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Bearing Application Solution for Magnetic Clutch Failures

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8/26/2013 Post a comment

We recently asked Richard Spore, a bearing applications engineer for C&U Americas, to define the solution for a problem faced by one of his customers. Clearly, this problem is likely prevalent with more than one customer. The problem is that a refrigeration transport equipment maker is experiencing excessive warranty costs for products used in over-the-road refrigeration applications. The warranty issues were being caused by bearing failure in the magnetic clutch used in the system.

Magnetic clutches are used in a various automotive applications, especially for over-the-road refrigeration trucks or "reefer" units. Typically, the bearings in the reefer unit's magnetic clutch work well as long as the unit is operating and providing refrigeration. When the truck is between deliveries and not carrying a load that requires refrigeration, the unit is shut down. This is where the problem begins.

As the truck is driven, a large amount of vibration is transferred to the components of the reefer unit. Because the clutch is idle at this time, the bearing components tend to vibrate, or oscillate, against one another. The balls oscillate against the inner and outer bearing rings, or raceways, and cause metal-to-metal contact. In some cases, the presence of bearing grease in the raceway may help to offset the metal-to-metal contact. However, there's usually enough vibration and oscillation occurring during these long idle periods to cause metal-to-metal contact between the balls and the raceways that can shorten bearing life. Typically, 50 percent of the clutches require premature service or repair, resulting in astronomical warranty costs.

The initial design used by the refrigeration transport equipment maker was based on two 61908 bearings stacked together. The refrigeration transport provider learned that another division of its corporate parent had experienced similar metal-to-metal contact issues with other components and was able to successfully address the problem by using a thin dense chrome (TDC) coating, called Armoloy, to create a sacrificial surface. Believing that this type of coating would work in a magnetic clutch application, the refrigeration equipment maker began a search for a bearing company to partner with, which is how C&U Americas came into the picture.

The manufacturer was very concerned about both the high warranty costs it was incurring and also the strain that this issue was placing on customer relations. As a result, the initial design plan spared no expense in the development of a bearing that would solve the clutch problem. The new design incorporated rings coated with Armoloy and used ceramic balls in lieu of steel. A standard bearing typically uses steel balls. But to maximize the reliability of the clutch bearings, balls made from silicon nitride (SiN4) were used due to their high strength and light weight.

C&U sent the inner and outer base rings of the bearings to Armoloy, where a proprietary method was used to prepare the rings for coating. All of the surfaces that would receive the Armoloy coating had to be honed beforehand to ensure proper adhesion of the thin dense chrome. The coating's thickness was carefully monitored to maintain a tolerance of about 1 to 2.5 microns on all critical functional surfaces. After the coating was applied, C&U completed the final assembly.

The new bearings were then subjected to many hours of stringent testing to validate the design, including the development of a special bearing test stand. Additional hours of field-testing, in real-world conditions, were also logged to further prove out the new design.

Part two of the solution was to come up with something more economical. The recommendation was to use a magnetic clutch bearing with the same envelope dimensions as two of the current 61908 bearings. The only real hurdle here was adding the Armoloy coating to the inner and outer rings while still maintaining consistent quality and internal clearance, and also keeping in mind that it was for a bearing that was twice as wide as the previous design. The Armoloy designers addressed the issue by developing new racks for coating the double row bearing. The solution maintained the required coating thickness.

The manufacturer then tested the use of steel balls in lieu of ceramic balls to help decrease the cost even further. The tests were successful and the second, more-economical design was implemented.

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