Press News

Quiet blowers with inner qualities

Low-noise fans are not a product of chance

Noise put out by machines can be annoying, especially in those areas that really require a quiet environment. For this reason, great importance is attached to computer, office, laboratory and medical equipment operating as quietly as possible. Mechanical components such as drives and cooling are the chief noise source here. When air-flow is being moved by small fans, then cleverly designed construction can significantly reduce the noise level of such units.

What exactly is noise? It is the result of very small changes in pressure that are carried through the air to the ear. For the human hearing range only those pressure waves in the band from 16 Hz to 16 kHz are of any significance. The sound is expressed as the sound pressure level in dB (A). This then also takes into account the frequency-dependent hearing performance of the human ear, the so-called A-weighting.

Acoustic measurement method

Two measurement methods have established themselves. On the one hand we have the measurement of the sound pressure level, a value that is dependent on distance and direction, and so is only really suitable as a rating value – though this measurement can be done easily without any great effort. The other weighting value method is called the acoustic power level. In this case the total sound radiation from the source is detected by means of several microphones on what is called the enveloping surface (fig 1). This complex method requiring more apparatus does however give more accurate values and is laid down in the standard DIN 45635 T.38 and in ISO 10302. So, for example, the fan is measured at its nominal speed at the working point of optimal efficiency. However the extensive measuring equipment is not available everywhere. For this reason the specialist fan manufacturer ebm-papst has built a sound measuring (anechoic) room, with a reflecting floor and sound absorbing roof and wall coverings (fig 2). With overall dimensions of 5.5 x 5.1 x 3.1 m (L x W x H) it is possible to

measure accurately not only the fans themselves but also complete pieces of equipment. The background noise level in the measuring room is a mere 6 dB (A), which means that even very quiet devices can also be measured. Measuring microphones, amplifiers and special acoustic analysers allow for high reproducibility and accuracy of the measured values.

The acoustic characteristic curve of a fan and consequently the sound power it radiates varies according to the operating conditions. To achieve a picture over the total operating range then inside the sound measuring room a fan has to blow into a pressure chamber. A variable opening in this chamber permits the whole pressure/ volumetric capacity range of the fan to be measured and meaningful characteristic curves of the acoustic values to be obtained (fig 3). The lowest values for radial fans occur with relatively low volumetric flows, whereas with axial fans it is with large flows.

Inner Values

A fan can create very unpleasant noises when the air-flow is interrupted, i.e. when the air comes up against or has to go round obstacles. Turbulence also causes air fluctuations that can be detected as noise. Axial fans are sensitive to any severe restriction to the volumetric flow. In this type of operation the flow round the blades near the hub detaches itself from the fan impellers and causes eddies. The noise level of the fan rises dramatically. With large fans, the energy produced in this vortex can not only lead to a lot of noise but also even cause the blades to break. So there has to be a reliable way of avoiding this occurring. However with small fans there is just the disadvantage of the high noise level.

Turbulence can also occur at other locations. The fan shaft with its motor and fan impeller has to be mounted in a housing. Traditionally this has been done by using struts. Once again though these struts act as an eddy-forming barrier to the flow. The rotating blades sweeping over straight struts create strong pressure surges. If the struts are distributed symmetrically, then noises like that of a siren can occur. This effect can be lessened by the use of curved struts distributed asymmetrically round the perimeter of the fan (fig 4). This on the one hand achieves a smooth transition between the blade edge and the strut and on the other results in a suppression of undesired sound radiation at certain frequencies, thanks to the asymmetrical layout. Even the human ear reacts sensitively to frequencies that stand out from a basic level of noise. Such dominant single frequencies (pure tones) are often the result of interference between the rotating parts (rotor) and the stationary built-in components (safety guard).

Fine –tuning is also in great demand

Alongside the main reasons for noise with fans as mentioned above, one should not forget the less intensive sources. Structure-borne noise can for instance mean mechanical vibration or oscillation in the fixed material. One reason for such vibration in fans can come from inaccuracies in the bearings (fig 5) as well as the excitation of the fan blades through turbulence as described above. Structure-borne noise can also result from non-uniformity of the electromagnetic moments and forces within the drive motor. (This is similar to the well-known transformer hum in cheap power supplies). Other factors could include insufficiently balanced rotating parts or even factors external to the fan, such as unsuitable mounting of the fan to the machine.

Structure-borne noise in the fan can be reduced significantly by taking the appropriate measures. A further reduction can be achieved by mechanically uncoupling the fan from the mounting wall of the device that is to be cooled. An oscillation-damping (rubber-) support greatly reduces possible noise transmission. The noise effect both within and round the device is often under-estimated. Protective screen covers in the form of simple sheets of steel with punched holes often act like a siren and everyone knows just how loud these can be. If the sheets of metal used are too thin or flex, then the sound is emitted in a way similar to that from loudspeaker membranes.

The construction of quiet running fans requires not only inter-disciplinary expertise but also especially the right laboratory equipment to technically achieve the required results.

This is the only way for the product to be improved. Once the fan is installed at the customer, then the influences of the final machine play a role. A good fan is even better if used with suitable guards and ventilation circuits. This is the best way to get close to achieving the goal of a ‘whispering fan’.

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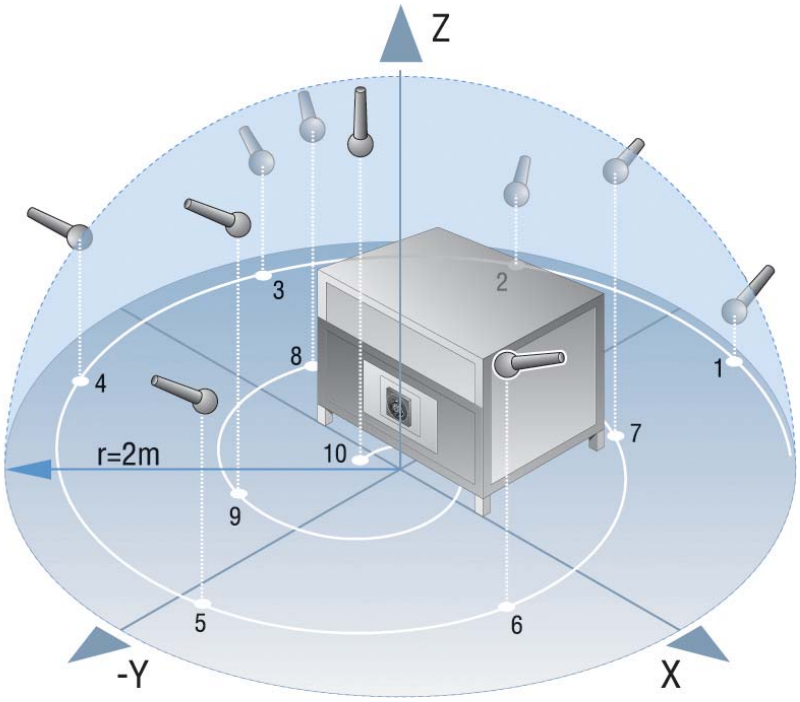

Fig 1: Construction schematic for measuring the acoustic power level

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Fig 2: Taking measurements in the anechoic room

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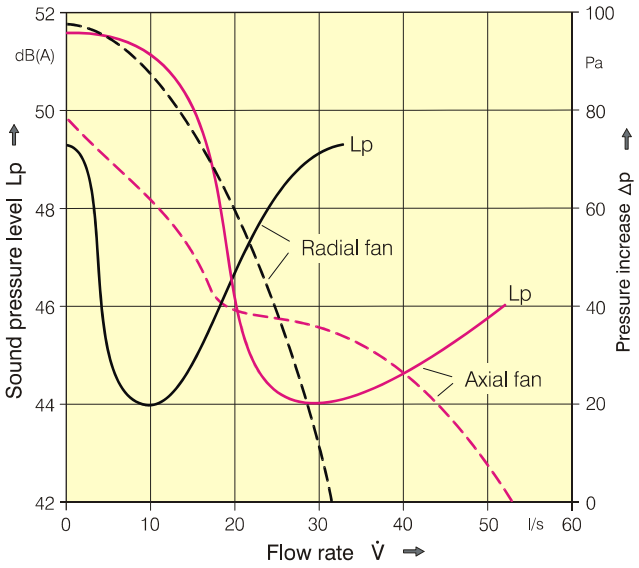

Fig 3: At a glance: acoustic characteristic curves demonstrate noise behaviour during operation.

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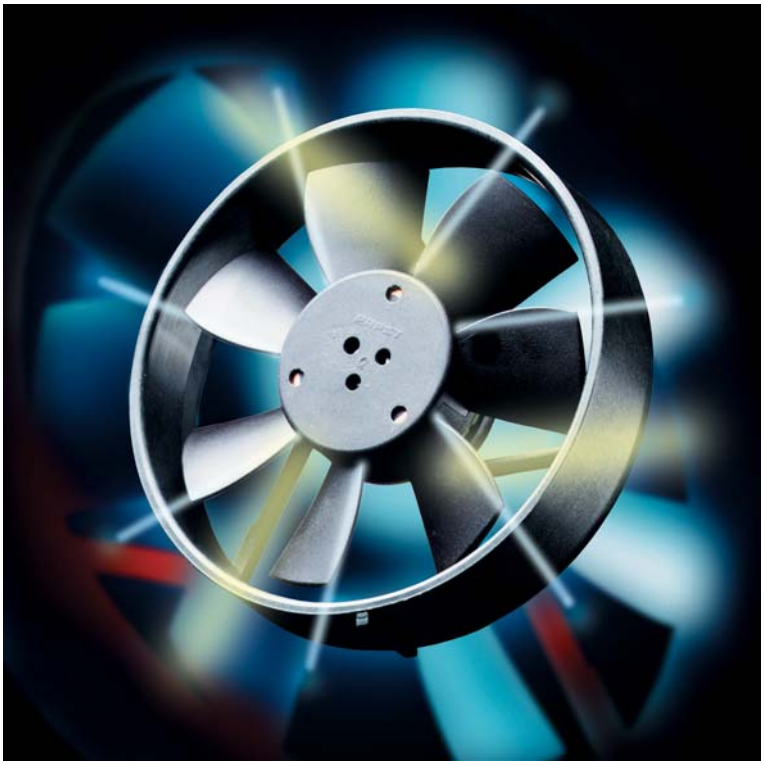

Fig 4: Fan view showing motor mounting struts

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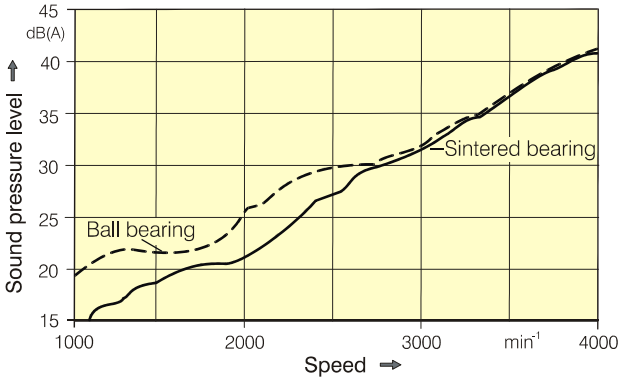

Fig 5: Bearing noise and total sound pressure level