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Press News

The theory and practice of small fans (2)

Fan variants: what type of drive, what type of material?

Small fans are differentiated not only in their type of construction but also by the type of drive used and the materials employed. An increasing role is played by integrated controls that are now possible thanks to modern electronics. These three different criteria are often interrelated and depend on the type of fan construction used. In this article we will explore these connections and the characteristics that result from them.

An energy input is necessary to set air in motion. When viewed in this way, the drive can be seen as the heart of the fan and, just like the heart, the drive has to work in a 'controlled' way. For many modern applications the control electronics are just as important as the drive itself. Last but not least, the materials used to manufacture the fan must also be suitable for the application, as well as allowing their manufacture to be at a reasonable cost. An optimal combination of these three 'components' will result in an efficient fan with a long service life.

Drive options

All of the various types of fans discussed so far can be equipped with different drive motors. The intended place of installation is of crucial importance for making the right choice of motor. Certain motor designs are particularly suitable for special applications, despite appearing at first sight to possess serious disadvantages. Generally one is looking for fan motors with 'rigid' motor characteristics, which just means that the motor speed hardly alters over the total fan curve or, to put it another way, the speed of the motor should only demonstrate minimal fluctuations, even though the torque requirement of the fan is changing dependent on the operating conditions.

Modern fans are now generally all equipped with small, electronically commutated DC motors, also termed EC motors. This kind of simple motor is considerably more cost-effective than the AC asynchronous types that were often used before. Fan speeds from 1,000 up to 6,000 rpm are now a possibility – in special cases this can be extended up to 15,000 rpm and even higher. Moreover the efficiency factor of DC drives is significantly higher

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than with AC motors. Unfortunately these small motors do have a weakness, which results in the typical saddle effect (Fig 1) as shown in the static pressure / flow rate diagram. In free air operation an axial fan has its lowest torque requirement and the motor its highest speed. As the counterpressure rises, so the energy requirement of the fan impeller increases and the motor can no longer maintain the speed. To a certain extent electronic correction of the motor can be of help here.

Still a force to be reckoned with

AC motors, as mentioned above, were in widespread use earlier and still have their applications today. Their efficiency is comparatively low and their speed can only be varied within certain limits depending on the mains frequency. So at 50 Hz the majority of the motors run at 2,700 rpm, although by using attenuation measures then 1,500 rpm is also a possibility. On the one hand, the higher power dissipation of the drives can give rise to heat problems for the fan's electronic circuitry or bearings, although for outside applications in low temperatures, this heat dissipation can be an advantage. If the temperature is very low, then a considerable extra amount of torque is needed to overcome the so-called breakaway torque of the bearings. One of the reasons for this is the viscous nature of the lubricating oil in the bearing. In such a case, an efficiency optimised DC motor would simply switch off and never get going. The 'lossy' AC-Motor on the other hand warms itself up to the necessary start temperature and carries out its function without any additional measures being required. This one example goes to show that when it comes to choosing the right fan, then the particular needs of the application always have to be taken into consideration, otherwise later on there could be a considerable reduction in the service life and reliability.

With certain fan types acceptable performance is achieved only by using special motors. Three- phase EC motors offer the advantage of a very high power output, accompanied by high operating efficiency and reversible operation. By way of contrast, in very small axial fans and in sensor fans, which for example keep the air in motion for the sensors in vehicle climate control systems, then claw pole motors are also used. Instead of a laminated stator with windings, in this instance there is just a coil with specially shaped polar strips. Such motors can be manufactured very economically.

Electronics included

When going a step further, from a pure drive motor to a more demanding electronic control, then again one can classify the fans accordingly. Alongside simple versions, where the electronically commutated DC motors just maintain a constant speed, one increasingly finds models where additional functions are integrated into the fan electronics. Temperature dependent speed regulation, using internal or external temperature sensors, is already to be found. Many fans are also provided with a tacho signal or an external control input, which offer the advantage that the fan speed can be monitored or even controlled from the PC or other external controller. Even more features are offered by ebm-papst St. Georgen in their Vario-Pro® range (Fig 2). For this range, the user defines which characteristics he requires, and the internal electronics are then programmed correspondingly. A microprocessor within the fan then monitors all the specified values. In this way temperature dependent speed profiles, externally set preset speeds and a variety of combinations of alarm and tacho functions can be implemented.

Plastic or metal

As well as the physical layout of the fan and the design of its drive, one very important classification criterion is the actual construction of the fan, and notably the materials used. Most modern fan housings are manufactured from plastics, though the exception to this is fans with AC motors, 7which are mainly made of aluminium diecast. The reason for this lies in the relatively high amount of heat that is dissipated, which can quickly be removed thanks to the high conductivity of the aluminium. Practically all other small fans are currently manufactured out of production-friendly plastics. These offer the advantage of design diversity obtained from injection moulding, a reduction in weight and high resistance to wear and corrosion (depending on the plastic used).

Today very long service life is achieved using ball bearings as well as modern sleeve bearings. The latter are made of porous metal and impregnated with high-performance lubricating oil that remains effective for the life of the fan. In normal operation the fan shaft runs on the wear-free hydrodynamic film of lubricant. Specially constructed fans, such as those having a protective paint layer or with motor and electronic components that have been potted under vacuum with PU resin, also have no trouble in achieving a long service life, even under very difficult operating conditions (Fig 3). For these types of applications specially sealed ball bearings and for certain application even bearings made of stainless steel are used.

It is not really possible to make a clear unambiguous classification of modern fans. Depending on the conditions encountered in the application and the resulting demands, different fan principles come into play. For this reason the physical principle of air movement has been chosen as the universal classification; all subsequent design options such as the type of drive, control or materials used are then geared to the special requirements of the application. Using this tried and tested classification sequence, the optimum choice for each application can quickly be reached.

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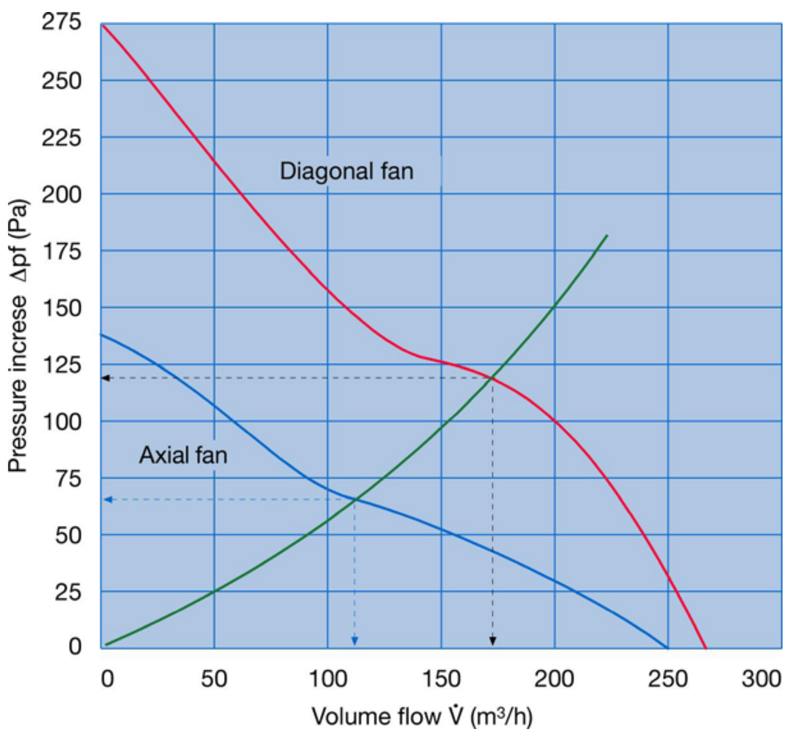

Fig 1: Static pressure / flow rate diagram.

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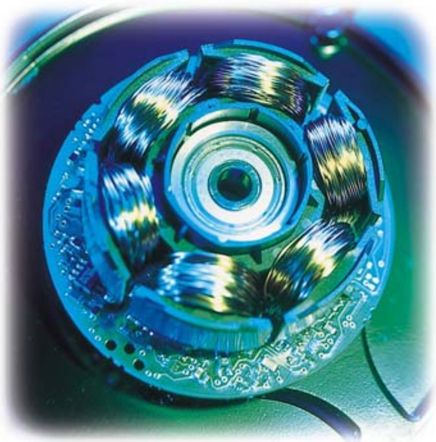

Fig 2: Sectional view Vario-Pro

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Fig 3: IP54 fans for extreme environmental conditions