Lower energy consumption requires lower air pressure

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The HVAC systems of the future must use less energy – much less. However, most Demand Controlled Ventilation (DCV) systems are currently constructed in such a way that the fan has to produce a higher pressure than is actually needed by the users. Lindab has an interesting solution to this problem.

The output of a fan in a ventilation system can be calculated by a simple formula:

Output (W) = Airflow (m³/s) x Pressure (Pa)

The output over time plus the efficiency gives the fan's energy consumption, and if this is to be reduced, the pressure and/or the airflow must consequently be reduced.

The necessary airflow depends directly on the requirements on air quality and temperature in the ventilated rooms, so therefore the airflow cannot be reduced significantly. The system must supply the airflow required to maintain a good interior climate.

So, if the world's ventilation systems are to use much less energy in future, the air pressure must be reduced as much as possible – but in reality, we are almost doing the opposite.

The problem is the pressure control

Today most Demand Controlled Ventilation (DCV) systems are currently constructed so that the air pressure from the fan gradually declines during its passage through the duct network. This is done with the aid of pressure-adjustment dampers designed to prevent annoying noise for the consumers. However, this type of pressure control creates at least as many problems as it solves.

In the first place because the incorporation of numerous dampers also has the undesired effect that the fan must produce a greater pressure than is actually needed by the users. This extra air pressure is lost in the process of the pressure control.

In other words, a significant part of the fan's energy consumption is due to the system's design – not the user's needs. In addition, stepwise pressure control makes the systems more expensive to buy, install and balance. It is also more difficult to optimise their energy and retrofit the building when required.

The solution to these problems is in principle simple: remove the large number of dampers so that the duct network is completely open and instead reduce the fan's maximum air pressure in the rooms where the air is to be used. In this way, the job can be done with much lower energy consumption.

Until a few years ago, the big challenge was to assure full pressure control over the users heads without generating noise. But there is now a solution, and it is likely to have a major effect on how ventilation systems will be designed in future.

Patented MBBV damper halves energy consumption

In 2012, Lindab Indoor Climate Solutions launched the "Pascal" system, which can reduce the full pressure from the fan in each room as needed, even in large buildings. The system is based on a patented plenum box with a MBBV damper that can silently control the air pressure up to 200 pa precisely behind the diffuser in each room.

"MBBV was a major breakthrough. It meant that we could eliminate all forms of pressure control in the duct network in one fell swoop. Completely open ducts produce far less resistance, and the fan no longer needs to produce a greater pressure than needed. That partly explains why the fan in a Pascal system typically uses 50% less energy than corresponding pressure-controlled ventilation systems. Another advantage is that the system is easy to clean and maintain," says Göran Hultmark, R&D Manager at Lindab Indoor Climate Solutions and associate professor at SBI/Aalborg University.

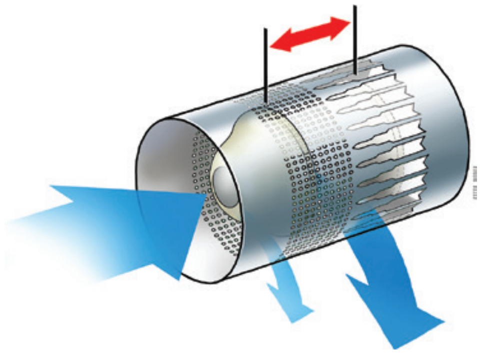
Room with greatest need controls the fan

Each room in a "Pascal" system acts as an autonomous unit. A temperature sensor incorporated in the diffuser or placed on a wall controls how open the MBBV damper is. Separate PIR or CO_2 sensors may also be added as required.

The pressure distribution system is constantly sending data from each room to a system controller about the temperature and the movements of the MBBV damper. The room with the greatest pressure requirement – i.e. where the damper is most fully open – determines the fan's speed. The system controller simultaneously evaluates the status of the other dampers and controls the airflow to assure the maximum energy saving.

"If five people sit in separate offices next to an empty meeting room, the need for cooling and ventilation is quite different than if they were together in the meeting room and their offices were empty. These kinds of changes occur all the time, and the "Pascal" system adapts itself automatically. The main principle is that it's always the most open damper that controls the fan speed. So, there is always just enough pressure in the system to reach the room with the greatest requirement, and the fan's speed and energy consumption are kept as low as possible," says Jesper Laursen, Product Manager at Lindab Indoor Climate Solutions.

In a "Pascal" system, the room whose damper is most fully open controls the fan. The air pressure and energy consumption are consequently always kept to a minimum.



The heart of the "Pascal" system: Lindab's patented MBBV damper allows the system to operate with completely open ducts and full air pressure in each room. An internal cone damper is moved back and forth in a tube perforated by holes of various sizes with the aid of a motor. By coordinating the movements of the cone damper with changes in air pressure, a linear pressure drop is produced that generates almost no noise.

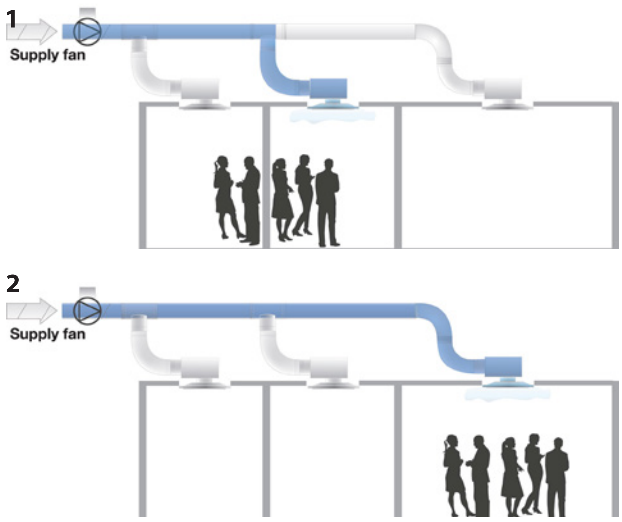
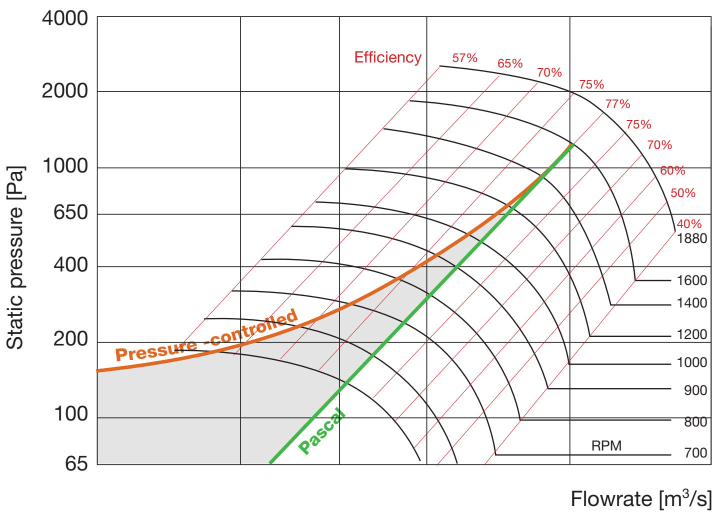


Illustration of two different situations where the number of people in each room determines which room has the greatest need and hence controls the fan.

MBBV is a plenum box with integrated volume flow regulator used for the DCV regulation of air supply diffusers. The MBBV is equipped with a unique linear cone damper technology which makes it possible to adjust in the full operational area 0–100% up to 200 pa with a low sound level. The built-in DCV actuator is delivered pre-programmed with a damper characteristic and makes the VAV adjustment very accurate and reliable in combination with a stable flow measurement over the damper.

In the "Pascal" system MBBV is controlled by a room controller where all settings are to be made after installation. This means that no factory settings or specific room labelling is needed for MBBV.



Lower efficiency loss: As the fan speed drops, the efficiency loss in the fan is less in a "Pascal" system than in a pressure-controlled system. That is because the "Pascal" system's airflow and pressure tend towards zero as the need for cooling drops. In contrast, a pressure-controlled system maintains a constant minimum pressure irrespective whether there is a need for cooling or not. The shaded area thus indicates the energy saving of the "Pascal" system. If the electric motor is also included in the picture, the total efficiency is reduced further at low speeds.

The MBBV must be used in combination with a suitable diffuser that can handle low airflows (LCP, LKP or LCC).

Easier to retrofit

Changes often need to be made to most business properties due to for instance restructuring, growth, moving or redesign as open office space. The use of buildings and rooms can change radically from one day to the next. So, the simpler the ventilation system is, the easier it is to adapt it to new requirements.

"To understand the flexibility of the "Pascal" system, we should recall that each room is an autonomous self-regulating unit. The airflow is controlled with the aid of a temperature sensor incorporated in the diffuser or mounted on a wall. So if an extension is added with several new rooms, this can be done without affecting the rest of the system. Unlike pressure-controlled systems, there is no need to reconfigure the whole system. The modular construction, open ducts and only five different components produce a system which is really simple to plan, maintain and retrofit," says Jesper Laursen.

There are currently some 400 Pascal systems in operation or under construction. The energy saving in fan operation can vary from one building to another, but is in all cases over 50 per cent greater than that of comparable DCV systems with pressure control.

The fans are the next big challenge

Even if an average energy saving of 50% may sound like much, the savings potential of the "Pascal" system is even greater. But to achieve maximum savings, the fans themselves must be optimised.

"Our ability to reduce the airflow and pressure to this extent is still relatively recent. The fans and their electric motors must be further optimised. We need fans that can change from large airflow and high pressure to low airflow and low pressure with no loss of efficiency. Fortunately, that's only a matter of time and technological development," says Göran Hultmark. ■