PROFESSION TECHNICAL

Air curtains and ventilation in buildings

Energy losses of 15 to 35% without an air curtain

Reduced energy losses

Calculated natural ventilation

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Ventilation through openings and doors has historically been underestimated but is undoubtedly the main cause of energy loss in most professional buildings. Whenever it is closed, the building "breathes" through a plethora of leak points with marked loss through the top of the building.

Two phenomena occur each time a door is opened or whenever doors are kept open:

- free convection, i.e. the flow of hot and cold air masses on top of each other. The buoyancy caused by the density variations creates this movement that pushes the hot air through the upper part of the window or door during winter while cold air comes in along the floor;
- natural or mechanical ventilation, i.e. the wind which "pushes" in the direction of the entrances, uncompensated extractions or the loss of hot air to the outside create a pressure difference between the indoor and outdoor air. This is the second main cause of cold air in winter.

In summer, the process is reversed, hot air enters through the upper part and conditioned air escapes along the floor.

> **Figure 1**

Figure 1 Movement of air through an open door.

Energy losses of 15% to 35% without an air curtain

Tertiary sector buildings (offices, public buildings and commercial buildings) are often designed for doors to remain closed. The calculation software views the door as a glass wall with the corresponding losses and a minimum air intake.

However, once these buildings are in use, the reality is entirely different as their fundamental purpose is to receive the public to the greatest extent possible. There have been many studies worldwide to quantify these losses: in late 2013, Professor Leon Wang, a member of an Ashrae technical committee, estimated that air intake through doors was responsible for 18% of a commercial building's energy. In Canada, Rick Quirouette, former chairman of the National Building Envelope Council, considered that thermal losses accounted for 15% to 35% of the annual energy cost of a commercial building. In a previous study on large premises, Jean Lannaud (AICVF & ATEE conference) pointed out that the share of thermal losses through doors may exceed the regulatory air renewal requirement. To give an example, for a 2.50 m x 2.50 m door (0°C outside – 20°C inside), convection alone is 42 kW. If the building possesses the necessary heating output, then the losses will be compensated, otherwise the indoor temperature will fall.

Figure 2 Air curtain: maintaining comfort conditions with doors open.

Reducing energy losses

An air curtain is placed at the door in order to achieve insulation through a climate barrier. All previous studies (TNO[1], Bsria, EDF) have demonstrated that the physical resistance of an air curtain is extremely low (< 1 Pa). The goal is not to stop the air draft from coming but to condition it to the indoor temperature set point. The air flow covering the entire surface of the door helps to eliminate convection and any losses through convection as a result. The ventilation or negative pressure must be treated by a heating coil. It is possible therefore to observe that an air curtain reduces losses to the outside environment by a theoretical 94% (TNO)

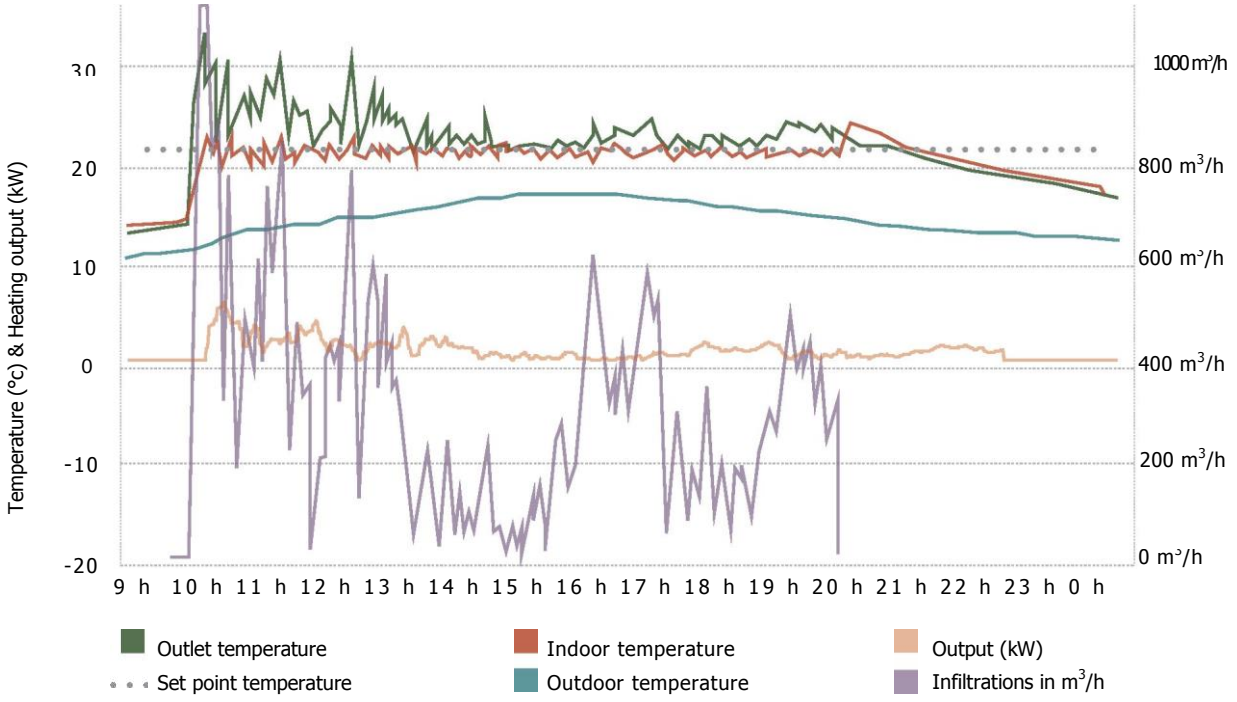

Figure 3 Example of outdoor air infiltration of a store through the doors (in purple)

and 80% in actuality. Only an automatic control can continuously guarantee these performances.

CHIPS, the Controlled Heating and Impulse Prediction System, is used to determine the precise range of the air strength by calculating the convection force. Indoor and outdoor sensors transmit the temperatures to the air curtain. The air curtain constantly calculates the convection force and adapts its blast to reach the floor. At present, certain climate barriers can also be used to continuously record the operating parameters and the surrounding climatic conditions. As a result, it is possible to monitor the performance of the curtain (attainment of the set point), record modifications to the set point, measure filter contamination, etc. The analysis software provides information on the energy savings achieved per day, per week or per month.**> Figures 2 and 3**

Natural ventilation is calculated

Precise knowledge of the output required to treat the convection and to heat the intake air volume (maintain the set point), has now made it possible to calculate the ventilation, i.e. the volume of air taken into the building in m^3/h by negative pressure. For the first time, a previously unknown factor often considered as "uncontrolled" can now be calculated and transmitted to the air curtain operator. The knowledge of the ventilation through the doors and windows can be very useful:

- to take ventilation into account in the fresh air volume to be provided;
- to understand the impact of operating events on the ventilation;
- to discuss the building configuration with the prime contractors or consultants.

Climate barriers at the entrances to buildings are now an essential insulation feature to reduce the building's energy consumption. They have also become a valuable source of information to improve understanding and control of the energy requirements. For the very first time, an air curtain is able to record and transmit information on the ventilation taken in through windows and doors, which is a key factor in optimising the building's energy use. ■

1. TNO: Dutch national research centre.