Rolling On

Validating grease-lubricated rolling bearings for large decanter centrifuges

Jan Cederkvist

They might seem small when faced with the big picture, but rolling bearings are one of the most critical and important elements of a decanter centrifuge. Normal operating conditions require bearings to rotate at high speed while simultaneously carrying a significant load. Their proper operation is essential to trouble-free operation.

The limiting speed of rolling bearings is influenced by a host of factors, including bearing design, arrangement, and cooling; manufacturing accuracy; and lubricant selection.

While both grease and oil typically are used as bearing lubricants, it once was thought that large decanters had to rely on the more complicated and costly oil-lubricated bearings. However, grease-lubricated bearings hold various advantages, such as simple and compact design, fewer installation costs, protection against bearing contamination, and low power consumption.

Changing the Rules

The traditional guideline when selecting a grease-lubricated bearing has been that the number of revolutions per minute (N) times the mean diameter of the bearing in millimeters (Dm) — that is, N•Dm — should not exceed 500,000. Because this value inevitably will increase with decanter size, it has been common practice to choose oil-lubricated bearings for the large decanter centrifuges, despite the advantages of using grease lubrication.

"It is not only possible — but in many cases desirable — to design a large decanter with grease-lubricated bearings," said Peder Dalgaard, a bearing application specialist at SKF (Göteborg, Sweden), a bearing manufacturer.

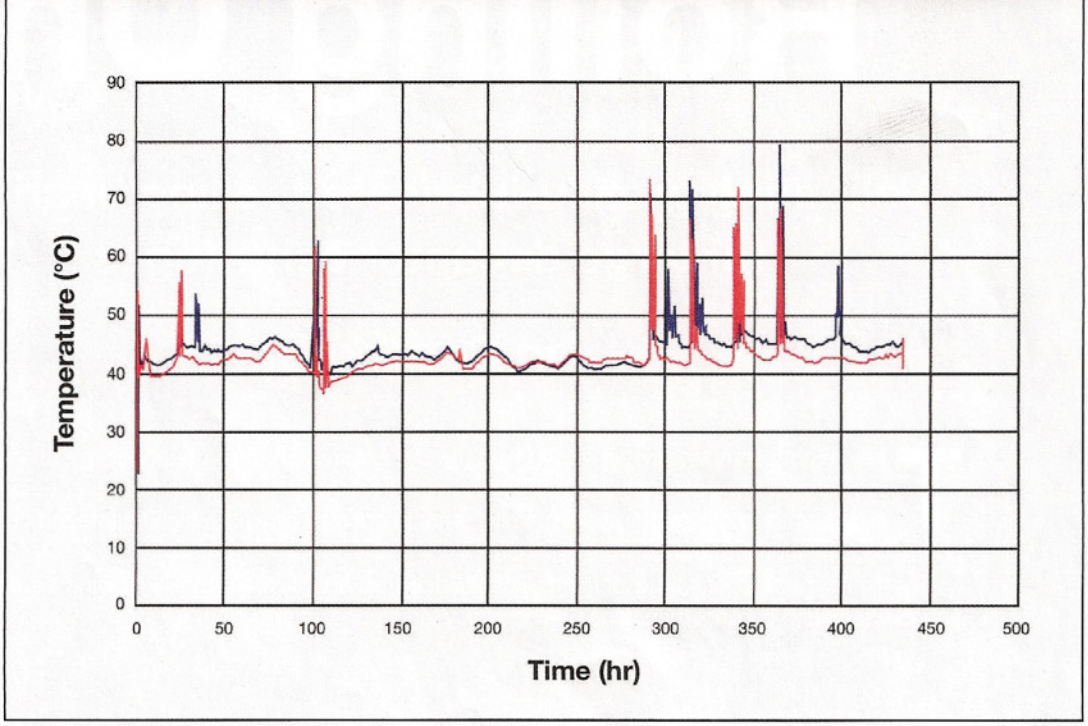
Lubrication grease is a solid lubricant consisting basically of a thickener and a lubrication oil. It is the oil, which is released gradually from the thickener, that lubricates the bearing. Grease has several advantages when used on decanters, compared to oil lubrication.

Decanter centrifuges are most often used in harsh environments where protection against ingress of dirt and grit into the bearing is of utmost importance. A lubrication grease will help seal the bearing and protect against contamination, as long as the bearing arrangement is designed properly. In fact, this can be much more reliable than more complicated and costly sealing arrangements.

Many oil lubrication systems used on large decanters are based on an oil-circulation system in which a larger amount of oil is circulated through the bearings. The circulating oil is filtered continuously to remove contaminants. For many years, circulating-oil systems have been used with large decanters, and they have proven to be reliable. The circulating oil, however, will brake — meaning produce slight resistance — the bearing and generate heat. Thus, circulating-oil systems require both external cooling of the oil and increased power to operate the decanter, when compared to grease-lubricated bearings.

Other oil lubrication systems inject small, controlled amounts of oil into the bearings. These systems have some of the same advantages of grease systems but do not offer the sealing properties of grease. In general, these systems also require more-sophisticated controls and may be more vulnerable to the harsh environment typical for decanters.

Bearing Temperature Versus Time at Overgreasing Test



Living Large

As a manufacturer of decanters, Alfa Laval (Lund, Sweden) has a wealth of experience using bearings with both grease and oil lubrication systems. The company set out to validate the idea of using grease lubrication as a reliable option for even the largest decanter centrifuges.

The first stop was bearing manufacturer SKF to define the properties that lubrication grease must have to work with both high-speed and decanter application environments. This project included extensive field testing and laboratory examinations, which became the basis for the guidelines developed for standard operational parameters for optimizing lubrication.

Teams worked directly with the bearing manufacturers in full-scale laboratory experiments on large decanters. They tested both grease- and oil-lubricated decanter centrifuges — examining several specific parameters, including bearing lifetime calculation, selection, and design.

Several years of investigation and testing led to a series of experiments to simulate actual applications and adverse conditions that bearings may encounter in large decanters. The experiments included normal operating conditions, starvation, and overgreasing of bearings, as well as tests with additional heating of the bearing surroundings to simulate high-temperature operation.

To run at high speed with grease-lubricated bearings, careful selection of lubrication grease is important. Lubrication grease is a complex product, and many parameters must be considered when selecting the grease for a particular application. Important parameters to consider include base-oil viscosity, thickener type, corrosion protection, stiffness, mechanical stability, oil separation, temperature limits, water resistance, and corrosion protection.

Base-oil viscosity is one of the important parameters because it determines the lubrication film between the moving elements in the bearings and heat generation in the bearing. The desired base-oil viscosity will depend on internal velocities in the bearing and the bearing load, so it must fit the bearing design.

All parameters are important due to the complex nature of grease, and conducting a field test on the design is recommended when a new or alternative grease type is selected.

Smooth Operation

The test results show that even with a large decanter centrifuge, grease lubrication is stable. The figure (p. 60) shows bearing temperatures measured in one of the tests. The specific test is an overgreasing test, where more grease than specified is deliberately added to the bearing at brief intervals. It is a common fault that users add too much grease to a bearing, which may be more harmful than adding too little.

The test's purpose was to see how well the design of the bearing components for a large decanter handles this situation. The bearings tested are a roller bearing (blue line) and a deep-groove ball bearing (red line). The curves show bearing temperature versus time. The temperature peaks, which are normal for grease lubrication, occur each time grease is added to a bearing and are due to the friction created until the grease is properly distributed inside the bearing and bearing housings. The graph shows that the temperature after lubrication drops quickly to resume a normal stable level. The stable bearing temperature is between 40°C and 50°C — a good operating temperature for the bearing.

Correct lubrication with respect to grease amounts and lubrication frequency is crucial for stable operation of large decanters. How much grease is needed — and when it is needed — depends on the size, design, and load applied to the bearings. It is important to combine both application experience and bearing-supplier knowledge to determine the correct grease amounts and intervals.

One way to ensure proper greasing amounts and intervals is to use an automatic lubrication system. Advantages of such systems include safer operation, a lower man-hour requirement, and more consistent and constant greasing intervals. An automatic lubrication system will yield better control, as the bearings are sent the precise amounts of grease needed, eliminating the problems of too much or too little grease. Further, automatic lubrication allows for shorter intervals between lubrication, as well as smaller amounts of grease, providing even further consistency of lubrication to the bearings.

Reliable at a Variety of Sizes

With this knowledge in hand, utilities and companies will be better equipped to choose between grease and oil lubrication systems for their centrifuge operations without compromising reliability. When choosing grease-lubricated bearings, those users will be able to take advantage of the inherent low power consumption, simple and compact design, lower installation costs, and protection against bearing contamination over oil-lubricated bearings.

Jan Cederkvist *is manager of mechanical technology in the product center for decanters in the Copenhagen, Denmark, office of Alfa Laval (Lund, Sweden).*