Volume flow control devices

Function, design and commissioning of VAV systems

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When considering variable volume flow in air conditioning systems, in particular air conditioning of large office buildings, the high energy-saving potential of many smaller facilities are simply overlooked. Today's electronic volume flow controllers can cover a broad range of technical finesse, from simple decentralised control to sophisticated bus technology. This article will show, by use of a practical example, that smaller systems are not only capable of meeting all the air conditioning requirements, but that they can be used in a practical and efficient way and with minimal effort at the design stage .

As a result, variable volume flow control for each room is already a practical choice, because only as much power is consumed as is required to maintain comfort conditions. Operating costs are significantly reduced by reducing the air flow. This not only has the effect of reducing overall ventilation capacity, but also results in a reduction in the energy consumption of air conditioning (heating/cooling/humidification/dehumidification) as well as in a longer service life for the filters. Demand-sensitive control is not just a criterion here, but also the control reacts as to how the room is being used at any moment. It could be far more cost effective, for example, to reduce the ventilation of a non-occupied room rather than to completely shut down the air supply, in order to avoid having to fully re-heat the room again. This would otherwise make a huge heating effort necessary.

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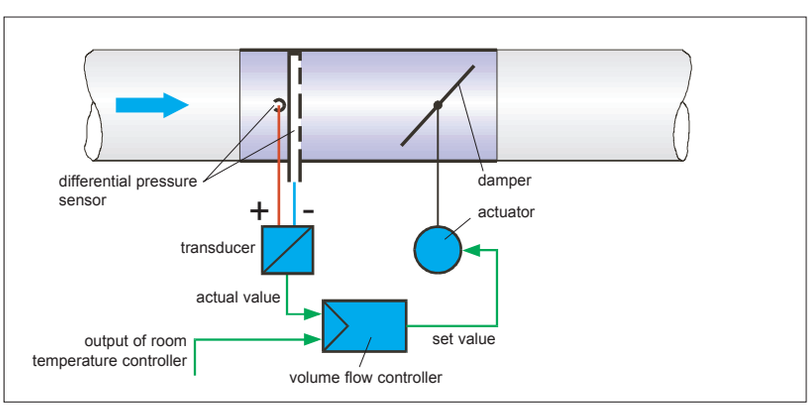
Function of a volume flow control device

We should differentiate between a volume flow control device (VAV controller), which needs electric or pneumatic power, and the mechanical system powered controllers. The latter being used more as constant volume controllers. This article deals with those units equipped with electronic components.

The air flow is regulated by a control circuit, which means measurement - comparison - adjustment. For measuring, the VAV controller contains a differential pressure sensor that provides an averaged measurement. This sensor provides good control accuracy, even with unfavourable upstream flow conditions. The differential pressure, known as effective pressure, is converted into an electrical signal and evaluated by a controller. The controller compares the actual value with the currently set value, and when there is a deviation, it alters the positioning signal to the damper actuator. The air flow remains at the set value, independent of the duct pressure (Figure 1)

In a decentralised control technology, the set value is defined by the room temperature controller. This has the effect of setting the volume flow controller between minimum and maximum air flow. The control takes place within these limits based on the signal from the room temperature controller. An adequate duct pressure in the unit is a prerequisite for correct operation under all conditions. All the required information on the system regarding minimum pressure drop is supplied by the manufacturer in the technical data. This minimum pressure drop across the unit must take into account the pressure losses in all the ducts and components installed both upstream and downstream of the volume flow controller.



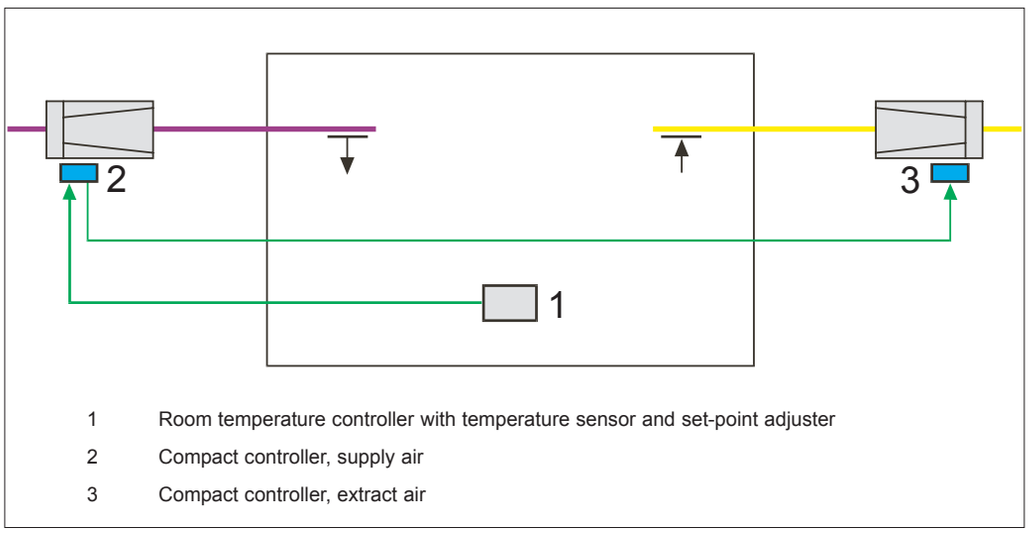
picture 1: Volume flow control device schematic.

Control components

The room temperature and volume flow control is the most common application in VAV systems. The room temperature controller is added to the flow rate control circuit as a cascade control (Figure 2). The following components are necessary as functional elements of a complete control circuit:

- Room temperature controller and room control unit,
- Air flow sensor and transducer,
- Volume flow controller and actuator.

In practice the controls supplier can offer different components that are specific to a particular project. The components that are provided can have various combinations of the above listed functions. Also each function can be carried out by a separate component; however this requires the necessary wiring connections and commissioning. In most cases, two or more functions are combined.



picture 2: Room temperature control with a variable volume flow system.

Project design

The following example (Figure 3) is particularly suitable for a decentralised control, whereby the combination of control functions specifically suits the responsibilities of the air conditioning installer and the building control contractor in a good way. Therefore the room temperature controller comprises a room module which contains the controller as well as the set-point adjuster and the temperature sensor. This module, more commonly described as a room temperature controller, is mounted in a suitable place in the room to provide an optimum temperature measurement. On the VAV controller, there is a so called compact controller that combines the effective pressure-transducer, the volume flow controller and the actuator into one casing (Figure 4). The interconnection of both controllers is carried out by means of a signal voltage. The electrical wiring is therefore extremely simple so that only an additional 24 VAC transformer is needed to supply voltage to both controllers.

In the design phase of a project the required air flow rates for individual rooms are calculated along with the sizing of flow rate controllers and most importantly the overall integration of the entire system is dealt with.

As a result, nothing is missed. Here is an overview:

Selection of the units
- Construction
- Accessories
- Control components

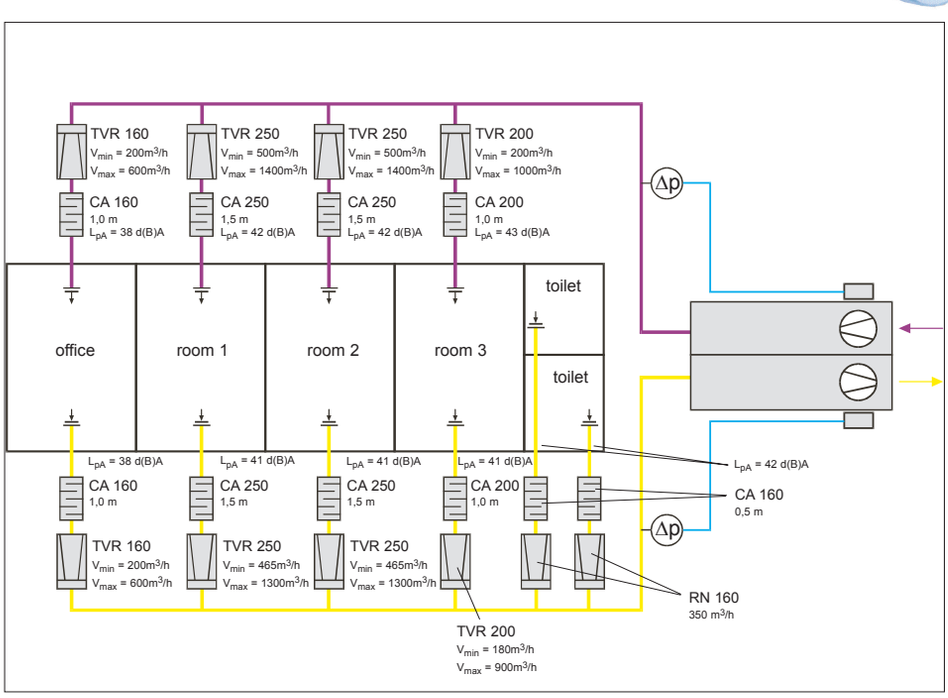
Sizing of the devices
- Sizes based on the air flow
- Acoustic requirements

Entire system
- Calculation of duct system
- Installation planning
- Electrical planning

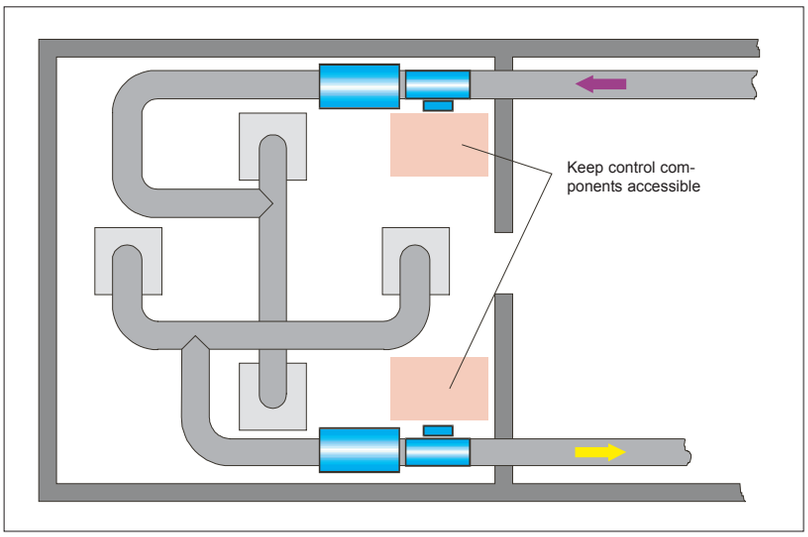
Selection of the devices

As a rule, the specified acoustic requirements are the main feature when selecting the devices. When there is a requirement for low noise levels normally terminal units with integral silencing sections are required. However for most normal applications the stand alone circular or rectangular flow rate controllers are quite adequa-

picture 4: Volume flow control device TVR-Easy.



picture 3: Variable volume flow system schematic, e.g. Internet cafe, laboratory.



picture 5: Installation of vav-system

te. The control equipment is chosen so that a commercial temperature controller (including a temperature sensor and a set-point adjuster) controls a compact controller. The setting of the Vmin and Vmax volume flows is carried out by this compact controller. Further adjustments are not necessary.

Sizing of the devices

In the first instance the unit size is determined by the required air flow rate. However, this should also be done bearing in mind the possible need to subsequently increase or decrease the nominal flow rate.

The next step is to determine the room sound pressure level for the size of unit selected. Under certain circumstances, the selection of the next size up can give better results making further noise control measures unnecessary. Checking the anticipated noise levels requires reference to manufacturers published literature. It is normal to deduct a figure for room attenuation in this process. To achieve 45 dB(A) in any room, a circular controller with a secondary attenuator is required. Take care when the resulting noise levels are close to the specified overall room level. In this case a full acoustic analysis is required to allow for all other noise sources.

Duct system calculation

The total duct system is usually sized on the basis of an air velocity of 6 to 8 m/s. A more detailed duct system calculation taking into consideration each of the individual boxes is normally not necessary. Finally, the volume flow controller has the regulating task, independent of the duct pressure. However, the largest section of the duct must be evaluated using the maximum flow rate, so that the fan can be sized and the set value for the duct pressure controller can be pre-determined. The selection of the measuring location for the duct pressure control is important. The pressure sensor is normally located in the ducting down stream of the fan but before the first off. Only in this way can sufficient system pressure be guaranteed under all operating conditions.

Installation

For installation, the experienced technician needs no special instructions. However, it must be pointed out here that the control components, in spite of being maintenance free and having a long life span, can fail or need to be checked. For this reason, accessibility is important and necessary. The flow volume controllers therefore must be installed in such a way that there is adequate access to the side where the control components are located (Figure 5). If necessary, the units can also be rotated, unless the manufacturer specifies a particular installation orientation.

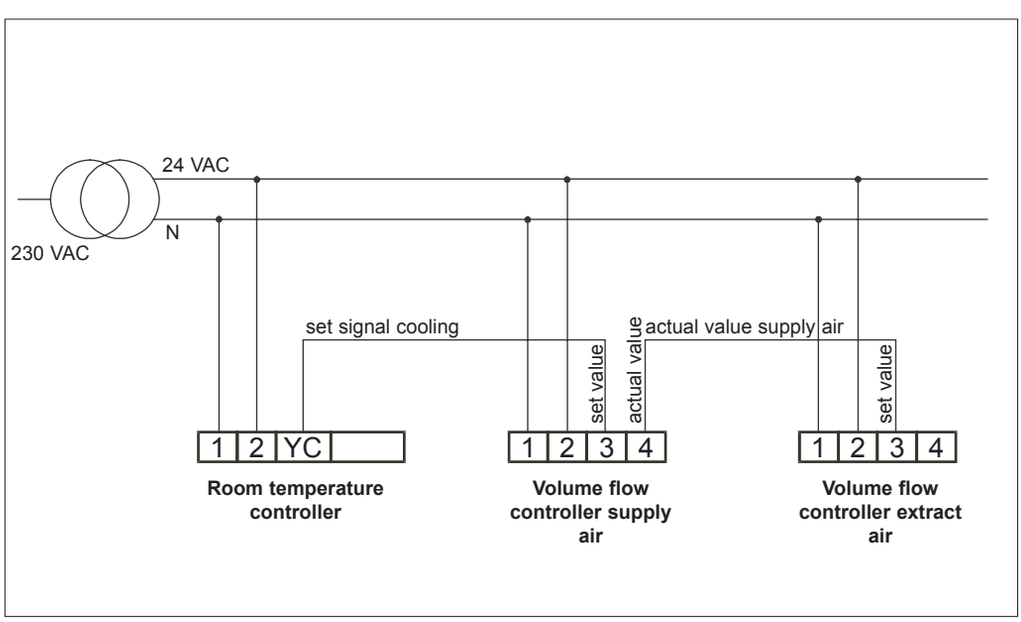
Electrical planning

Most commercial electronic volume flow controllers need a 24 VAC supply. A decision has to be made as to whether to provide a 24V network or transformers are used for each room/zone. In our example (decentralised concept), the second variant (Figure 6) is recommended.

Commissioning

For commissioning, normally no adjustment is necessary. All controller functions should be checked in every room. The actual value and the set value of the compact controller can be examined and checked with an adjuster. Recently there is also a controller available with a control light to indicate when the air flow is correct (Figure 4). Should the flow rate limits change after installation, this is no problem. The new values are provided using an adjuster or directly set into the controller.

The volume flow controllers are mechanically maintenance-free. However, the controller functions should be checked as part of an annual maintenance check of the unit. Here, there is also an opportunity to assess the room



picture 6: Wiring diagram of room temperature control with both variable supply and extract volume flow control.

inquired

The design and installation of variable volume flow controllers promises a simple option to achieve the required results. But even here, it can quickly lead to errors. The IKZ-HAUSTECHNIK editorial office asked Dipl.-Ing. Klaus E. Tegtmeier of Gebrüder Trox GmbH what he thinks.


Klaus E. Tegtmeier

IKZ-HAUSTECHNIK: In your expert opinion, where do the most common errors occur during the design and installation of a volume flow controller?

Tegtmeier: From the experience of our colleagues in the service team, as well as from our own site visits to many completed and up and running systems, there are two quite clear areas of error: the installation location and the wiring of the unit.

First of all, when considering the installation location, care must be taken to ensure that the device is mounted in the right place. If the volume flow for each room is preset on each unit, there is a risk of errors during installation. Consequences: the air flow must be reset, which is possible but causes additional and unnecessary effort and work. However, if the units are installed with the wrong air flow direction, the whole unit must be completely demounted and reinstalled correctly.

Our main issue, to which we always come back to, is the accessibility to the control components. The controller must be commissioned and also even the best technology can malfunction. Furthermore, the need to change the usage that means, whether new heat sources or workstations have been added or removed. The settings can then be adjusted accordingly. ■

connections can often occur. However, wiring errors are often not detected until the function test for commissioning is being carried out. This error must be corrected by either re-connecting or renewing the cables.

IKZ-HAUSTECHNIK: How can these errors be avoided?

Tegtmeier: A lot of errors can be avoided when the fitters are comprehensively informed and the activities coordinated. Often, they are left to their own devices and sometimes have insufficient, or at worst, no written guidelines to hand.

There can be no place for mediocre work. However, we all know it is common practise. Nevertheless, one should not yield to this, but should take into consideration, as early as possible in the planning stage, that the device remains accessible for servicing. In the building phase, the building supervision is required to establish with the technicians that this area remains free and accessible.

Pictures: Gebrüder Trox GmbH, Neukirchen-Vluyn

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