Important Factors to Consider When Comparing Acoustical Data

Introduction

When forced convection cooling is required, acoustical noise can often be a determining factor on which product or supplier is chosen. It is because of this that it is important to know that the acoustic data being compared was obtained using similar testing parameters. There are several factors that can affect the noise value:

- Measurement method (e.g. ANSI S12.11-1987 vs. Freely Suspended)
- Operating point (e.g. Free delivery vs. Impeded point)
- Distance from the source (e.g. 1 meter vs. 3 feet)

Each of these factors can make a product seem more or less appealing, depending on how it is used.

Measurement Method

The industry standard method for measuring acoustical noise is ANSI S12.11-1987. In this standard the fan is mounted to a specified chamber and the acoustic measurement is taken. Because it is mounted to a chamber, there will be some noise due to structure borne vibration. In order to "pad" their data, some companies will test their product "freely suspended". In this procedure the fan is hung by springs; thus, the fan is isolated from any vibrational influences on the noise. This will make the acoustical noise seem less than it actually is. An example of this is a Patriot DC (Quiet) PQ24B4, a 6.75 in fan. Per ANSI at 3 feet the Sound Pressure Level (SPL) is 54.7 dBA and freely suspended at 3 feet it is 52.0 dBA, a difference of 2.7 dBA.

Operating Point

The fan's operating point can also play and important role when taking acoustical measurements. A fan's acoustic level when measured at free delivery or in the stall region will be much louder than a fan in the efficiency zone of the curve (Figure 1).

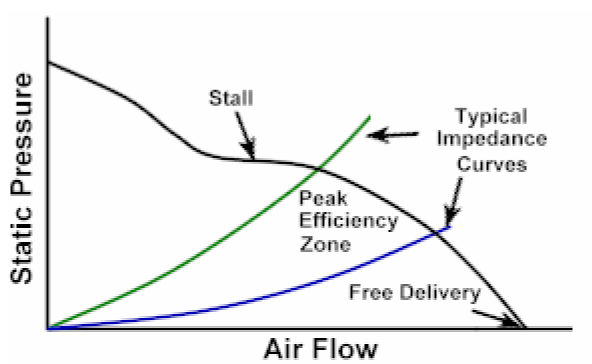

Figure 1: Acoustic Measurements at Different Loads

Looking at our example from before, a PQ24B4 fan, tested per ANSI standards at free delivery is 54.7 dBA. Under the same testing conditions, except at a static pressure point of 0.251 inches of water, the noise level is 52.0 dBA. Thus, acoustical values for a fan at an impeded point in the efficiency zone will appear to be quieter than values for the same fan at free delivery. Please note that when testing freely suspended, the acoustical value given is at free delivery. In order to test a fan at a static pressure it must be mounted to a chamber.

Measuring Distance

The third consideration when comparing acoustical data is distance from the source. This will only be a concern when dealing with the SPL because, the sound pressure is dependent on the radius from the source. In our industry, this distance is typically either three feet or one meter. Though this difference may appear small, its impact on a sound pressure value is significant. The formula for the SPL is:

$$SPL = LwA - 20\log r - 0.6 + C$$

SPL = "A" weighted Sound Pressure Level (dBA re 20 Pa)
LwA = "A" weighted Sound Power Level (dBA re 1 pW)
r = Radius from noise source, feet
C = Correction term for temperature and pressure

The "A" weighted scale is used in the industry to compensate for the fact that the ear is not equally sensitive at all frequencies. When comparing two separate noise sources, even thought the SPL values may be the same, one may appear to be noisier if the sound power is centered around a frequency in which the ear is more sensitive. It is because of this that sound level meters us the "A" weighting scale.

The sound power level attempts to describe the acoustic energy emitted from the source. It is also referred to as Noise Power Emission Level (NPEL). This number is essentially independent of the measurement environment, so it doesn't require the measurement distance to be noted.

Solving for LwA:

LwA = SPL + 20log r + 0.6 - C

Since LwA is independent of the distance from the source:

LwA (at 3 feet) = LwA (at 1 meter)

Therefore:

$SPL_{ft} + 20\log_{10} r_{ft} + 0.6 - C = SPL_m + 20\log_{10} r_m + 0.6 - C$

SPL_{ft} - SPL at 3 feet
SPL_m - SPL at 1 meter (1 meter = 3.281 feet)

Canceling out like terms and solving for SPL:

$SPL_{ft} = SPL_m + 20_{log10} (3.281) - 20\log_{10} (3)$

SPL = SPL + 10.3201 - 9.5424

$SPL_{ft} = SPL_m + 0.778$ dB

From this equation it can be seen that the sound pressure level at 1 meter is 0.8 dB less than it is at 3 feet. As noted in our first example and in the Acoustics Ratings chart, a PQ24B4 fan freely suspended at 1 meter is 51.2 dbA and at 3 feet will be 52.0 dbA. Therefore, SPL values at 1 meter will appear to be quieter. It can also be noted that as a general rule, as the distance from the source is doubled, the SPL decreases by 6 dBA.

As can be seen, it is important that when comparing two quantities or values that you are comparing "Apples to Apples". In acoustics it is important that the measurement method, operating point and distance from the source is taken into consideration when comparing two values. Each of these factors can affect the end acoustical value and make a product seem more appealing. Some companies will only give the best acoustical point such as freely suspended at 1 meter or per ANSI at one meter and at an impeded point. These are all acceptable methods, but unless you compare them to an equivalent value obtained from the same method, they do not provide an accurate comparison. To make it easy, we have posted in our catalog both measurement methods, at free delivery and an impeded point, and with the above-mentioned conversion, the SPL at different distances can be easily calculated.

References:

1. Cyril M. Harris, Handbook of Acoustical Measurements and Noise Control, 3rd ed., (New York: McGraw-Hill, Inc., 1991), p.1.13.