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"FAN ENGINEERING"

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2

FAN SOUND & SOUND RATINGS

INTRODUCTION

A first source of noise in any air moving system is the main fan. The user's primary aim is to ensure that the fan will satisfactorily perform its duty. That is to say, it will handle the required volume flowrate at the system pressure and for the stated power. Even more important, however, is what nuisance will be caused, by its noise, to operators of the plant, to neighbors, or to inhabitants of the conditioned area.

Definitions:

Noise:

Sound undesired by the recipient.

Sound:

Sound can be described as any variation of pressure in a medium air that can normally be converted by the human eardrum into vibrations, causing signals to be transmitted into the brain.

Frequency:

In order to vibrate the eardrum, the pressure variation in the medium must occur rapidly. The number of variations per second, expressed in cycles per second or Hertz, is called the sound frequency. The human ear can hear sounds from around

20 Hz to 20,000 Hz respectively-the lowest and highest sounds. The lowest note on a piano as a reference has a frequency of 27.5 Hz while the highest note is at 4186 Hz.

Sound power level (SWL):

A fan's noisiness can be expressed in terms of their sound power (the amount of watts of power it converts into noise). Fan noise can be measured by its sound power level, a ratio that compares its sound power logarithmically to a reference value, the Pico Watt (10 -12 watts). Sound power level unit is the decibel. The level of sound intensity can be described as:

$$SWL = 10log - \frac{W}{W_0}$$

where:

SWL = sound power level in decibels (re 10 -12 watts)

W = sound power of the noise generating equipment (watts)

Wo = reference power (re 10 -12 watts)

Sound pressure level (SPL):

A fan's amount of sound power is comparable with a heater's power output. Both calculate the energy pumped into the world around them (in one case the noise energy, the other the heat energy). However, neither the sound power level nor the power output can tell us the effect of the ambient space on a human being.

In the case of a heater, the engineer can determine the resulting temperature at any point by considering the volume of the surrounding, the room materials, and what other heat sources are present. In a similar way, the acoustic engineer can measure the sound pressure level at any point, taking into account very similar parameters.

A logarithmic scale also measures sound power levels, but the unit is the decibel re 2 x 10.5 Fa. A further benefit is the use of the decibel scale. Since in a logarithmic way, the ear is sensitive to noise, the decibel scale more like reflects how we respond to a noise.

$$SPL = 20\log\frac{p}{p_0}$$

where:

SPL = sound pressure level in decibels (re 2 xl0^(-5) Fa)

P = sound pressure of the noise (Pa)

Po = reference pressure (= 2 xl0^(-5) Pa)

It should be realised that in specifying a sound pressure level, the distance from a noise source is implied or stated.

Octave bands:

Noise typically consists of a mixture of notes of different frequencies, and a single sound power level is not adequate in itself to explain the intensity and nature of a noise since these different frequencies have different characteristics.

Thus noise is divided into octave bands (frequency bands in which the upper frequency is twice that of the lowest) and a sound pressure level for each band is quoted. The commonly recommended octave band frequencies have mean frequencies of 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz.

Relationship between sound pressure and sound power levels:

The relationship between SPL and SWL is given as:

$$SPL = SWL + 10\log\left[\frac{Q_\theta}{4\pi r^2} + \frac{4}{R_c}\right]$$

where:

SPL = sound pressure level dB (re 2 x 10^(-5) Pa)

SWL = sound power level dBW (re 10^(-12) W)

r = distance from the source (m)

Q_θ = directivity factor of the source in the direction of r

R_c = room constant

Table1: directivity factor of the source in the direction of r

Position of source	Directivity factor
Near center of room	1
At center of floor	2
Center of edge between floor and Wall	4
Corner between two walls and floor	8

Weighted sound pressure levels:

Noise levels A, B, C, and D are an attempt to generate single number and sound intensity indices. To obtain them, various values in each of the frequency bands are subtracted from the sound pressure ranges, subtracting most from those bands that have the least effect on the ear. Logarithmically, the effects are then combined to create an average sound level of a single number.

Noise-producing mechanisms in fans:

There are three principal noise generating agencies at work in the production of a fan's total acoustic output. These may be summarised as follows:

- ✓ Aerodynamic
- ✓ Electromagnetic
- ✓ Mechanical

In most industrial fans, the order given is indicative of their relative importance, although for units at the extremities of the size range, mechanical noise becomes an increasing hazard. Electromagnetic noise, as would emanate from an electric motor, is often masked by the aerodynamic noise, especially where, as with a direct driven axial flow fan, this driving unit is contained within the casing and, therefore, the moving airstream. It can, however, be of great importance in slow speed machines driven, for example, by 6 to 12 pole motors which are inherently more noisy. In these cases, the electromagnetic contribution may be of a higher magnitude than the aerodynamic signature, especially in the lower frequency domain. For centrifugal fans, where the motor is usually outside the airstream, electromagnetic noise will not contribute to the in duct sound power level. It may, however, mask the breakout noise from the fan casing and ducting system. Many electric motors used with such fans are of the totally enclosed fan ventilated type, and in these the cooling fan may itself be the dominant noise source in the free field around the unit.

Effects of flowrate and pressure lose in sound performance:

At a constant fan speed, the sound power generated will be dependent on the system resistance against which the fan has to operate. It is, therefore, of importance to ensure that this has been correctly calculated.

Overall, by increasing the flowrate and also pressure lose, the sound pressure increases which is shown in below figures.

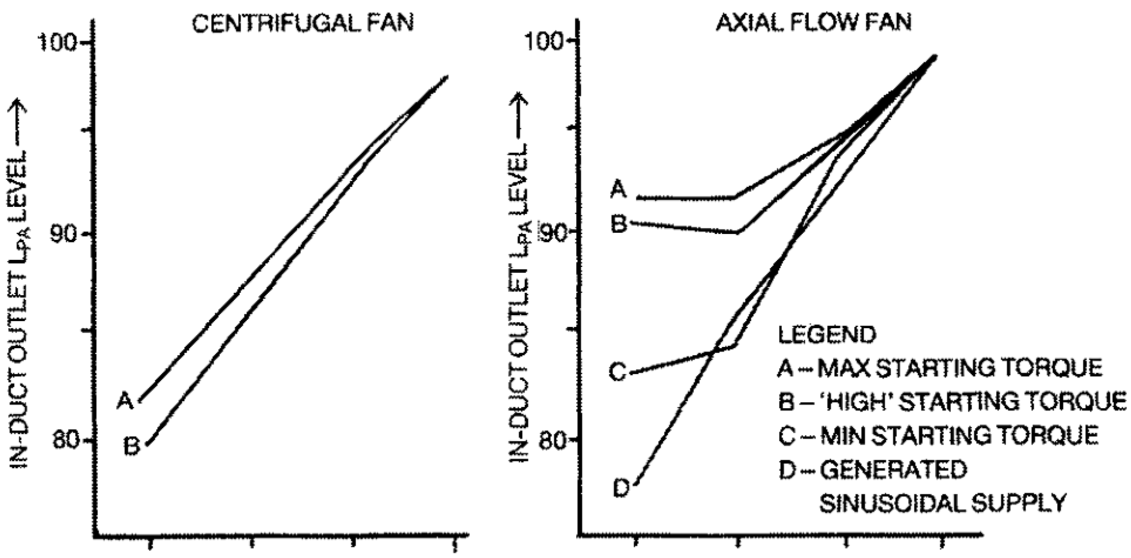

Fig1: The relation between flowrate and sound pressure

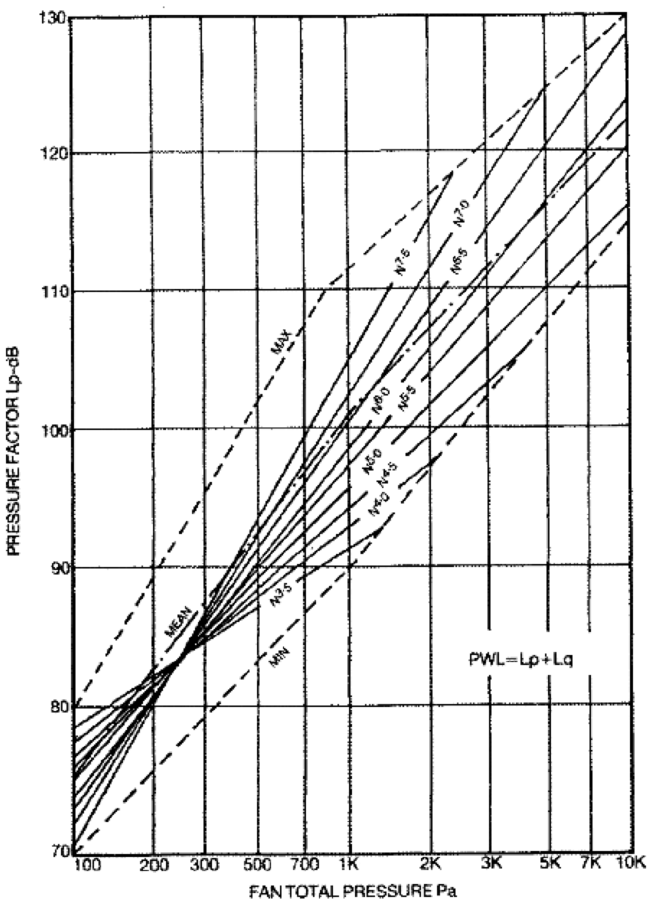

Fig2 : The relation between pressure lose and sound pressure

Reducing Noise in Fan

Sound Resources in Fan:

BLADE STRUCTURE

Tip clearance is one of the main factors in sound reproducing in the fan. Tip clearance is the distance between the top of blade and fan casing.

The space at the blade end of the fans negatively affects the system or aerodynamic performance. If the distance between the blade and the body is not within the limits, it will cause turbulence. The smaller the gap, the less noise the fan will generate due to turbulence.

MOTOR POWER & ROTATIONAL SPEED

Different motor powers and different rotation speeds are used in fans to obtain efficiency at different performances. Fans with the same feature perform differently at different speed and power ratings. For example, by using a low motor power at high speed, a value at high flow and pressure is obtained. At the same time, the same pressure and flow can be achieved by using a high motor power at low speed.

SILENCERS, THE MOST IMPORTANT WAY TO REDUCE FAN NOISE

Silencers are used as sound reducers according to the sound character that occurs in air conditioning and ventilation systems. It is produced in two main types: rectangular and round sections. Pressed glass wool of various density such as 50-70 kg/m^3 is used as a filling material in the muffler. In fact, the glass wool is covered with air and the glass fleece prevents the particles from flying from the surface at high air velocities up to 20 m/s.

AIRONN INNOVATION IN SOUND REDUCTION-SELFSILENCER AXIAL FAN

Aironn Utility model patented Axial Self-Silencer Smoke Exhaust and fresh air fans are suitable to operate at different temperatures. Fan body is made of high quality galvanize coated sheet metal. 70 kg/m^3 density nonflammable rock wool filled inside the double-walled fan body provides high sound absorption performance. With this product, clients are able to have efficient sound performance with minimum space.