed air, whether heated or unheated, across an opening to create a barrier inhibiting the transfer of heat and particulate matter from one zone to the other. An appropriately designed system will create this barrier across the entire height and width of the opening to create the effects shown in Figure 1.

There is a clear distinction between an air curtain and an over door heater, which is a small electric or water heated fan unit with a low volumetric air flow rate. Over door heaters are intended to be installed above doorways with a low pedestrian footfall where the door is mainly closed (as in small speciality shops for example). They are useful in conditioning air entering a space to prevent the discomfort caused by drafts. However, they are not designed to perform the same task as an air curtain and should not be seen as a less expensive alternative.



# 1. INTRODUCTION

## 1.4 WHAT ARE THE KEY BENEFITS OF USING AN AIR CURTAIN?

### **SIGNIFICANT ENERGY SAVINGS**

The correct use of an air curtain solution can lead to significant savings in terms of building energy usage, running costs, carbon footprint and environmental impact. It does so by reducing the amount of energy required to maintain a difference in temperature between two zones: either zones inside the building or between the building and the outside world.

### **IMPROVED INDOOR AIR QUALITY**

The ability of an air curtain to create a non-obstructive stream of air preventing the ingress of particulates, dirt and dust across an open entry substantially improves the quality of the air within the building. This improves comfort and health, particularly in industrial areas and polluted city centres.

### **INCREASED BUILDING PERFORMANCE**

The flexibility available for combining air curtain solutions with a building's existing heating and cooling system allows for a more complete control of overall building energy consumption.

### **ENHANCED SAFETY**

In cold storage applications an air curtain supplying a transparent stream of air across the exit of an open door freezer has an obvious advantage over the alternative thick non-transparent plastic strips. The latter can lead to work place accidents as a result of limited visibility into and out of the space.



Air Curtains are most commonly used for commercial, industrial and refrigeration environments, although their use is not limited to these applications. The usage of this technology varies depending on application but on the whole the concept is similar throughout. The creation of a comfort controlled, non-obstructive barrier into a building (Figure 2) by deliberately regulating four variables: air speed, air temperature, the direction of discharge and noise levels. Figure 2 shows the boundary between a heated space and an unheated space both with (left) and without (right) an air curtain.

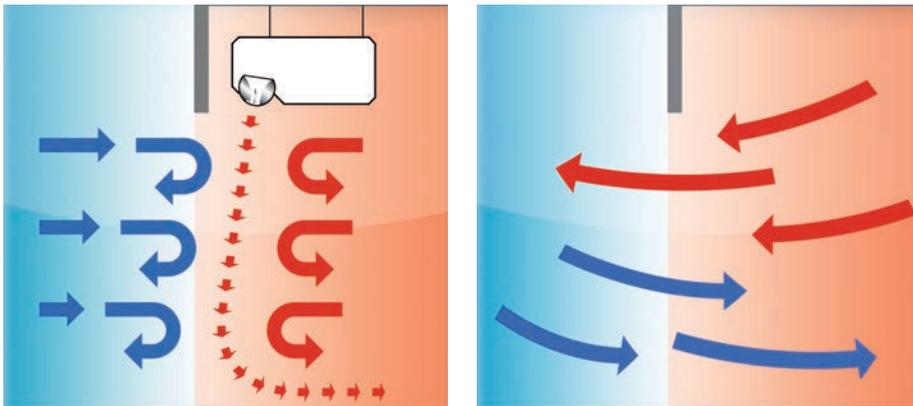


Figure 2 - Air flow across a boundary between a heated space (red) and an unheated space (blue) both with and without an Air Curtain (left and right, respectively)

### 2.1 COMMERCIAL/COMFORT

An 'open door' policy designed to reduce the physical barriers to entry for customers, preferred by high street retailers (shops, banks etc.), is a driving force in the specification of air curtains in the commercial market. In an attempt to increase footfall into their premises, store managers attempt to create an entrance as inviting, unobstructive and comfortable as possible. There are a range of options available for achieving this goal including: single overdoor air curtains (Figure 3), multiple horizontal or vertical units (Figures 4a and 4b), and air curtains concealed within the ceiling (Figure 5).

## 2. APPLICATIONS



Figure 3 - Overdoor air curtain

A photograph showing the entrance of a retail store with a large glass door. A long, horizontal air curtain is installed above the door, extending across the width of the entrance. The store's interior is visible through the glass, and a mannequin is seen on the right side of the frame.



Figure 4a - Modular overdoor

A photograph of a modern building entrance featuring a modular overdoor system. The system consists of several rectangular panels that form a protective barrier over the glass entrance doors. People are walking through the entrance, and the interior of the building is visible.



Figure 4b - Vertical air curtains

A photograph showing a glass entrance door with two vertical air curtains. The curtains are tall and narrow, positioned on either side of the door. The interior of the building is visible through the glass.



Figure 5 - Concealed air curtains

A photograph of a glass entrance door for a store named 'Foot Locker'. The air curtains are concealed within the door frame, making them barely visible. People are walking through the entrance, and the store's interior is visible through the glass.



## 2.2 INDUSTRIAL

Within the industrial sector the main driving forces for the specification of air curtain solutions are a result of the production and transportation process involved. These generally require large openings in the building envelope which expose the indoor climate to the prevailing conditions for extended periods of time (Figures 6a and 6b). In this environment it is clearly advantageous to protect the internal (working environment) from the external conditions to preserve comfort for staff and reduce the ingress of dirt and other particulates.



Figure 6a - Single industrial air curtains



Figure 6b - Multiple industrial air curtains



## 2. APPLICATIONS

### 2.3 COLD STORAGE

For cold storage applications the concept is the inverse of the previous examples. In these applications, instead of using an air curtain solution to prevent heat losses from an area, the function this time is to create a non-obstructive barrier which limits heat gains to an area. In these installations the air curtain is placed on the exterior of the cold space and creates a barrier of air to prevent warm air entering the refrigerated space and cooler air from escaping. The main advantages of this solution are that the energy requirements in both zones are reduced and the visibility between the zones is increased (Figure 7).



Figure 7 - Cold Storage Air Curtain



## 2.4 SPECIALIST APPLICATIONS

The scope of air curtain solutions is always expanding. The flexibility of the technology and its applications means that these solutions can be extended to include a range of specialist and customised solutions to reduce the nuisance caused by dust and other waste material. These applications require a significant amount of design expertise. The use of a knowledgeable manufacturer is an essential part of acquiring an appropriate system.

Figure 8 is an example of an industrial air curtain application. Mechanical incineration plants or mechanical biological waste treatment for waste disposal have large delivery doors which need to limit the emission of pollutants to permissible levels.



Figure 8 - Industrial Air Curtain



# 3. THEORY IN BRIEF

## 3.1 HEAT LOSSES

There are three main mechanisms through which heat is lost across an opening in a building envelope: losses through mechanical ventilation, losses through natural ventilation and losses caused by natural convection. Each of these mechanisms is briefly described in the following subsections.

### 3.1.1 MECHANICAL VENTILATION

In using a mechanical ventilation system, the interior of a building, or a region within a building, can be pressurised in three separate conditions: positively pressurised, negatively pressurised or non-pressurised (with no pressure differential between zones). These variations in pressure difference across an opening between zone can be a result of poorly balanced ventilation system, ineffective controls or in some cases of a deliberate design decision. Air curtain solutions can work in all of these scenarios (within reason). Yet, they are most effective when the pressure differential across the air stream is zero.

### 3.1.2 NATURAL VENTILATION

Buildings are not completely airtight. Openings in a building like doors, windows and cracks will naturally allow hot air to escape and colder air will enter the building to replace it. This natural ventilation mechanism can be exacerbated by the prevailing wind conditions and direction, relative to the openings. The use of an air curtain in this scenario can reduce the effects of heat loss as a result of wind-driven natural ventilation.



### 3.1.3 NATURAL CONVECTION

Cold air is denser than warm air, which allows hot air to rise. Across an unimpeded boundary between a heated area and a cool area, hot air will escape from the top of the opening. This process will naturally allow colder air to enter the heated space close to ground level, which is known as natural convection. Under these conditions an air curtain can limit the exchange of air between the two zones by creating a barrier to impede air flow (Figure 2).

## 3.2 ENERGY USE AND EXPENDITURE

Maintaining a temperature within a region through heating or cooling has a cost. That cost can be viewed in two ways: the energy needed to attain that temperature and the associated monetary value. Figure 9 provides a visual representation of the relative costs, both energy and fiscal, of the various options provided in this document as well as the consequences of using a well optimised and a poorly optimised air curtain solution. The graph is benchmarked against an equivalent building with an open door and unimpeded air flow. It clearly identifies the impacts of using a well optimised air curtain solution for businesses operating an open door policy in terms of both energy usage and energy expenditure.

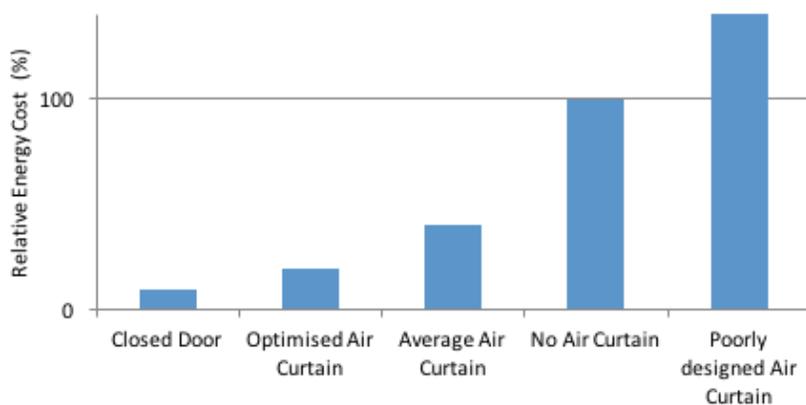


Figure 9 - Indicative cost comparison for various air curtain options base-lined against an open door



# 4. OPTIONS

## 4.1 TYPES OF AIR CURTAINS

There are two distinct classifications of air curtains: recirculating and non-recirculating air curtains.

### 4.1.1 RECIRCULATING

A recirculating air curtain (Figure 10) draws air from ductwork that primarily collects and returns air which has been discharged back to the air curtain inlet. Typical applications will often use a plenum with a return built into the floor which connects back to the inlet of the air curtain via ductwork.

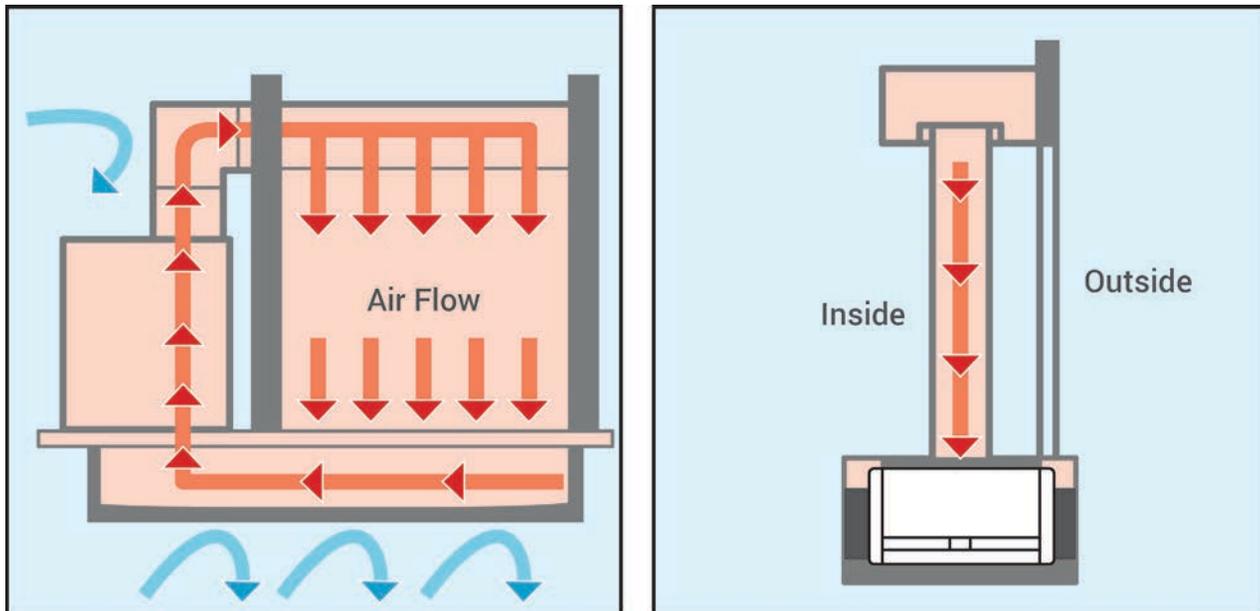


Figure 10 – Recirculating air curtains



## 4.1.2 NON-RECIRCULATING

The majority of air curtains manufactured today are classified as non-recirculating. Non-recirculating air curtains typically draw air into the unit directly from the surrounding environment. An air curtain equipped with inlet ductwork, which draws air from outside the surrounding environment, is also considered to be non-recirculating.

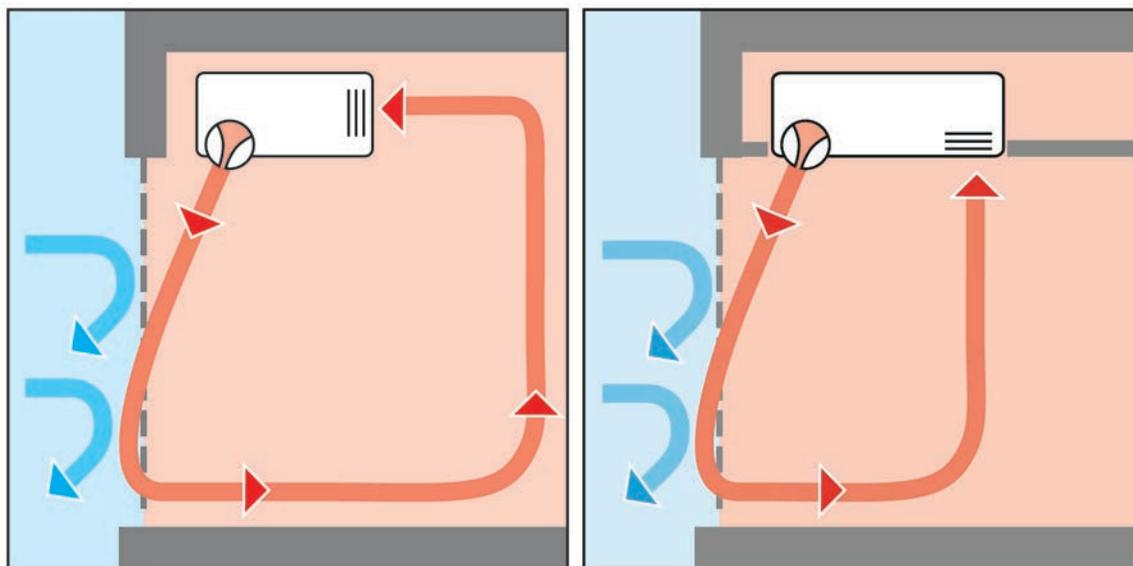


Figure 11 –  
Non-recirculating air  
curtains: open (left) and  
concealed (right)

## 4.2 AIRFLOW PROPERTIES

An air curtain consists of a fan deck assembly contained inside an enclosure with a variety of components which direct, condition and control the air flow generated.



# 4. OPTIONS

## 4.2.1 GENERATION OF THE AIR STREAM

The door opening must be completely covered by the stream of air generated by the air curtain. The larger the opening, the more power is required to generate the necessary volume of air and outlet velocity. Ideally, the stream of air produced by the air curtain will contain a limited amount of turbulence to reduce the amount of power required by the fan assembly and prevent mixing between the two zones. An air curtain can use one or more streams of air to generate this effect and a number of different elements (nozzles, vanes, rectifiers etc) can be used to direct the flow of air.

## 4.2.2 AIR VOLUME CONTROL

The airflow has to be controlled and adapted to the outdoor climate. Normally, the motor speed and air volume are controlled. However, the air speed can be kept constant and a greater airflow can be realised by increasing the air discharge opening. This control could be manually operated by the user (recommended only for smaller installations) or automatically operated by an intelligent control system.

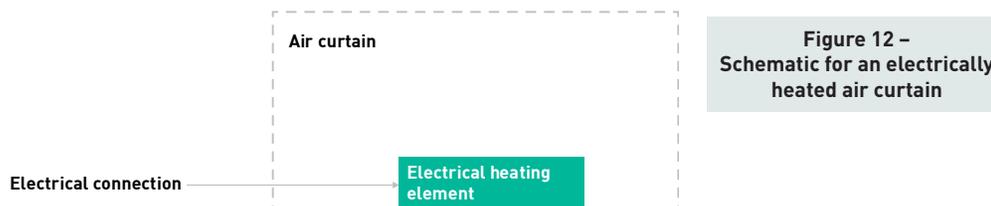
## 4.3 SUPPLY AIR TREATMENT

The airflow has to be controlled and adapted to the outdoor climate. Usually, the motor speed and air volume are controlled. Yet, the air speed can be kept constant and a greater airflow can be realised by increasing the air discharge opening. This control could be manually operated (recommended only for smaller installations) by the user or automatically operated by an intelligent control system.



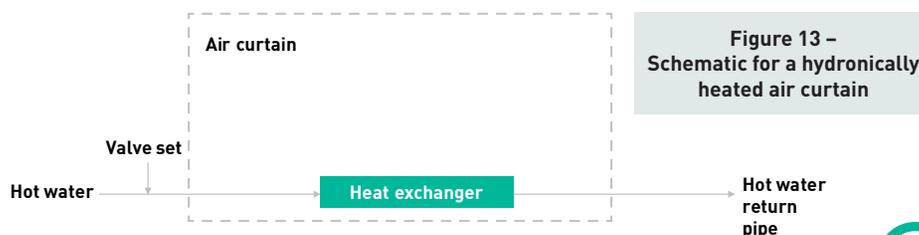
### 4.3.1 ELECTRIC HEATING

Electrically heated units are quick and easy to install compared to water heated and direct expansion units (see 4.3.3), but are more costly to operate (Figure 12). The maximum output power is also fixed for an electrically heated air curtain, which can be both an advantage and a disadvantage. It is easy to calculate the running costs for these units and they are easy to control. However, once installed it is not easy to increase the output if the power from the selected unit is not sufficient to maintain the desired comfort level.



### 4.3.2 HIDRONIC COIL

Air curtains with an integrated hydronic coil as a heat exchanger can be seen as the direct opposite of electric heated units in terms of easy installation, running costs and flexible output power (Figure 13). To supply the coil with hot/cold water or steam, there must be an external power source such as, for example, a local boiler or district heating/cooling. This means that if the building lacks an existing and suitable water heating and distribution (piping) system, the installation costs for this type of unit would be quite high. On the other hand, the running cost for a water heated unit will be significantly lower than for a similar electrical heated unit.



## 4. OPTIONS

### 4.3.3 DIRECT EXPANSION HEAT PUMP COIL

A direct expansion heat pump is a heat pump connected to the refrigerant circuit. The heat exchanger in the air curtain will work as a condenser and/or evaporator, depending if heated or chilled air is required (Figure 14). A direct expansion solution for heating or cooling applications has the advantage of lower running costs, but the defrosting cycle presents a challenge. Normally, this is solved by reversing the operation of the heat pump. In this case, however, that would result in the air curtain producing chilled air in a heated room vice versa for cold rooms.

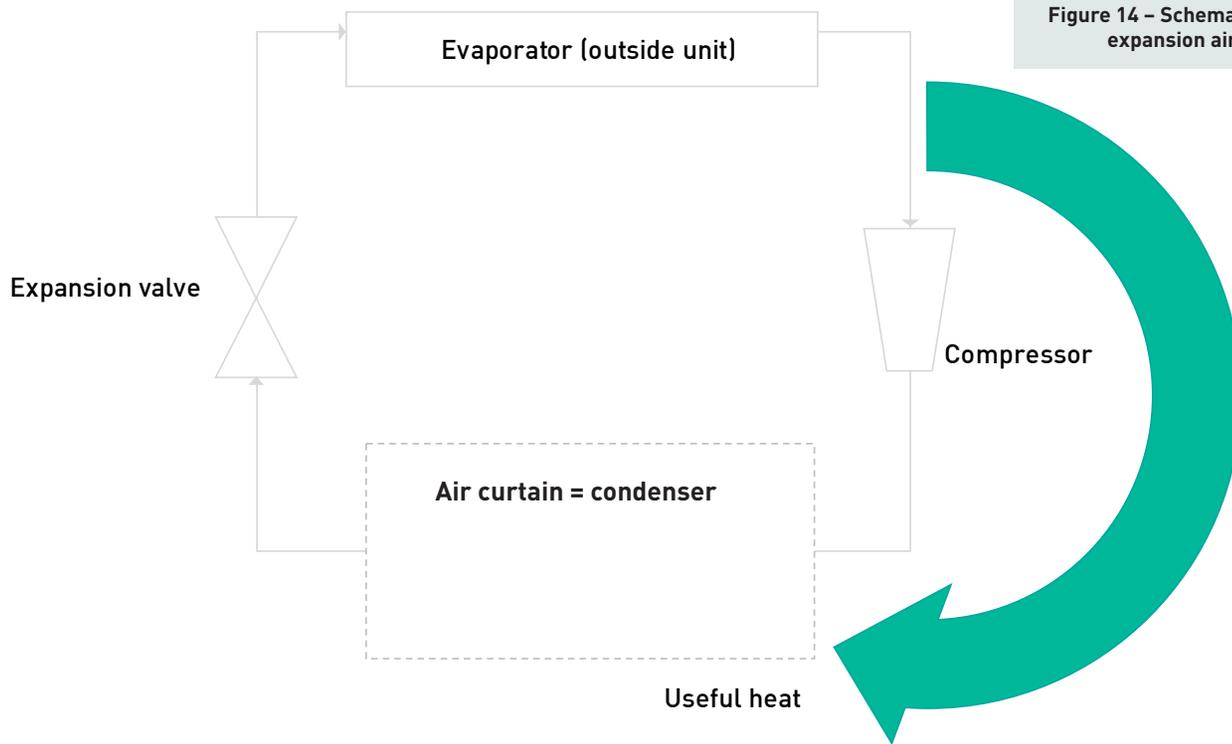
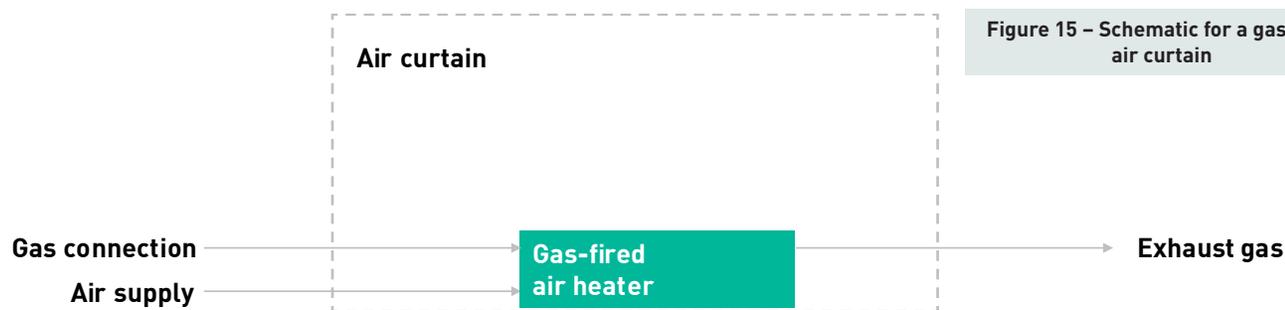


Figure 14 – Schematic for a direct expansion air curtain



### 4.3.4 INDIRECT AND DIRECT GAS FIRED

Using gas as heat source can be done in two different ways: either with burners placed directly into the airstream or indirectly with an external gas fired air-to-air heat exchanger. Indirect gas fired air curtains have a lower energy efficiency compared to the direct fired alternatives. Both of these heating types are best suited for industrial and heavy commercial applications.



### 4.3.5 HYBRID

Hybrid heating means that the main heating, which is based on a water coil using central heating water, is supplemented by an electrical heating element. Hybrid heating is, in particular, a solution when the available supply water temperature from the boiler is not high enough. The electrical element will compensate for the missing energy so that the required discharge temperature will be reached.



# 4. OPTIONS

## 4.4 CONTROL OPTIONS

A control system for the regulation of the discharged air is essential for the efficient operation of an air curtain. There are a number of control options available, but at the very least an air curtain should be able to regulate air speed and, if the air curtain is capable of conditioning the jet of air, the level of heat/cooling available. By regulating those parameters, energy can be saved and the overall energy efficiency of the unit is increased. Air curtain systems can also accept zone control and linked system commands as well as receiving remote instructions from a central building management system (BMS).

Localised control can be implemented to modulate an air curtain's activity by placing various sensors in the vicinity of the opening that the air curtain screens (door contactors, proximity sensors, etc.). Using these control systems, it is possible to achieve higher levels of performance and efficiency.

## 4.5 FILTERING

The main task for an air curtain filter is to protect a water coil against contamination. Therefore, quite a coarse air curtain filter can be used to maintain the required air flow rate. However, even a coarse filter will become contaminated and must be cleaned or replaced eventually. The frequency of the cleaning depends on the environment the air curtain is installed in. In a dusty environment (like a clothes shop) the filters will need to be cleaned much more frequently than in a cleaner office style environment.

There are a range of different filter alarms available on the market to monitor this process ranging from simple timers to more advanced dynamic alarms which measure the pressure drop across the filter.

Since even a slightly contaminated filter will reduce the air flow through the unit, filters should not be used on air curtains with electrical or direct gas fired heating due to safety reasons, since the internal temperature will increase with decreasing air flow.



## ABOUT THE EUROVENT ASSOCIATION

Eurovent is Europe's Industry Association for Indoor Climate (HVAC), Process Cooling, and Food Cold Chain Technologies. Its members from throughout Europe, the Middle East and Africa represent more than 1.000 companies, the majority small and medium-sized manufacturers. Based on objective and verifiable data, these account for a combined annual turnover of more than 30bn EUR, employing around 150.000 people within the association's geographic area. This makes Eurovent one of the largest cross-regional industry committees of its kind.

The organisation's activities are based on highly valued democratic decision-making principles, ensuring a level-playing field for the entire industry independent from organisation sizes or membership fees.

Eurovent's roots date back to 1958. Over the years, the Brussels-based organisation has become a well-respected and known stakeholder that builds bridges between manufacturers it represents, associations, legislators and standardisation bodies on a national, regional and international level. While Eurovent strongly supports energy-efficient and sustainable technologies, it advocates a holistic approach that also integrates health, life and work quality as well as safety aspects. Eurovent holds in-depth relations with partner associations around the globe. It is a founding member of the ICARHMA network, supporter of REHVA, and contributor to various EU and UN initiatives.



### Head Office

Diamant Building  
80 Bd. A. Reyers Ln  
1030 Brussels  
Belgium

**Phone:** +32 466 90 04 01

**Email:** [secretariat@eurovent.eu](mailto:secretariat@eurovent.eu)

**Web:** [www.eurovent.eu](http://www.eurovent.eu)



# 5. SELECTION, INSTALLATION AND MAINTENANCE

## 5.1 SITE ASSESSMENT AND AIR CURTAIN UNITS INSTALLATION

An air curtain is usually mounted above or alongside a door or window opening. When mounted above the opening, the air curtain discharges its air vertically across the opening. When mounted alongside the opening, the air is discharged horizontally across the opening.

The benefits associated with using an air curtain will only be fully realised if the equipment is properly sized, installed, adjusted, and maintained. The checklist presented in Table 1 has been compiled to assist with this process.

Description	Check
Commercial/comfort	
Industrial application	
Cold store application	
Other application	
<b>Mounting of air curtain</b>	
Horizontal mounting	
Vertical mounting	
<b>Height and width of the open aperture of the doorway</b>	
The air curtain covers the whole opening of the doorway with a small overlap	
<b>Presence of obstruction</b>	
Yes	
No	
<b>Site geography</b>	
Strong prevailing winds	
Seasonal outdoor conditions	



<b>Building design</b>	<b>Check</b>
Unit accessible for maintenance	
Doorways located on a straight face of the building	
Doorways on a corner of the building	
Other doorways on opposite sides of the building	
Multi-storey building	
Old building	
Air Tight building	
Leaky building	
Unit installed outdoor	
Unit installed indoor	
<b>Electrical supply</b>	
Single phase power supply	
3-phase power supply	
<b>Heating and cooling medium</b>	
Electric heated	
Hydronic coil	
High grade low pressure hot water (LPHW) above 65°C water flow temperature	
Low grade low pressure hot water (LPHW) below 65°C water flow temperature	
Chilled water for cooling air curtains, low grade above 10°C flow	
Chilled water for cooling air curtains, high grade above 6/12°C flow	
Direct expansion system	
Indirect and direct gas fired	

# 5. SELECTION, INSTALLATION AND MAINTENANCE

## 5.2 AIR CURTAIN INSTALLATION 'QUICK CHECK'

The information within this section has been designed as a 'quick check' for non-technical stakeholders to confirm that their air curtains have been installed in an appropriate and functional way. These checks are not comprehensive and should not replace the manufacturer's installation instructions.

### 5.2.1 HOW FAR IS THE AIR CURTAIN FROM THE DOOR HORIZONTALLY?

An air curtain should be installed close enough to the opening to prevent heat loss from cold air entering the space or vice versa for cold room applications. As shown in Figure 16, in an ideal installation, there would be no separation horizontally between the opening and the air curtain. However, the air curtain can still be effective provided the separation is within 50 cm.

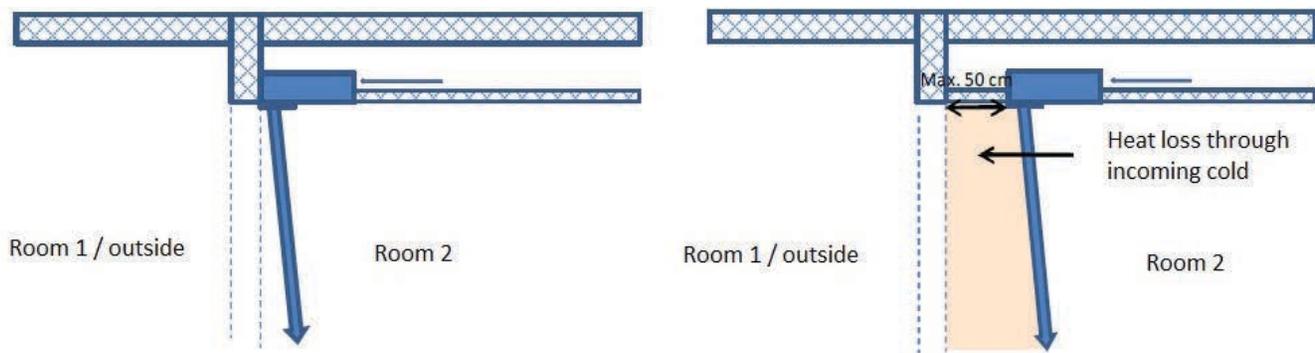


Figure 16 – Horizontal installation recommendations: ideal (left) and maximum (right)



## 5.2.2 HOW FAR AWAY IS THE AIR CURTAIN FROM THE DOOR VERTICALLY?

Ideally, the outlet of an air curtain is installed directly above the opening it is designed to protect. If an air curtain is installed too far above the opening, the result will be one of the following two outcomes: the air curtain may not be fully effective or a larger more powerful unit may be required. Both these outcomes are a consequence on the energy required to create and maintain the jet of air across the opening. As a general check, unless the additional height has been taken into consideration, a vertical separation of up to 50 cm is acceptable (Figure 17).

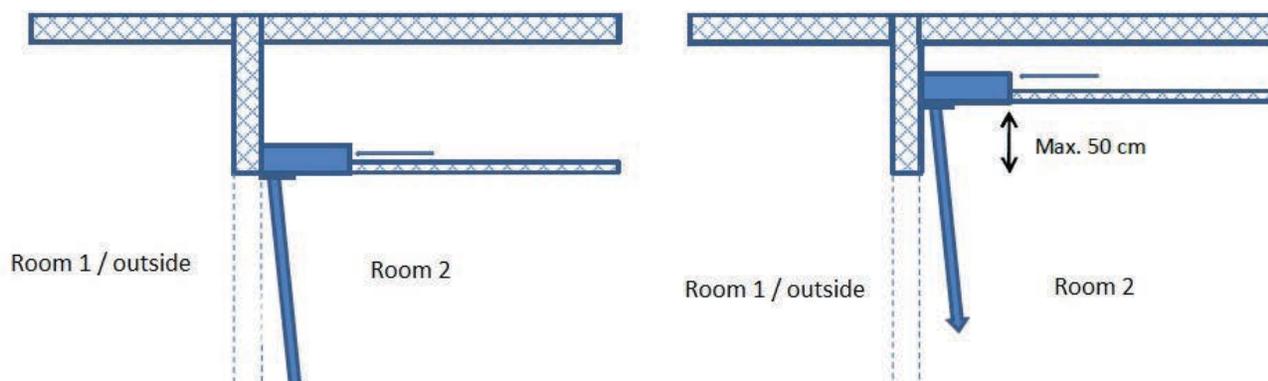


Figure 17 – Vertical installation recommendations: ideal (left) and maximum (right)



## 5. SELECTION, INSTALLATION AND MAINTENANCE

### 5.2.3 DOES THE AIR CURTAIN COVER THE ENTIRE WIDTH OF THE DOOR OPENING?

In an appropriate installation, the stream of air generated by air curtain should cover the entire opening it has been installed to protect. If the air curtain is oversized, it will use additional energy without providing any additional benefit to the consumer. If the air curtain is undersized, it cannot create an air stream large enough to fully protect the opening it has been installed above, leading to increase space heating or cooling costs as a result of infiltration.

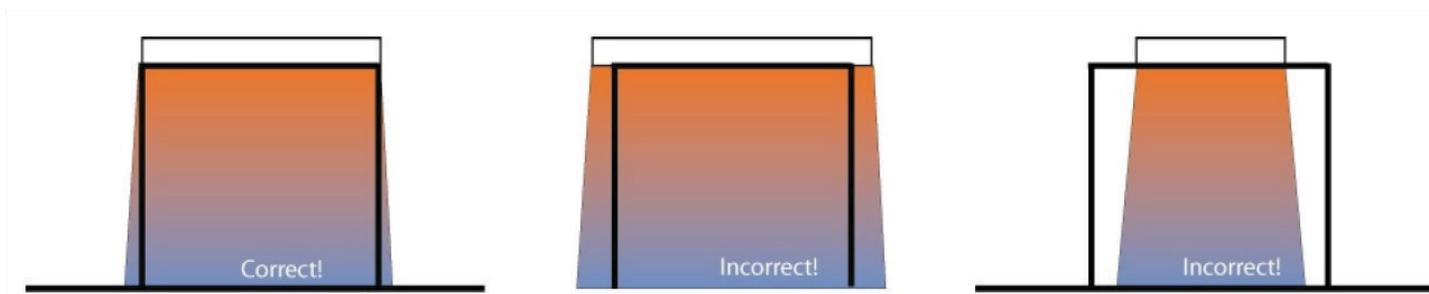


Figure 18 – Installation recommendations: correct coverage (left), oversized (middle) and undersized (right)

## 5.3 AIR CURTAIN MAINTENANCE

In order to ensure the continued high performance of any commercial, industrial or refrigeration product, a maintenance programme is essential. The recommended maintenance period can vary between manufacturer, operating environment and product type and will be outlined in the product documentation.

To facilitate the maintenance programme, a checklist, presented in Table 2, has been compiled to highlight the main components to evaluate.

## 6. EUROPE'S AIR CURTAIN INDUSTRY



Description	Check
Operation of the fan	
Electrical connections	
Grounding	
Heat exchanger (water or electric): damage	
Heat exchanger (water or electric): cleaning	
Medium connections: valves leakage	
Medium connections: heat exchanger leakage	
Inlet grille: cleaning	
Discharge grille: cleaning	
Exterior: cleaning	
Switches: check the proper operation	
Thermostats: check the proper operation	
Screw and bolt: check the connection and tighten them	
Filters: cleaning and/or replacing	

### 6. EUROPE'S AIR CURTAIN INDUSTRY

This guidebook has been developed by Europe's leading air curtain manufacturers. They produce state-of-the-art air curtains that set global standards in terms of quality, energy efficiency and indoor air quality aspects.

In order to raise awareness of their products, within the framework of the Eurovent Product Group 'European Air Curtains', a Special Project has been launched. The main members of the Eurovent Product Group 'European Air Curtains' joined the Eurovent Special Project and have developed this set of informative guidelines to raise awareness of the potential of their technologies.



## SOURCES

<sup>1</sup> Source: U.S. Energy Information Administration:  
<http://www.eia.gov/cfapps/ipdbproject/IEDIndex3.cfm?tid=2&pid=2&aid=2>

<sup>2</sup> Source: Eurostat data:  
<http://ec.europa.eu/eurostat/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=ten00094&language=en>

<sup>3</sup> European Commission: energy-efficient buildings ppp multi-annual roadmap and longer term strategy, Prepared by the Ad-hoc Industrial Advisory Group- Directorate-General for Research, Industrial Technologies 2010 Unit G2 'New generation of products':  
[http://www.ectp.org/cws/params/ectp/download\\_files/36d1191v1\\_eeb\\_roadmap.pdf](http://www.ectp.org/cws/params/ectp/download_files/36d1191v1_eeb_roadmap.pdf)

<sup>4</sup> Assumptions: 20% of infiltration losses are through entrances. Air Curtains can eliminate 50% of the infiltration losses across entrances and only 20% of non-residential building have air curtains installed

<sup>5</sup> Based on the annual output (5800 GWh) of the nuclear power station at Ringhals, Sweden  
<http://www.statensnet.dk/pligtarkiv/fremvis.pl?vaerkid=23084&repid=0&filid=58&iarkiv=1>

### Logos of participants in the European Air Curtains Special Project Group

