GREENHECK

Fan Application

FA/103-00

PRODUCT APPLICATION GUIDE

A technical bulletin for engineers, contractors and students in the air movement and control industry.

Understanding bearings for the fan industry

Bearings are one of the most critical components in the operation of a fan and careful consideration must be given to the selection of the appropriate bearing for each application. Fan manufacturers that have comprehensive product line ranging from small light duty commercial fans to heavy duty, high-speed industrial fans inherently acquire more experience in bearing application. Through the years Greenheck has worked closely with our bearing supplier partners to establish the quality features required for our full range of products, and to provide the bearing life expectancy required by our industry.

The following information is intended as a guide to understand fan-bearing life, components and some of the typical applications for which they are used. We will begin our discussion by defining some of the industry terms used to describe bearing life expectancy.

Bearing Life

Bearing life is usually expressed as the number of hours an individual bearing will operate before the first evidence of metal fatigue develops in the rings or rolling elements. In past years, four different terms were used when referring to bearing life. The terms commonly used were B_{10} or L_{10} and B_{50} or L_{50}. The terms B_{10} and L_{10} had the same meaning and the terms B_{50} and L_{50} also had the same meaning. It's time to end the confusion! In today's terminology the preferred term is L_{10}. However, L_{50} is sometimes used, therefore both meanings must be understood.

L_{10} life: *The preferred term in specifying bearing life.*

The American Bearing Manufacturers Association (ABMA), formerly the AFBMA defines the Basic Rating Life, L_{10} as the bearing life associated with a 90% reliability when operating under conventional conditions, i.e. after a stated amount of time 90% of a group of identical bearings will not yet have developed metal fatigue. L_{10} life is also referred to by manufacturers as the `minimum expected life'.

L_{50} life: *Or average life.*

Although the L_{10} life is the proper method of specifying fatigue life per the ABMA, another term is often used in the industry. The L_{50} or average life is accepted as the bearing life associated with a 50% reliability, i.e., after a stated amount of time, only 50% of a group of identical bearings will not yet have developed metal fatigue. L_{50} life equals five times the L_{10} life.

In other words, to get a L_{50} life equal to a L_{10} 80,000-hour life, you must specify the L_{50} life to be 400,000 hours. The following chart shows a comparison of L_{10} to L_{50} equivalents.

Required L_{10} Life Hours	Equivalent L_{50} (avg) Life Hours
20,000	100,000
40,000	200,000
80,000	400,000
100,000	500,000
200,000	1,000,000

GREENHECK
Building Value in Air.

P.O. Box 410 • Schofield, WI 54476 • 715.359.6171 • Fax 715.355.2399

Writing the Bearing Specification

Basic Rating Life, L_{10} is a useful tool when specifying a given level of bearing construction. When required to provide a given L_{10} life, all equipment manufacturers must supply the same capacity bearing for a given RPM and shaft diameter. Also, an 80,000 hour L_{10} bearing will have a theoretical life twice as long as a 40,000 hour L_{10} bearing and hence will last longer in the field.

Here's Greenheck's recommendation for a typical bearing specification:

"Bearings shall be air handling quality, heavy duty grease lubricated, ball or roller type. Bearings shall be selected for a Basic Rating Life, (L_{10}) of 80,000 hours at maximum operating speed and horsepower for each construction level." (*Air handling quality means the bearings meet the requirements for use in air handling applications; high speeds, long life and quiet operation. All bearings are 100% tested for excessive noise levels and bore dimensions are verified to be within tolerances.*)

Note: If all the fan products you are specifying are from the Greenheck Fan & Vent catalog, you can specify L_{10} 100,000 hour life bearings at no extra charge.

The chart below provides another way to look at the expected bearing life. Assuming you specified Greenheck's standard bearing life of L_{10} 80,000 hours and your fans run an average of 8 hours per day, you can expect 27.5 years of life on 90 percent of the bearings.

L_{10} Life	Average running hours per day		
	8	16	24
80,000	27.5 yrs	13.7 yrs	9.2 yrs
100,000	34.3 yrs	17.2 yrs	11.4 yrs
200,000*	68.6 yrs	34.3 yrs	22.8 yrs

*Years of bearing life for fans running seven days a week, fifty two weeks per year.

In most cases, the Basic Rating Life will be much greater than shown because the bearings are selected for the maximum RPM and horsepower for each size and fan class. Most fans are selected significantly below their maximum fan rpm.

*Bearings with a L_{10} 200,000 hour life are optional for most centrifugal and vane axial products. However, in most cases, it is not practical to specify L_{10} 200,000 because of the associated cost. (And, do you really need the bearings to last for 68 years?) It is more practical for your customer to spend the additional money on maintenance.

Avoid writing bearings specifications without having the correct Basic Rating Life (L_{10} or L_{50}) terms in front of the required hours of life. If your specification reads 200,000 hour bearing life, your chance of getting what you want is minimal. Some suppliers will assume L_{50} 200,000 life is all that's required and you will end up with an inferior bearing system. Other suppliers will assume you are specifying the optional L_{10} 200,000 hour life and add unnecessary cost. The best suppliers will ask for a confirmation of the L_{10} life required.

No Guarantee

Bearing Basic Rating Life is theoretical and is based on a collection of statistics. Specifying a L_{10} life does not guarantee that the fan bearings will have a 90% reliability when installed on a fan in the real world. The calculation for Basic Rating Life assumes proper lubrication is provided, no shock or vibration exists, alignment is virtually perfect, no debris enters the bearings and ambient temperatures are not extreme. In the real world, none of these conditions are realistic and the "installed life" of the bearing will depend on the application and maintenance.

To get as close as possible to the specified life, the installer and end user must follow the recommendations in the manufacturer's installation and maintenance instructions. Once the bearing life expectancy is clearly defined, that information can then be combined with other bearing requirements to select the most appropriate bearing for each application.

Bearing selection

Most manufacturers use some type of bearing selection program that calculates equivalent bearing loads and bearing life. Some of the main selection criteria include shaft diameter and weight; lubricant viscosity; motor horsepower; fan sheave pitch diameter, weight and location on the shaft; fan speed; fan wheel weight; bearing and wheel

locations on the shaft; thrust loads; and the direction of belt pull. Most often the selection program used is one developed by a bearing manufacturer. Greenheck engineers use Dodge bearing selection software. Based on the output results of this data, Greenheck engineers are able to select the bearings that best meet each individual application.

Light duty bearings

Ball bearings with stamped steel housings are well suited for applications with very light loads and lower speeds. The main design characteristic that defines stamped bearings is the rubber sleeve around the bearing insert, which snaps into the stamped housing. The use of these bearings is limited to fan products with 3/4 inch and smaller diameter shafts, and one horsepower and smaller motors.

Ball Bearing with rubber sleeve and stamped steel housing.

Air handling quality

When the operating level of the ball bearings with stamped steel housing is exceeded, air handling quality ball, spherical or tapered roller pillow block or flange-mount bearings are primarily specified.

These bearings have been engineered specifically for air handling applications and feature special construction and tighter quality control. In order for a bearing to be of "air handling quality," it must meet the following specifications:

1. Reduced swivel torque

Proper alignment of the bearing to the shaft is essential in preventing vibration, noise and damage to the bearing components. To allow a bearing to self align under light loading, it must have a low swivel torque. A low swivel torque enables the outer race of the bearing to pivot or swivel within the cast pillow block, allowing the bearing to align to the shaft much easier. It should be noted that this feature is special only to air handling ball bearings and tapered roller bearings. Spherical designs inherently allow for easy self-aligning because the race has a radius that allows the rollers to pivot somewhat within the race, so the race doesn't need to pivot within the pillow block.

2. Noise and vibration testing

All "air handling quality" bearings are 100% vibration tested. These high test standards are designed to discover microscopic manufacturing defects that may either cause higher noise levels or lead to premature failure of the bearing.

3. Bore Size Test

All "air handling quality" bearings are 100% inspected to insure that the inner race diameter is within tolerance. A bore size larger than tolerance would allow the bearing to shift which could cause misalignment.

The benefits of "air handling quality" bearings to the life of ventilation equipment are being seen throughout the HVAC industry. More and more manufacturers are providing air handling quality bearings as their standard.

Ball bearings

The Dodge D-Lok pillow block bearing incorporates a "heavy-clamp-style" locking collar as an alternative to the typical set screw locking system. This design allows the bearing race to be tightened concentrically about the shaft. This type of locking mechanism gives two distinct advantages over the set screw method. First it maintains one common center axis of the shaft and bearing, whereas tightening of the set screw forces the shaft off to one side, offsetting its rotating axis. Secondly, the shaft and bearing race come into surface-to-surface contact upon tightening. This increase in contact surface area not only improves the holding strength of the bearing to the shaft, but it also eliminates problems with burring on the shaft caused by the tightening of set screws.

Application

Greenheck uses Dodge D-Lok ball bearings for all centrifugal, vane axial and industrial units within the ball bearing application range. In our fan and ventilation line, Dodge D-Lok ball bearings are

Ball bearing with D-Lok

used on Greenheck's extended pressure CUBE exhaust fans (Model Cube-XP).

The balance of the fan and ventilator products that exceed the limitations of the stamped steel bearings use the air handling ball bearing with the set screw locking method. This includes fans with a shaft diameter of one inch and larger, and a motor of 1 1/2 horsepower and larger. In applications with lower speeds the D-Lok mechanism is available, however, the D-Lok advantages are negligible and not cost justified.


Ball bearing with set screw

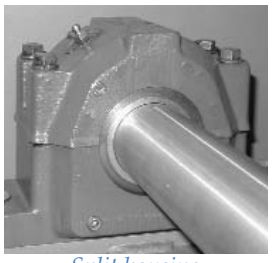
When the application load and speed exceed the capacity of ball bearings, roller pillow block bearings are typically specified. Like ball bearings, roller bearings can carry a combination of radial and thrust loads; however, roller bearings, in order to operate properly, require a radial load at least equal to the thrust load. Insufficient radial loading allows the rollers to skid within the race, which could cause premature failure of the bearing components. Tapered roller bearings that are similar to the spherical rollers, are commonly specified for vertical applications where high thrust loads are encountered.


Roller bearing with set screw

Currently, roller bearings are available with either the standard set screw-locking method, or the Dodge Imperial patented adapter-mounting system (spherical roller bearings only).

Thus far all of the bearing options we have discussed have been in a solid housing, either stamped or pillow block. Once the application exceeds the speed limit for the contact seal and grease sump design of the solid housing, a split pillow block bearing is typically specified. The split pillow block design incorporates a friction-free labyrinth seal and a larger grease cavity. Higher speeds can then be attained and the rollers become the limiting factor instead of the seal.

Split pillow block housings incorporate a tapered adapter sleeve-mount locking system. Because of the geometry of the sleeve-mount design, a larger bearing is required for the same shaft size as would be used in a solid pillow block design. Consequently, the capacity of the rollers increases, thus requiring a higher minimal radial load for proper operation of the rollers.


Split housing

In some applications where contaminants need to be kept out of the bearing, special seals other than the labyrinth-type are used in the split pillow block housing. In these cases, the seal may be a speed-limiting factor and must be accounted for in the selection of the bearing.

In certain products, such as some vane axial belt drive fans, the installation of a pillow block bearing can be difficult simply because of physical space constraints within the belt tube. In such a case, a flange-mount bearing can be used. The bearing components are essentially the same as the pillow block version, but the housing allows for face mounting around the shaft instead of pedestal mounting under the shaft.


Flange mount bearing

Summary

The information in this article is a guideline to help communicate a better overall understanding of bearings and good bearing application.

Don't let your air handling equipment suffer a short life span because of premature bearing failure. Applications are often times unique, and your selection will be based upon the bearing options best suited to your job specifications.

Greenheck engineers have over 40 years of experience in bearing selection and work closely with our vendors to ensure customers receive the highest quality products. Determine what bearing life your application requires and let Greenheck's experienced engineering team specify the right bearing for the job.