Bearing lubrication is essential for reliability

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One of the major contributing factors to achieving reliability is proper lubrication.
Bearings operate on very thin films of lubricant, which have to be maintained to ensure that design life is achieved.
The ways of ensuring this - and maximizing bearing life - are: first to select the correct lubricant; secondly to apply it properly; and thirdly to maintain it in a clean condition.

Neglect or failure in any of these areas will seriously increase the risk of premature bearing failures and interfere with the trouble-free running that is now of such crucial importance in ultra competitive global markets.

The increased speeds and higher temperatures at which modern bearings routinely operate, combined with the demands placed on them for improved accuracy and reliability, mean that the process of selecting a suitable bearing lubrication, today, is more critical than it has ever been.

Properly selected a lubricant will: reduce friction and wear by providing a hydrodynamic film of sufficient strength and thickness to support the load and separate the balls from the raceways, preventing metal-to-metal contact; minimize cage wear by reducing sliding friction in cage pockets and land surfaces; prevent oxidation/corrosion of the bearing rolling elements; act as a barrier to contaminants; and serve as a heat transfer agent in some cases, conducting heat away from the bearing.

Bearing lubricants fall into three main categories: oils, greases and solid dry film lubricants,
which are usually limited to moderate speed and very light loading conditions.

Greases, because of their convenience, are by far the most widely used of the three, and have been the focus of much development over the last decade.

The selection of a particular type of bearing lubricant is generally governed by the operating conditions and limitations of a bearing system. Three of the most significant factors in selecting a lubricant are: the viscosity of the lubricant at operating temperature; the maximum and minimum allowable operating Temperatures; and the speed at which the bearing will operate.

The primary advantage of grease over oil is that bearings can be prelubricated, eliminating the need for - and the cost of - an external lubrication system.

Besides simplicity, grease lubrication also requires less maintenance and has less stringent sealing requirements than oil systems.Grease tends to remain in proximity to bearing components, metering its oil content to operating surfaces as needed.

The negatives with grease are that it does not conduct heat away from a bearing as efficiently as oil. In addition, grease can increase the initial torque within a bearing and cause running torque to be slightly higher.

Finally, the speedability limits for greases (expressed as a dN value, with dN being the bearing bore in millimeters multiplied by the rotational frequency) are generally lower than for oils due to the plastic nature of grease that tends to cause overheating at high speed.

Although grease lubrication is inherently simpler than lubrication with oil, there are still applications where oil is the better choice.

In high-speed spindle and turbine applications, for example oil is supplied continuously and provides cooling as well as lubrication.

A further example is instrument bearings with extremely low values of starting and running torque. These require only a minimal, one-time lubrication, each bearing receiving just a few milligrams of oil - a single drop or less.

The limiting speeds for oil-lubricated bearings are imposed by the bearing size and cage design, rather than by the lubricant.

To illustrate this point, petroleum or diester-based oils can accommodate bearing speeds up to 1,500,000 dN or higher. In the case of silicone-based oils, the maximum speed rating drops to 200,000 dN.

Similarly, when computing life for bearings lubricated with silicone-based oils, the basic load rating (C) should be reduced by two-thirds (C/3).

In addition, to ensure long life at high speeds, the lubrication system should provide for retention, circulation, filtration and possibly cooling of the oil.

Solid soft films are primarily used to provide solid lubrication for bearings in extreme applications where traditional fluid lubricants would be rendered ineffective.

They offer the advantages that their friction is independent of temperature (from cryogenic to extreme high temperature applications), and they do not evaporate or creep in terrestrial vacuum or space environments.

The solid soft film lubricant can either be applied directly to the surface or transferred by rubbing contact from a sacrificial source such as a self-lubricating bearing cage.

Examples of these two processes include the application of physical vapour deposited MoS_2 and PTFE-based TB polymeric cage material.

The processes are complementary and have been used successfully in a variety of extreme aerospace applications.

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