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Title: Controlled Air Flow Inlets

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INTRODUCTION

Within the EU project NATVENT, which deals with the application of natural ventilation in office type buildings, one of the items to be studied was controlled air flow inlets. Natural air supply is a key part in the design of natural ventilation in offices. In case these air supplies are designed in the wrong way one may expect complaints in terms of draft and stuffiness. Size and controls on inlets are vital elements in design. Controlled air inlets may help to overcome the problems of draft and stuffiness, and may contribute to an energy efficient design of the building.

Several types of control can be considered such as: pressure control, humidity control, pollutant control and temperature control.

AVAILABILITY

Just a few of these innovative developments are available on the European market. Especially France have produced this type of inlets already for many years. One may say that France is really on the fore front in designing as well as in the application of these product. Because of the climate the Scandinavian countries have focused on control by outside temperature. Over the last few years in the Netherlands and France a number of new developments are going on.

The difference in philosophy of the countries involved on ventilation and the way the requirements are described in the building regulations in these countries have a large influence on the design and performance of the available controlled air inlets.

Some examples may explain the situation:

- in France air inlets may not be fully closed, while in The Netherlands they must be completely closable.
- in The Netherlands the controllability of these inlets are must be between 1 and 25 Pa, where in France the control may be at about 20 Pa.

These conflicting requirements don't miss their effect on the design of the controlled inlets.

PERFORMANCES

Pressure controlled inlets

The objective of these inlets can be expressed as a constant natural supply air flow independent of wind pressure and pressure differences due to buoyancy

Big differences are found in the capacity or sizes of the inlets available on the European market. As mentioned earlier the reason for this is mainly the difference in the requirements in the building regulations. As an example for the same size of room the difference in the capacity of air inlets expressed in cm^2 is in:

- France 20 cm^2
- UK 40 cm^2
- Belgium 70 cm^2
- the Netherlands 100 cm^2

As can be seen these differences are far from negligible, up to a factor of five! The difference in response pressure is also remarkable. The pressure at which air flow rate has reached an almost constant level differs from about 1 to 20 Pa. For the normal building environment the pressure differences across air inlets normally are in the range of 0 Pa to 50 Pa.

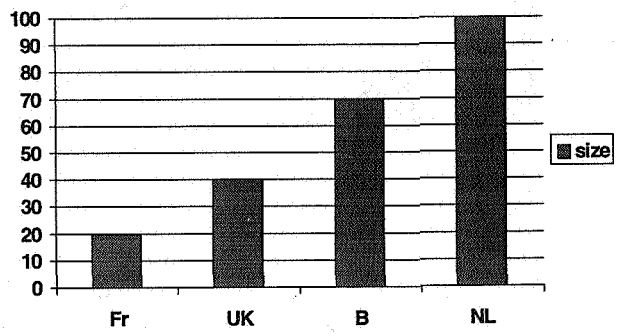


Figure 1 Relative size of inlets

The response time of the control of inlets is also quite different. Some inlets respond almost immediately while others react only after a few minutes.

Examples of passive inlets

An example of a pressure controlled inlet which acts in the way as described above can be found in figure 2.

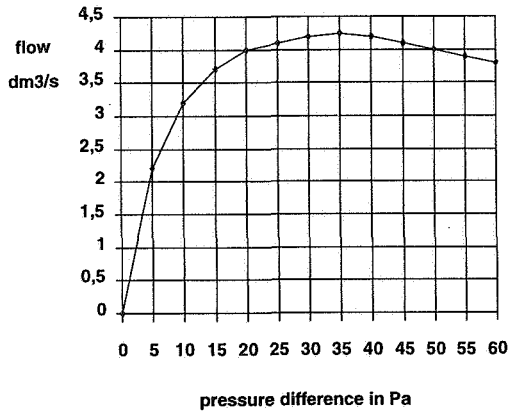


Figure 2 Characteristic of a pressure controlled inlet from France

A passive pressure controlled inlet which is developed by TNO and patented by a Dutch firm Compri is showed in figure 3.

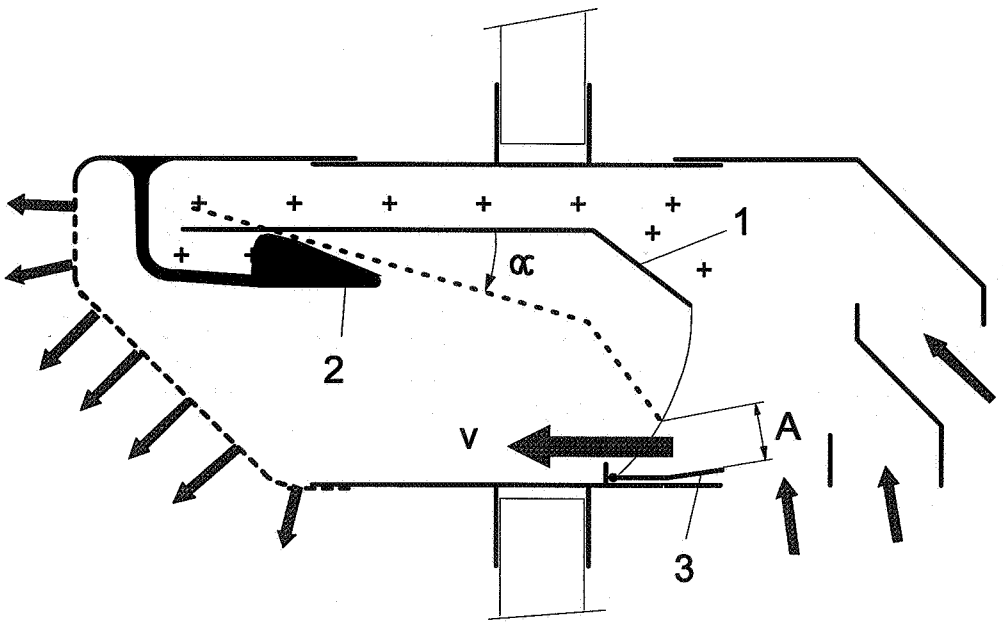


Figure 3 Cross section a passive pressure controlled inlet COMPRI IAQ

A performance curve of a pressure controlled inlet at 1 Pa can be seen in figure 7.

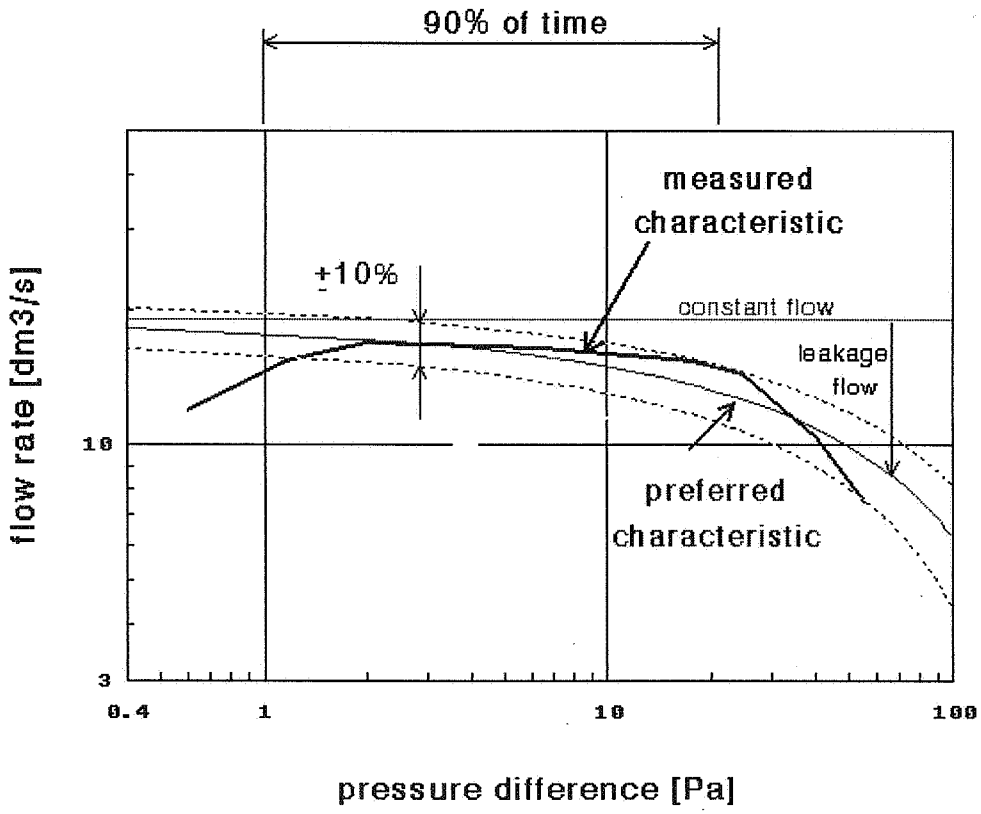
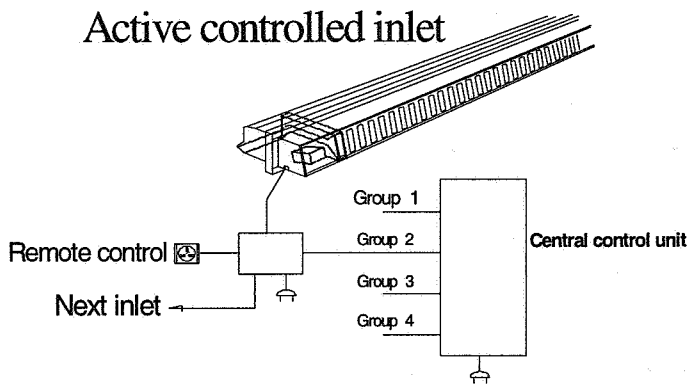


Figure 4 An example of the performance of a passive pressure controlled inlet from the Netherlands

Active inlets

There is also an active controlled air inlet on the market. In this inlet a device measures the pressure difference across it. With the help of a small motor the grid of the inlet is controlled. An example of this kind of inlet from the Netherlands is given in figure 5.



The advantage of this active type of control is of course the possible connecting with a building management system. This allows one to overrule the local control and open or close all the inlets in the building centrally.

Figure 5 An example of an active controlled air inlet

The disadvantage of this active inlets are price, about four times the passive ones and the fact that one needs electric power at each of the inlets. The performance of the active inlet can be seen in figure 6.

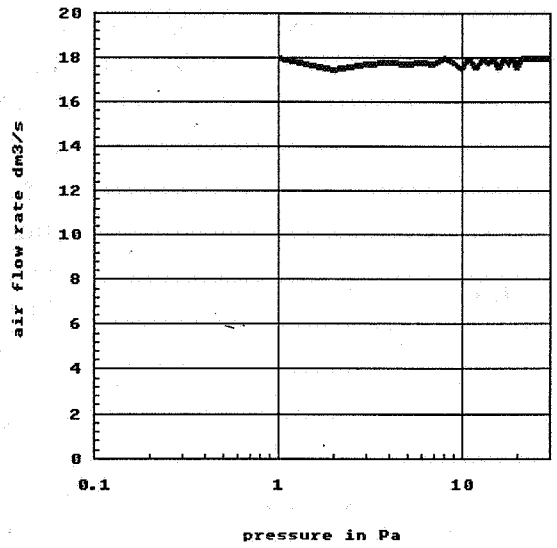


Figure 6 The performance of an active controlled inlet

Humidity controlled inlets

Most of the humidity inlets act on the relative humidity of the air. The calibration of the available inlets is quite reproducible and accurate. The principle of these type of inlets is mostly based on the change in length of a tape. An example of the characteristic of an inlets from France is given in figure 7.

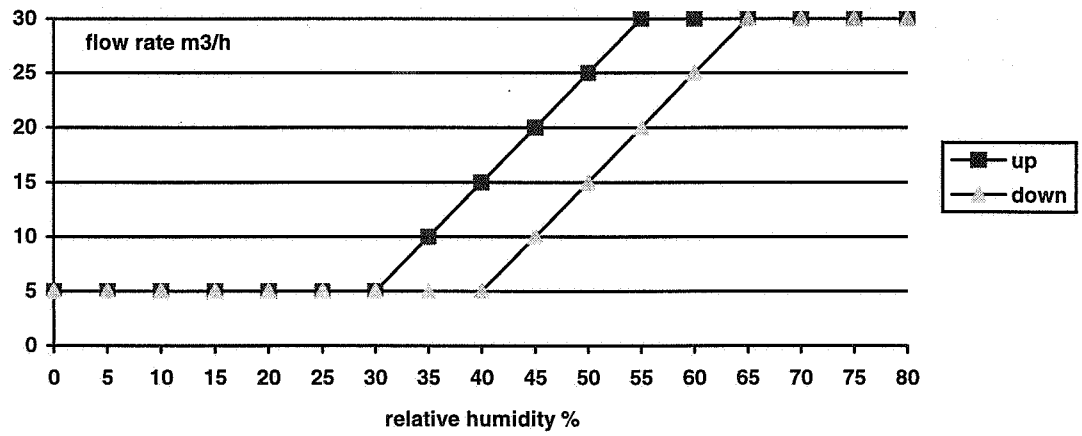


Figure 7 An example of the characteristic of an humidity controlled inlet

Pollutant controlled inlets

There are just a few pollutant controlled inlets available. In the Netherlands there is one manufacturer who claims to have a system where the pollutant level is measured with so called mixed gas sensors. The signal from this sensor can control the extract fan and the inlets with electronic controls. Calibration of the sensor seem to be a problem for which there is not yet a solution.

Temperature controlled inlets

Temperature controlled inlets are on the market in countries where the outside temperature is more dependent for the driving force for ventilation. An example of the characteristic of a temperature controlled air inlet from Sweden is given in figure 8.

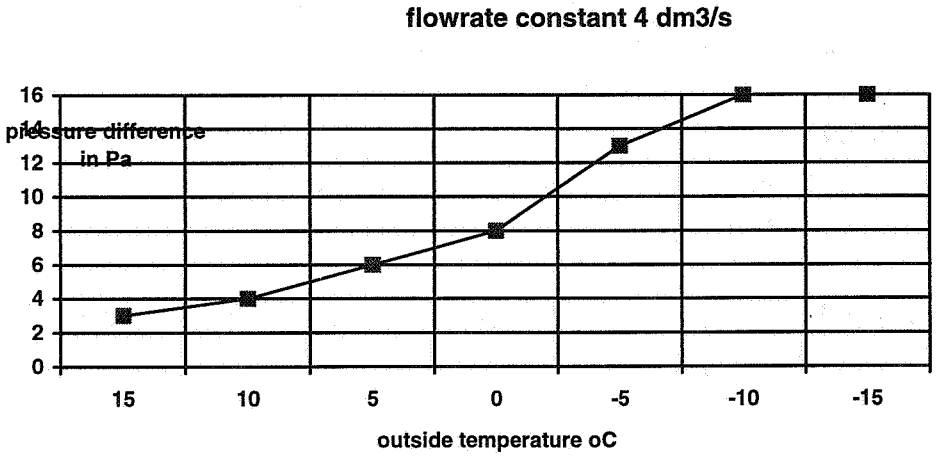


Figure 8 An example of the characteristic of a temperature controlled inlet

The lower the outside temperature the larger the pressure difference. The control of the inlet is a bi-metal sensor which by bending closes the inlet. Unclear is how these inlets are calibrated. Most of these inlets also have a considerable so called dead time and hysteresis.

APPLICATION OF CONTROLLED INLETS

General

The application of most of these controlled inlets are in dwellings. But even in dwellings there are only applied in a relative small part of the dwelling building stock. A rough estimate for the whole of Europe is less than a few percent of all dwellings have a kind of controlled inlet.

Due to the so called "green or sustainable design" of buildings a promising future market exists.

The building regulations and standards on ventilation throughout Europe don't push the application of controlled inlets.

Pressure

These inlets are applied mostly in dwellings, but in a minority of the dwelling building stock.

The application is sometimes in dwellings with indoor air quality problems. To overcome the problem people decide to try the application of pressure controlled inlets.

One of the barriers to apply them is the price of the inlets. Roughly spoken the passive inlets cost about three times a normal inlet. The application therefore will be in the more expensive dwelling types.

Again price is a barrier because the price of these active inlets is ten times that of a normal one. Nevertheless the future looks very optimistic. In a number of plans at the moment architects are considering the application of pressure controlled inlets.

A potential market are offices where comfort and energy savings are the driving factors.

Some people claim that in comparison with a full mechanical system, the system with pressure controlled inlets and mechanical extraction is about one third of the cost of a full mechanical system.

Humidity and/or moisture

The application is mostly in the so called wet rooms in dwellings. In France an enormous amount of these inlets are applied in apartments. The moisture removal and control can be considered as good.

But in most rooms in buildings moisture or humidity is not the determining pollutant.

In the case of an office type building the application may not be obvious.

Pollutants

Pollutant controlled inlets are rarely available on the market. Nevertheless it is good to realise that pollutant controlled ventilation is applied in several types of buildings, such as schools, theatres, shopping malls, congress halls, parking lots etc.

CO_2 , CO and smoke control is mostly applied. This application is normally focusing on the control of the extract. In some cases the principle of a non selective sensor is applied. If these sensors will be more selective and sensitive, the possibilities of inlet control will have new chances.

Temperature

Although the application up till now is not very widely spread, the opportunities in the colder climates are quite good. The price normally is not a barrier. In relation to the prevention of draft problems and energy savings a wider application is possible in climates where thermal buoyancy is the dominant driving force. So in colder climates and high rise buildings the application of temperature controlled inlets are feasible. A good marketing and promotion plan is a necessity.

CONTROLLED INLETS IN VENTILATION SYSTEMS

General

Controlled inlets can be integrated with all types of ventilation systems. The application with passive extract is of course from the standpoint of promoting natural ventilation the most obvious one. The integration in a system with cross ventilation is however also possible. Relatively easily is the integration with mechanical exhaust systems. In cases the natural driving force is failing the mechanical extract system guaranties the minimum required flow through the building. The distribution may not be right but the flow at least is guarantied.

In studying the integration the following aspect can play an important role:

- indoor climate, mainly the prevention of draft problems,
- indoor air quality, mainly related to CO_2 levels,

- energy savings, mainly due to a better control

Indoor climate

Controlled air inlets have a big advantage above normal inlets. Because of the control on the flow rate the velocity of the jet entering the room normally will be under control even at high wind velocities. Inlets with fixed openings must be controlled manually by the occupant when the wind velocities increase to a level at which draft may occur. The most common reaction by people is to close the inlet instead of switching it to another control position. Fixed inlets therefore causes more draft problems then pressure controlled inlets.

A normal inlet with a fixed but controllable opening needs more occupant interaction which normally don't take place. Hence a part of the time the office is occupied the flow rate will be to high and unnecessary energy losses due to ventilation will occur.

Indoor air quality

A multi-zone model study carried out in the Netherlands shows the effect of pressure controlled inlets in combination with central mechanical exhaust at design level in an office under average weather conditions.

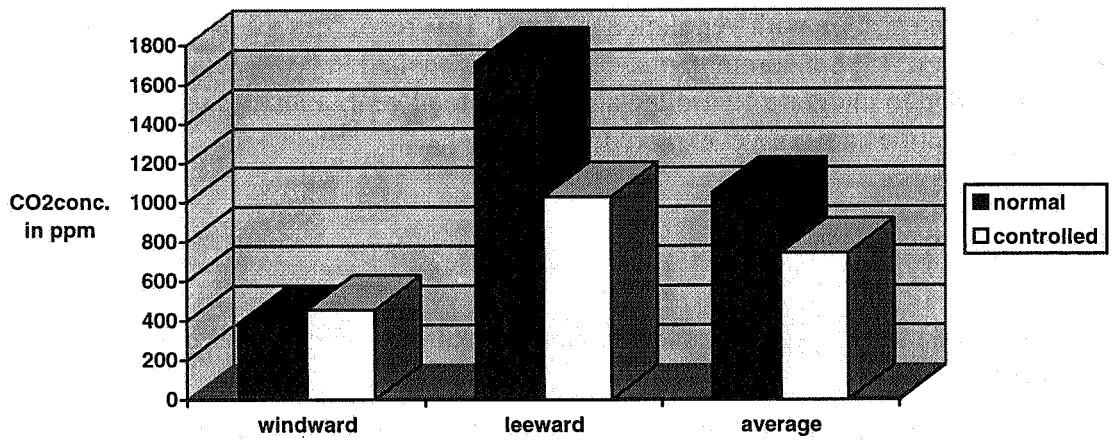


Figure 9 Increase of CO_2 concentrations above the outside level in office rooms with normal and controlled inlets in combination with mechanical exhaust.

The results given in the figure above are results under average weather conditions! The normal inlets are simulated to be controlled by the occupant in an almost perfect way. Both temperature differences and wind speed effects the position of the inlet.

It can be clearly seen that the pressure controlled inlets have a significant improvement on the CO_2 concentrations on the leeward sided office rooms.

IMPROVEMENTS IN CONTROLLED INLETS

Although the available controlled inlets can already be applied more widely than up till nowadays a number of improvements can be foreseen.

The most important ones are listed below:

- presence control
- interaction with building energy management systems
- sound attenuation
- air cleaning or filtering
- development of controlled inlets for ducted systems
- better integration in ventilation systems.

With regard to presence control simple technical solutions like infra red sensors can be easily applied to the already existing inlets. This option is important to decrease the ventilation heat. Interaction with building energy management systems is important because these systems can overrule local control if necessary. This can be of importance for energy as well as for safety for instance in case of fire or other hazard.

Natural inlets are is sometimes not applied because of high outdoor traffic noise levels. The barrier of noise can be taken in most situations with sound attenuation. Sound attenuated air inlets air widely available. It may be a good improvement on controlled inlets. Special attention is needed for ideas on controlled inlets for ducted systems.

In case of heat recovery a ducted system is necessary. A combination of the two leads to very energy efficient ventilation systems.

The last item is integration with ventilation systems. This report describes a number of solutions which are still not common practice but only applied in the special cases. More attention is needed to integrate controlled air inlets in total ventilation system design. A number of possibilities are not yet explored.

CONCLUSIONS

Controlled air inlets are available on the market but mainly applied up till now on dwelling type buildings.

The size and dimensions vary enormous because of local requirements throughout Europe.

Several types of control are available : pressure control, humidity control, pollutant control and temperature control.

As it stands now pressure controlled and temperature controlled inlets seems to have the most practical chances to be applied more in office type of buildings.

The performance of the controlled inlets are not always of that level that application in offices is obvious.

Some of the pressure controlled inlets are however very promising in terms of indoor air quality, comfort and energy.

Price is still a barrier to the wide application of these inlets.

Pressure controlled inlets improve the ventilation of offices. Controlled inlets can give significant better indoor air quality, better comfort and at the same time a lower energy use for ventilation.

A number of possible features as improvements on the existing ones can be easily foreseen.

The most important however is a better promotion of the lately developed controlled inlets. The products are there, the market is there, but the application still is far behind.

Demonstration project to show the real world that these inlets are vital parts of natural ventilation systems are necessary.

References

[1] B. Knoll
AIVC Technote 35, Advanced ventilation systems
AIVC
Warwick
March 1992

[2] W.F. de Gids
Controlled air flow inlets
NATVENT report Workpackage 3, activity 2
Delft
August 1997