Visit digikey.com

Cooling Fan Noise - Sleeve Bearing vs Ball Bearing

Introduction

Quite often in low-flow electronic cooling fans for computers, where the aerodynamic noise is low, the predominant noise emitted by the fan is generated in the bearing system. This type of fan usually has either an oil-impregnated sleeve bearing or ball bearings. Both bearing systems create noise that can be very different in both frequency content and amplitude. It is generally accepted in the computer and business machine industries that ball bearing fans are noisier than sleeve bearings fans. Furthermore, ball bearing fans can become noisier by mishandling or long term running. This paper will present a brief discussion of the various noise-source mechanisms in each bearing system and will show acoustical data, comparing the two systems against various factors such as life, shock, vibration, etc.

Discussion

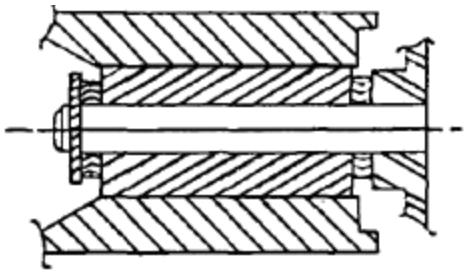

Figure 1-A Sleeve Bearing Assembly

Before discussing the acoustical aspects of sleeve and ball bearings, a brief discussion on the basic operation of each bearing system is in order. Figure 1-A shows a typical sleeve bearing assembly for a small cooling fan. In this particular case the shaft rotates while the bearing is stationary. It is also possible to use a stationary shaft with the bearing rotating. In either case, lubricating oil is impregnated into the porous bronze bearing and is fed to the shaft via the small porosity openings in the bearing bore. Rotation causes a wedge or film of oil to build up on which the shaft rides. If a perfect bearing system could be built, this oil film would prevent metal-to-metal contact and thereby eliminate almost all-bearing noise. Because the shaft and bearing have rough surfaces, at least on a microscopic level, the bearing can create a scraping or grinding sound. Also due to forces such as unbalance and motor driving frequencies, vibration can cause the shaft to rock in the bearing and make contact at the bearing ends. This type of contact causes a knocking or rattling sound. Another source of noise is from the thrust washers which must slide relative to each other thereby creating a rubbing sound. At any rate, noise from a sleeve bearing is usually broad band in nature and somewhat intermittent. However, most good sleeve bearing designs are very quiet and stay quiet until they begin to run out of oil.

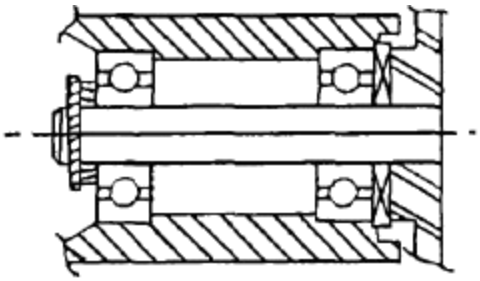

Figure 1-B Ball Bearing Assembly

A typical ball bearing system is shown in Figure 1-B. In contrast to a sleeve bearing system, the ball bearing system is relatively noisy to start with compared to a sleeve bearing and tends to get noisier over time. Because of a ball bearings construction, consisting of an inner and outer race, a series of balls and a cage to support the balls, there are a multitude of possible noise sources. Again surface finish, roundness, alignment, grease, etc. play an important part in noise from a ball bearing. Also ball bearings are easily damaged, particularly in the form of brinnelling, which is a denting of the race following a shock load. This brinnelling, although it has no major effect on life, at comparatively light loads, causes a great increase in noise. Noise from a ball bearing system is both broad band and pure tone in nature and is generally in the higher frequency ranges.

Visit digikey.com

Now looking at some data (see Figure 2) that compares sleeve to ball bearing fans one can see that the ball bearing fans are somewhat noisier than sleeve bearing fans. (Note: data presented is total airborne fan noise including aerodynamic noise). This data supports the fact that, all else being equal, most ball bearing fans are noisier by 1 to 3 dBA over their counterpart sleeve-bearing fan. Also the additional noise is somewhat puretone in nature. Therefore, the annoyance level is considerably higher than with the sleeve-bearing fan. This higher noise level is also in the higher frequency ranges, which makes it even more annoying to the human car.

One area that is important to fan noise is the ability of the bearing system to endure a shock and not become noisier. Sleeve bearing fans, generally speaking, can easily sustain multiple shocks of 80 g's with duration of 11 msec without impacting noise at all. This is not true for ball bearing fans. Figure 3 shows what can happen to ball bearing fan noise if the fan is subjected to 40 g's (11 msec duration). This is a very important factor since the equipment manufacturer has no control over how this equipment is treated after the fan is installed, particularly in shipment. It is quite common for a ball bearing fan to be noisy before it is even used just from the handling of the equipment it is installed in.

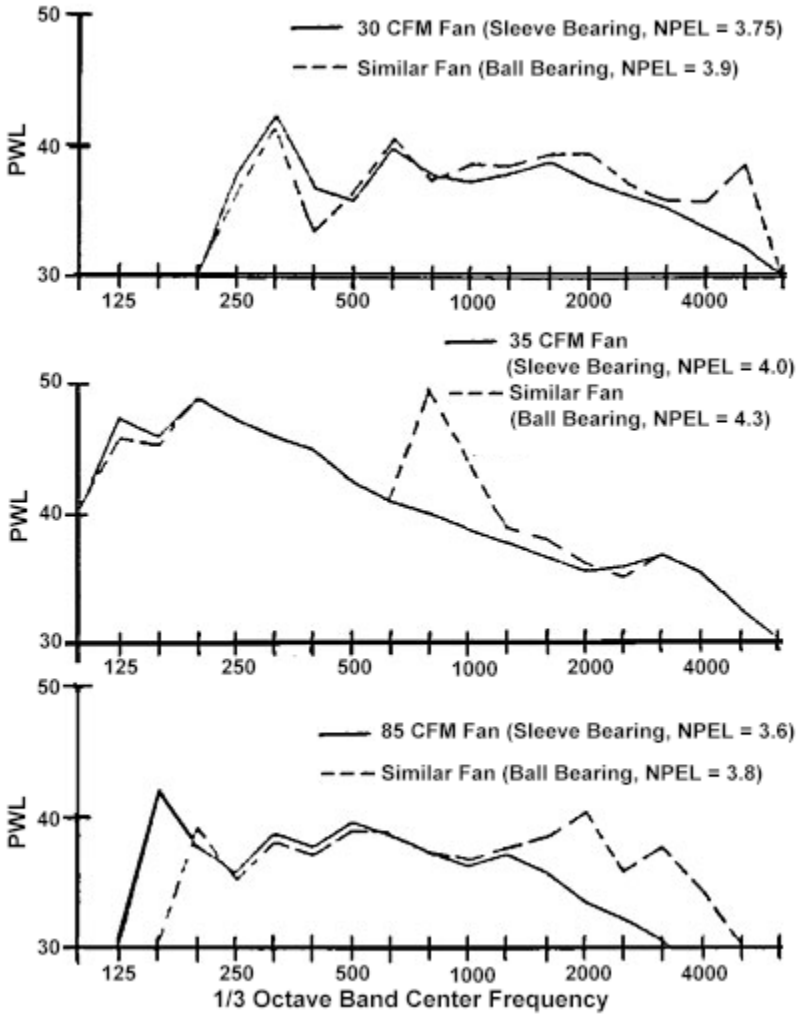

Figure 2: Sleeve Bearing vs Ball Bearing Fan Noise

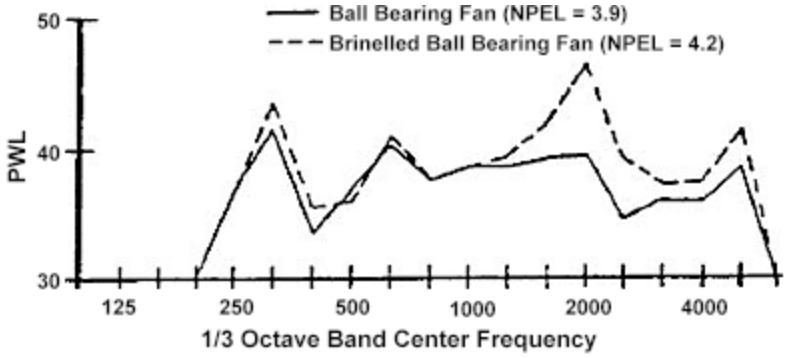

Figure 3: Fan Noise Due to Damaged Ball Bearing

Visit digikey.com

One last important point is what happens to both bearing systems noise level versus running time or life. Typically, sleeve bearing fan noise does not increase due to life. This remains true up until the system begins to fail due to loss of oil however; as can be seen in Figure 4, ball bearing fans can begin to get noisy in a very short time. This increase in noise is due to many facts, such as grease channeling, loss of grease, damaged bearing camouflaged by the grease, etc. Also, as time goes on, the grease may begin to dry out which allows for a very noisy fan, but it will continue to run for a long time. This brings up an interesting point, the reason for the use of ball bearing fans is to extend the fan life past sleeve bearings. However, if usable life were defined to end when the fan became noisy it is quite possible the sleeve bearing fan would out live the ball bearing one.

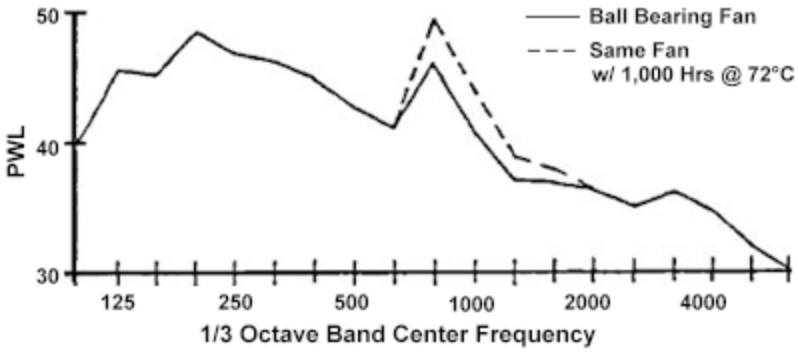

Figure 4: Fan Noise vs Life

Conclusion

The data presented here, though somewhat brief, brings forth a point that fan users should consider before selecting a fan. Even though ball bearing fans appear to have longer life, they most likely will be noisier and cause far more complaints about noise that sleeve bearings fans. The point made here is that in those fan installations that have critical noise requirements, sleeve bearing fans will most likely meet the needs better than ball bearing fans.

There is one additional point to add and that is at low operating temperatures, sleeve bearings and ball bearings have similar life expectancies. At higher temperatures, sleeve bearings have a much lower life expectancy than the ball bearings. At higher operating temperatures, you must always consider the differences in life expectancy as well as acoustical advantages in the different bearings.