FAN NOISE & VIBRATION

SECTION INDEX

01. FAN NOISE

❖ GENERAL

For all practical purpose, 'Sound' can be characterized as any disturbance in an elastic medium that has the capability of being heard by the human ear, whereas 'Noise' is referred to as any undesired sound. Noise is also a random phenomenon; the majority of the sound emitted by a fan is random with respect to frequency and time. Thus the sound from a fan can be regarded as noise. The largest proportion of the noise that is generated by the fan is of aerodynamic origin and may have the following components:

Noise due to the passage of blades through the air.

Noise due to forces exerted by the fan blades on the air.

Noise due to passage of blades past any fixed point or structural member.

Noise due to the flow separation between the solid surface and the air boundary in a region of decelerating flow.

Noise due to air turbulence caused by shear forces in the fluid regions remote from boundaries.

Noise due to interference caused by the contact of turbulence wakes on obstructions.

In general it is said that noise is a function of tip speed, static pressure, fan power, air flow, number of blade and fan diameter, but there are no specific parameters for calculating the expected noise level emitted by fan for a given operating conditions.

❖ FACTORS AFFECTING FAN NOISE

a. **Structural Members in The Flow Path** : The movement of air past structural members is impeded and generates turbulence (air noise) in the air stream. Apart from turbulence, a low frequency noise occurs when the blades pass over these members at varying air speeds.

b. **Fan Speed (Tip Speed)** : In general it has been found that the fan noise is proportional to the approximate fifth power of fan tip speed (i.e., the higher the tip speed, the greater the fan noise).

c. **Number of Fan Blades** : In a given system, the work done by each blade is inversely proportional to the number of blades. Increasing the number of blades reduces the loading on each blade and thus a lower pitch angle may be set which in turn will result in a lower noise level.

d. **Blade Chord Widths** : The wider the blade chord width, the greater the load distribution over the blade , and therefore the lower the noise.

e. **Pitch Angle** : The noise level, is minimized at a pitch angle that is less than the maximum recommended blade pitch angle, and, is increased at other angles.

Inlet Shape : As the inlet shape influences the static pressure, it also affects the noise production of fans.

02 VIBRATION

❖ GENERAL

As 'noise' refers to any undesirable air-borne sound, 'vibration' is the induced motion in mechanical components. A vibration is usually the source of sound and is part of a system by which sound is transmitted.

In addition to wasting energy, system noise and vibration may result in the following :

1. Increased Operating Cost.
2. Reduced Structural life of system & equipment.
3. Increased maintenance cost.
4. Adverse effect on the environment.

❖ SOURCES OF VIBRATION

a. Unbalanced Fan.
b. Inconsistency in Blade Tip Angle Settings.
c. Unequal Blade Tip Levels.
d. Misalignment of The Drive Shaft.
e. Couplings Unbalanced.
f. Structural Resonance.
g. Damaged or Worn out Gear Box / Motor Bearings.
h. System Mounting Nuts / Bolts Loose.

03. RESONANT FREQUENCIES & HARMONICS

❖ GENERAL

Resonant frequency (resonance) is a state in which the induced vibration frequency into a system is equal to the natural frequency of the system. As any mechanical system is subjected to fatigue, a fan's structural integrity is greatly effected by its resonance, which upon occurrence, can destroy the fan in no time; it is therefore advisable to maintain a safe margin of operating frequencies to avoid resonance.

During fan operation, the following resonant frequencies can force a blade to vibrate at its natural frequencies :

a. **Beam Pass Frequency :** This may be defined as an effect characterized by a blade passing over a structural member of obstructions during each revolution and can be calculated as follows :

b. Beam Passing Frequency = [(No. Of Obstructions x rpm) / 60] Hz

c. **Blade Pass Frequency:** This frequency is dependant on the total number of blades and calculated as follows :

d. Blade Passing Frequency = [(No. Of Blades x rpm) / 60] Hz

❖ HARMONICS

Frequencies that are integer multiples of 1 x RPM frequency are known as ' harmonics' During the fan operation, it is always recommended that the first three harmonics (i.e. 1 x RPM, 2 x RPM & 3 x RPM) be compared with the first mode resonant frequency of the blade in order to maintain a safe margin to avoid resonance.

04. SOUND DATA & GUARANTY EXCLUSIONS

❖ SOUND DATA

Sound level data on **Parag Energy Efficient Axial Flow FRP Hollow & Solid Bladed Fans** can be furnished upon request. Sound Pressure level readings can also be broken into 1/3 octave band analysis, if required. Since fan sound data is affected by several factors such as type, shape & number of structural members, inlet shape, fan tip speed, background noise etc. it should be used for estimation and comparison purpose only.

❖ Sound Level Guaranty Conditions

Guaranties of sound level data of **Parag Fans** can be provided based on the following information:

a. Precise location of the point or locus of point where the noise specifications are to be met.

b. Velocity recovery cone dimensions and location relative to the fan.

c. Plant layout showing the orientation, dimensions and tower location with respect to adjacent buildings and major structures.

d. The prevailing background noise and attenuation data in the surrounding area.

❖ **Sound Level DATA TOLERANCE & GUARANTY EXCLUSIONS**

a. A measurement tolerance of ± 2 dB shall always be applied to all sound level measurements

b. All secondary noise sources such as drive motor, gearbox, falling water, etc. shall be excluded from any sound level guarantee put forth by Parag.

05.SOUND DATA MEASURED AT AMCA APPROVED LAB IN USA