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Effective Ventilation Strategies Demands Flexible System Design

A Svensson

Technical Manager, Stifab AB, Sweden Ad.Prof. in Indoor Climate Technology, Lund University

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Synopsis

User experiences of the workings of a ventilation system have often been pretty disheartening. Draughty, too hot, noisy, too stuffy are some of the verdicts which in many cases have been confirmed by objective measurements.

Often the complaints are due to the air flows not being appropriate to the room. This in turn can be due to adjustment difficulties or to the flow balance in different branches of the system being affected by residents tampering with the supply or exhaust air terminal device settings.

In order to avoid these problems Stifab has developed a product - a self-acting pressure regulator- which makes it possible to design more flexible systems.

The pressure regulator makes it possible for a constant pressure to be maintained in the different branches of the ventilating system. This is practically independent of changes or influences elsewhere in the system.

To guarantee perfect performance throughout the useful life of the ventilating system, the regulators are stationed at appropriate points in the distribution system.

The paper describes examples of different system design in order to get:

1. a flexible demand controlled ventilating system
2. guaranteed air flow balance between supply and exhaust

General aspects of a ventilation system

When designing a ventilation system, care must be taken to ensure that it meets certain fundamental requirements which can never be neglected.

The following aspects are important in this connection:

1. Simple reliable systems
2. Systems which are easy to maintain
3. Systems which are easy to adjust
4. System with in-built inspection facilities
5. Systems with in-built flexibility of capacity (air volumes and cooling and heating capacity)

6. Systems permitting flexibility with regard to flow pattern and air velocity in the occupied zone
7. Systems which are energy-efficient
8. Systems which can maintain a good standard of comfort
9. Systems ensuring that the entire occupied zone will be ventilated, i.e. without any stagnant zones
10. Systems which are stable in relation to both external and internal disturbances
11. Systems which avoid short circuits between supply and exhaust air

Generally speaking, the system has to be designed in such a way as to help simplify the operation, care and maintenance of the installation. Products requiring service must be easy to reach and dismantle.

It is also pretty obvious that if a tenant "sabotages" his own ventilation system, he alone must suffer for it.The other residents in the building must not be affected by this disruption. Unfortunately, disturbances in the form of deliberately blocked exhaust and supply air terminal devices have been only too common.

Fixed measuring points in the system for checking air flows are an obvious requirement.

It is widely testified that an installation will be much more favourably regarded if the user can alter the setting without difficulty. In housing, for example , this flexibility makes it very easy for residents to adapt their air flows to actual requirements.

The ability to control air flows according to the needs of the different rooms is something we have not been over-endowed with where traditional mechanical supply and exhaust ventilation systems are concerned.Instead the aim has been to keep air flows as constant as possible. It is clearly an advantage if residents, within reasonable limits, can adapt the air flow to the actual needs of individual rooms. This must of course be achieved without having to reduce air flows in other rooms. One must always be able to guarantee minimum air flows in the various room units.

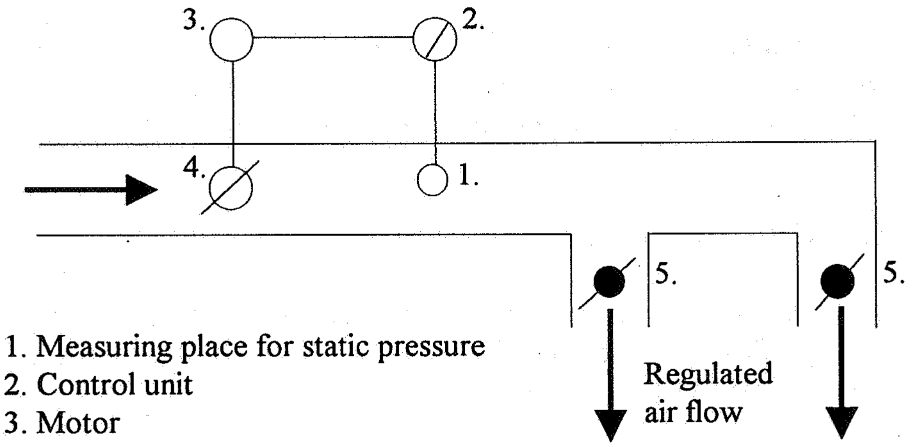
Flexibility

We began by mentioning the need for flexibility, and the main focus of development during the nineties is certain to be on questions of this kind.

As individuals making different demands on our climatic system, we will greatly appreciate the installations which we are able to adjust for ourselves. So is there an easy way of making our systems flexible?

One technically simple and good solution is to maintain constant static pressure at strategic points in a distribution network by means of constant pressure regulators CPR, see Fig. 1. In this way there are very good possibilities of varying the air flow downstream of the constant pressure regulator with a simple type of damper. The damper can be governed in various ways. Manual control is preferable to an arrangement where the damper, or the supply and exhaust air terminal devices, are connected to a timer.

At this point perhaps someone will object that this is a way of making systems even more complicated and vulnerable. This is true insofar as one is thrown back on electronics for governing the constant pressure regulators. But simple mechanical regulators are already commercially available. Pressures from a few Pascal up to 200 Pa can be kept constant. The pressure is very easy to set, using a device with a Pa scale.



1. Measuring place for static pressure
2. Control unit
3. Motor
4. Damper
5. Air flow regulating damper

Fig. 1 Pressure regulator and damper system for easy regulation of air flow. Units 1, 2, 3 and 4 together make up the pressure regulator (CPR).

Some applications of the constant pressure system

The constant pressure technique can be used in ventilation installations of every kind. For comfort ventilation, it can be used in:

❒ CAV systems (Constant Air Volume) for obtaining;

- correct and constant air flows
- easier commissioning
- in-built flexibility because, if necessary, the flow can easily be adjusted after commissioning

- VAV systems (Variable Air Volume) for;

    - simple arrangement, since one pressure regulator can be used for all devices on a branch duct
    - easier commissioning
    - lower maintenance costs, thanks to the simpler system

- DCV systems (Demand Controlled Ventilating) to provide;

    - a simple arrangement for demand control of air flows because the constant pressure regulator (CPR) permits manual operation of dampers / terminal devices
    - easier commissioning
    - CPR facilitates future extension of the system

In all systems supply and exhaust air can be controlled in such a way that the two air flows will always be balanced.

Planning

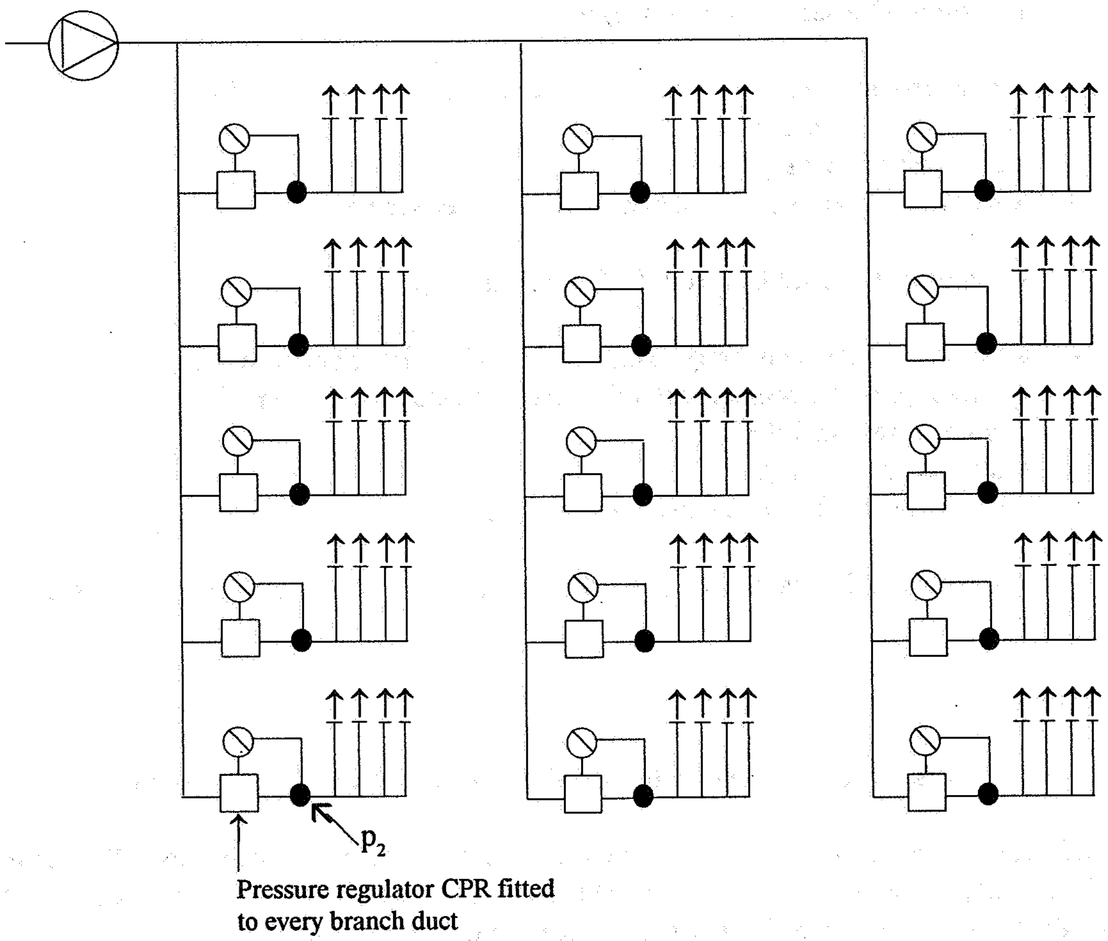
This constant pressure system is easier to plan than traditional ventilation systems.

It is sufficient to check that the static pressure in the branch duct furthest away meets the minimum requirement as per the catalogue data. One is then also guaranteed that the static pressure in other branch ducts will be sufficient for driving the other pressure regulators.

Fig. 2 shows an example in which the pressure regulator is used in a CAV system. One pressure regulator is fitted to every branch duct.

The purpose of the pressure regulator here is to maintain constant air flows in the system. The flows are kept unchanged even if, say, pressure losses across the filters are increased by fouling or if there are thermal driving forces at work in the system.

This means that the system does not have to be adjusted to flows exceeding the nominal ones with a clean filter.



Principle: The pressure p_2 is kept constant in every branch duct. The flow from the terminal devices will thus be kept constant, regardless of any disturbances upstream in the distribution network.

Fig. 2 The pressure regulator used in a CAV system

Constant pressure regulators (CPR) used in a DCV system

All systems in which demand control of air is desirable can be classified as DCV systems.

A system which is simple and therefore very attractive and in which the balance between supply and exhaust air flows does not present any problem is when the pressure difference between outdoors and indoors is used as reference.

Various installation options will be described here.

Once it has been decided to plan a DCV system, one has already decided to give priority to flexibility. This can be imparted to either the supply or the exhaust air side.

The following basic rules should apply:

- ❒ The supply air is used for ventilation only. That is, mainly isothermal air is supplied. In these instances, priority can be given to either the supply or the exhaust air side. In domestic installations, for example, it may be appropriate to give priority to the exhaust air side, because certain minimum exhaust air flows are stipulated for various spaces.

- ❒ The supply air is used as a heat carrier. That is, the ventilation air is also used for heating and/or cooling. In cases of this kind, the supply air side must be given priority and, accordingly, the requisite flexibility.

Whichever side receives priority, the control unit for the non-priority side must be fitted in such a way that a continuous negative pressure of about 3 Pa can be maintained indoors.

Example: Domestic ventilation
Adjustable exhaust air terminal devices are installed in at least all sanitory cubicles in the dwelling unit. The supply air is delivered to all bedrooms and living rooms through a constant pressure system. See Fig. 3.

All supply air terminal devices must be adjustable. The pressure regulator on the supply air side maintains constant pressure in the dwelling.

Two alternative installations are possible:

- ❒ Positioning of the control unit in the dwelling and the pressure nozzle in the outdoor air.
  The desired value of the control unit is set to about + 3 Pa

- ❒ Positioning of the control unit where it senses the atmospheric pressure and the pressure nozzle at a represantative point in the dwelling.
  The desired value of the control unit is set about - 3 Pa.

With these solutions the supply air flow is throttled down to a minimum in the event, for example, of a window being opened.

With this principles, the supply air flow can easily be re-allocated with the adjustable supply air terminal devices, without any effect on the total flow.

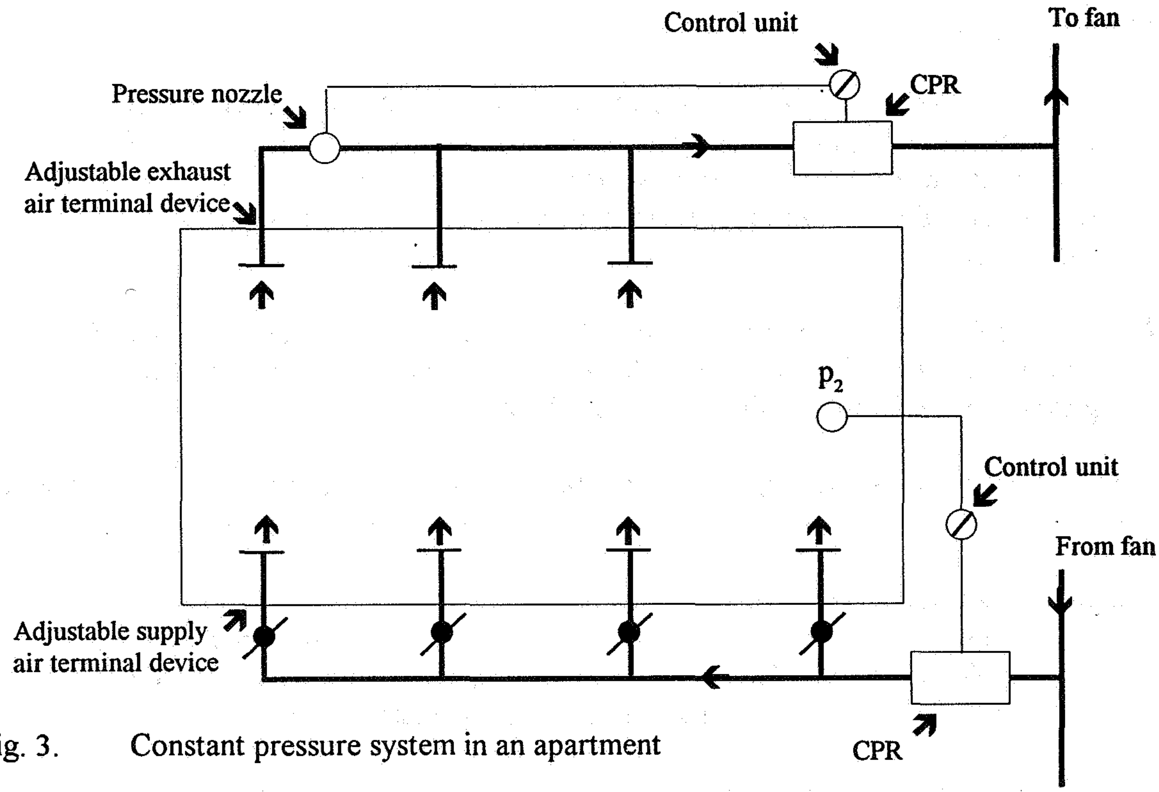


Fig. 3. Constant pressure system in an apartment

Conclusion

It is important that we should develope our ventilation systems. They must be adapted to the requirements made as regards air quality, comfort and the human need of individual regulation.

Flow control flexibility is a neglected field. Although the desire to achieve better systems has existed, progress has been retarded by the increased expenditure so easily resulting from improved solutions.

In this paper we have seen various possible ways, using constant pressure regulators, of achieving simple, flexible solutions. These basic solutions ensure:

1. that the requisite minimum air flows can always be maintained in the individual room units,
2. that the air flows can be forced to a predetermined maximum in the individual room units,
3. that the minimum flow for the dwelling unit as a whole can easily be increased by adjusting the desired value (pressure) setting of the pressure regulator,
4. that air flows can easily be checked, by checking the pressure in the ducts or connecting boxes and knowing the properties of the supply air terminal devices,
5. that the balance between supply and exhaust air flows will always be correct,
6. that there will be no problems with draughts caused by too high a pressure difference between inside and outside.
7. that the noise levels will not exceed the maximum design values, due to the constant pressure in the distributor duct,
8. that the system will be easy to adjust, thanks to the mechanical pressure regulator,
9. that a positive effect will be gained from users or residents being able to control ventilation air flows for themselves.