CHOOSING A HIGH SPEED GREASE

- DOCUMENTS OF INTEREST

The right choice of the right grease is the key.

Most industrial facilities have bearings that rotate faster than normal processing equipment. When it comes to lubricating these pieces of equipment, not all lubricants behave the same way. For grease-lubricated components, the effects of the grease on the bearings can lead to increased heat, drag and ultimately premature failure. By properly selecting a grease that can handle these higher speeds, you can help minimize any potential failures caused by mismatching the lubricant to the application.

High-speed Applications

During the frequent plant visits of our technicians, they often are asked about the temperature at which bearings should operate. Inevitably, the bearings that seem to be running the hottest are the ones that rotate the fastest.

A clear example are overhanging fans. This fans are frecuently belt-driven at a 1-to-1 ratio from a large electric motor with an average speed of the motor of 1,750 revolutions per minute (rpm).

If there are no reduction or increase in pulley size, it is safe to assume the speed of the bearings is quite similar. Frecuently these bearings are greased with a product that is much too thick for them, leading to the generation of excess heat and shortening the bearing life.

By matching the grease properties more closely to the bearing needs, you can help prolong the life of the bearing.

While this example paints a picture of a type of machine in most plants (fans), it is common to find high-speed applications in other components as well. For instance, some pumps that are directly coupled to a motor and have grease-lubricated bearings may spin in excess of 2,000 rpm. The same holds true for certain mixers, agitators and blowers. These components may suffer if a multi-purpose grease is simply applied without much regard to the needs of the bearing. To understand what the bearing requires in terms of lubrication, you must first learn how to determine the speed factor of a bearing.

Calculating the Speed Factor

The speed factor is a term that helps define the relationship of the speed at which a bearing rotates with the size of the bearing. There are two main ways to calculate this factor. The first is known as the DN value, which uses the bearing inner diameter multiplied by the speed at which it rotates. The second method is known as the NDm value. This uses the bearing's median size, also known as the pitch diameter, and the rotation speed to calculate the speed factor.

The speed factor can help you determine a variety of lubricant properties, which you can then utilize to select the proper lubricant. Among these properties would be the viscosity of the oil and the National Lubricating Grease Institute (NLGI) grade of the grease for the application.

Viscosity

The most important physical property of a lubricant is the viscosity. Viscosity is what determines how thick or thin the lubricating film will be based upon the load, speed and surfaces in contact. This must be matched to the needs of the bearing. Most general-purpose greases have a base oil viscosity of around 100 to 220 centistokes. While these type of greases may work fine for moderate speeds and loads, when the bearing speed increases, the viscosity must be reduced accordingly.

GREASE TYPE	BASE OIL VISCOSITY (40ºC)	SPEED FACTOR (NDM)
Slow-speed High-preasure industrial grease	1,000-1,500 cSt	50,000
Medium-speed High-preasure industrial bearing grease	400 - 500	200,000
EP, NLGI#2, multi-purpose grease	100 - 220	100,000 200,000
High-speed High-temperature long-life grease	<70	600,000
High-speed long-life grease	15-32	>1.000,000

There are many ways to calculate viscosity. By utilizing the speed factor mentioned earlier, you can use standardized charts to identify an appropriate viscosity for the bearing at the operating temperature.

In the previous example of the fan bearing, the NDm value of the bearing was 293.125, which led to a base oil viscosity of approximately 7 centistokes. The bearing was operating at around 150ºF (65.5ºC). With a standard viscosity index of 95, this equates to an ISO 22-32 base oil viscosity.

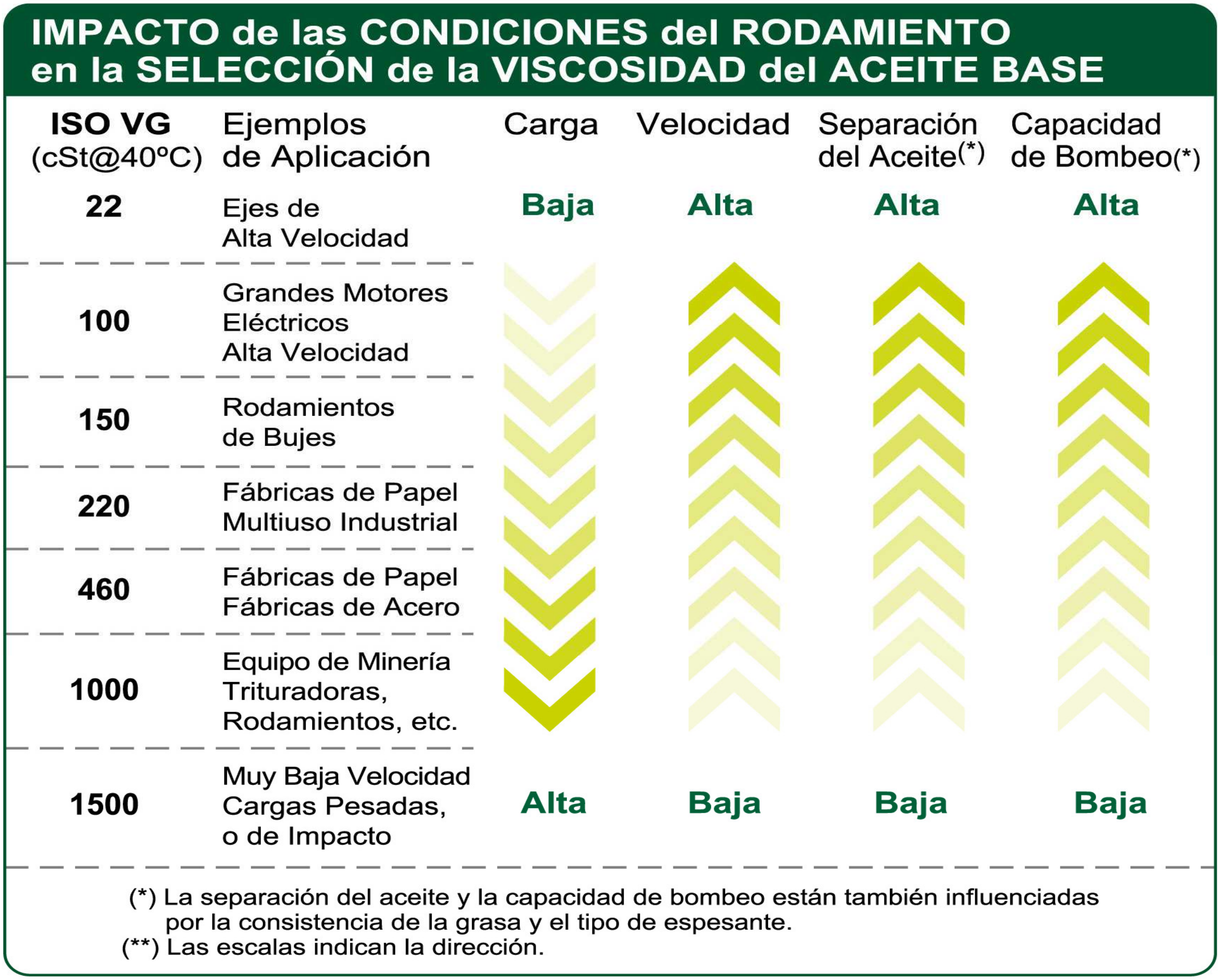
If you were to use a standard multi-purpose grease, this bearing would receive about 10 times the viscosity needed. Although some excess viscosity isn't necessarily a bad thing, this level would be a bit extreme.

Excessive viscosity can lead to excess heat generation and increased energy consumption. Both of these are detrimental to the health of the bearing and the lubricant. The hotter the bearing runs, the lower the viscosity of the grease becomes. This can cause increased grease run-out and require more frequent applications of fresh lubricant grease. The energy consumption can also add up over time, resulting in money lost due to nothing more than the increased drag from excess viscosity.

With grease, it is common to be able to lubricate bearings easily until they reach speed factors greater than 500,000. This is when specially formulated high-speed greases are employed. Some greases on the market are touted to work up to speed factors of 2 million. However, it is worth noting that not all greases are created equal, and not all can perform well at varying speed levels.

Channeling Characteristics

One property of a lubricating grease that can determine how it will lubricate at high speeds is called channeling. This term is used to define how well grease can flow and fill a void left in its surface. Method 3456.2 of Federal Test Method Standard 791C offers one way to test the channeling characteristics of a lubricant. In this test, grease is applied to a container, and the surface is leveled off.



After the temperature has been stabilized, a steel strip, known as the channeling tool, is pulled through the grease, leaving behind a void or channel in the grease. After 10 seconds, the grease is checked to see if it has flowed back into the channel or covered the bottom of the vessel. If the grease has filled the void, it is known as non-channeling.

If the grease did not fill the void, it is labeled as a channeling grease.

Channeling greases are more easily pushed out of the way of the element as it rotates, thus leading to less churning and less temperature gain. Greases that are non-channeling flow back into the path and can result in the generation of excess heat because of the friction.

Thickener Type

Aside from the base oil viscosity, another grease property that impacts its channeling characteristics is the thickener type. The thickener in a grease is commonly referred to as the “sponge that holds the oil”. The structure of the fibers in the thickener can affect certain grease properties, such as channeling, bleed, dropping point and overall consistency. Some grease thickeners have long fibers, while others have short fibers. Short-fibered thickeners will have a smoother texture. More complex thickeners, as well as those with lithium, calcium, polyurea and silica thickeners, are short-fibered. The greases formulated with these thickeners typically have better channeling characteristics and are more easily pumped.

Long-fibered thickeners, such as those with sodium, aluminum and barium, tend to have worse channeling characteristics. The longer thickener fiber can also be sheared through the churning process, which can cause a change in consistency. In addition, since these greases often flow back into the channel that has been cut by a bearing, they can result in an increase in heat and exacerbate the shearing process.

NLGI Grade

The base oil viscosity and the amount of thickener concentration greatly influence the NLGI grade of the finished lubricating grease. The NLGI number is a measure of the grease's consistency. The higher the NLGI number, the thicker the overall consistency. The scale ranges from 000 (fluid like) to 6 (solid block). When it comes to high-speed greases for rolling-element bearings, the NLGI grade tends to go up while the base oil viscosity goes down.

OPERATING TEMPERATURE	DN SPEED FACTOR	NLGI Nº. (*)
-30 to 100ºF (-34,4 to 37,7ºC)	0-75.000 75.000-150.000 150.000-300.000	1 2 2
0 to 150ºF (-17,7 to 65,5ºC)	0-75.000 75.000-150.000 150.000-300.000	2 2 3
100 to 150ºF (37,7 to 135ºC)	0-75.000 75.000-150.000 150.000-300.000	2 3 3

(*) Depends on other factors as well, including bearin type, thickener type, base oil viscosity and base oil type.

This balance is to ensure there isn't excess oil bleed from the thickener. Based upon the bearing's speed factor as well as the temperature in which the bearing operates, we can draw solid conclusions about the appropriate NLGI grade of the grease.

Bearing Type

Rolling elements in bearings come in a variety of shapes. The shape of the element makes an impact on the required viscosity, NLGI grade and regreasing interval. This all has to do with the amount of surface area in contact with the grease between the element and the race.

The more surface area, the more the oil will be wrung out of the thickener. Also, the bearings that have more contact (spherical, cylindrical, needle, tapered roller, etc.) tend to be more heavily loaded than a standard ball bearing. This added load lends itself to an increased separation rate as well as the need for higher viscosity base oils.

BEARING TYPE	RELATIVE LIFE OF GREASE
Deep-groove, single row ball bearing	1
Angular contact, single row ball bearing	0,625
Self-aligning ball bearing	0,77 - 0,625
Thrust ball bearing	0,2 - 0,17
Cylindrical, single-row roller bearing	0,625 - 0,43
Needle roller bearing	0,3
Tapered roller bearing	0,25
Spherical roller bearing	0,14 - 0,08

Dropping Point

Perhaps one of the most notable considerations when selecting a high-speed grease is the temperature at which the bearing will operate. To ensure the selected grease will perform at elevated temperatures, we should check the dropping point of the grease (ASTM D566 and D2265). These test results can be found on most all grease technical data sheets. The test uses a small cup with a hole in the bottom in which the grease is applied to the inside walls. A thermometer is then inserted but does not touch the grease. This apparatus is then heated until a single drop of oil separates and drips out of the bottom of the cup. The temperature at which this occurs is the dropping point of the grease.

TYPICAL MAXIMUM OPERATING GREASE TEMPERATURE

- If dropping point (DP)<300ºF, subtrac 75ºF from the DP
- If 300ºF <DP <400ºF, subtrac 100ºF from the DP
- If DP>400ºF, subtrac 150ºF

A high dropping point is important for bearings operating at elevated temperatures.

However, just because a grease has a high dropping point doesn't mean the base oil can withstand elevated temperatures.
The dropping point does not equate to the maximum usable temperature. There should be a buffer between the temperature at which the bearing operates and the dropping point of the grease. it.

Incompatibility Issues

When changing grease types, it is important to remove as much of the old grease as possible to minimize any incompatibility issues with the new grease. If feasible, disassemble the equipment and clean out as much of the grease as possible.

A piece of Advice

Although the majority of applications will be properly lubricated with a general-purpose grease, for those instances when the NDm value is excessively high, it is essential to ensure the lubricant is able to protect the equipment. Even if you are diligent and select a grease based upon all the previously mentioned properties, the only way to truly know if the grease will perform in the desired manner is to conduct a field trial. Monitor the bearing temperature and look for any signs of grease or oil leaking out from the seals or purge vents.

Finally, be sure to do your homework and calculate the NDm values of your bearings in order to select the appropriate lubricant. With proper attention and lubricant selection, your high-speed equipment will enjoy a longer service life.

6 Factors for Selecting a High-speed Grease

Base Oil Viscosity – Ensure the viscosity adequately provides the lubricating film but is not too thick to cause excessive heat and drag.

Channeling Characteristics – The grease should be able to channel so excess heat isn't generated from grease churning.

Dropping Point – The dropping point of the grease should exceed the operating temperature by a wide margin to avoid excessive bleed and possible bearing failure.

Thickener Type – Choose a thickener that can provide the proper dropping point, channeling and bleed characteristics. Also, if you use multiple greases, check the thickener types for compatibility in case of accidental mixing.

NLGI Grade – The consistency of the grease will have an impact on the bleed characteristics and channeling properties of the finished lubricating grease.

Additive Load – Most applications require additives to help the oil lubricate. For greases, a wide variety of chemical and solid additives can be blended to aid in film strength and reduce friction and wear.