METHODS FOR ASSESSING THE BEARING SURFACE DURABILITY PERFORMANCE OF LUBRICANT FORMULATIONS

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ABSTRACT

Lubricant formulations and lubricant additives have been demonstrated to have a major impact on the surface durability of rolling element bearings. However, there are very few standard tests used to assess the performance aspects of lubricants as it relates to bearing surface performance. Lubricant formulations have been slanted heavily toward protecting gear concentrated contacts from galling and wear. In addition, much of the performance differentiation of lubricants has been dependent on highly accelerated standardized laboratory tests related to gears. Methods have been developed for properly evaluating a lubricant’s performance characteristics as it relates to bearings. These methods are explained and the corresponding test results are reviewed to show their effectiveness as a lubricant performance evaluation tool. The implications of these findings provide direction and suggestions for ways to minimize or avoid potential detrimental performance effects of lubricant formulations on rolling element bearings.

IMPORTANCE OF TEST PARAMETERS

Many of the lubricant evaluation tests being used by the industry involve fixing various operational parameters and then making a comparison of one lubricant formulation relative to another. In actual applications the lubricant itself can have an influence on some of the very parameters being fixed in the evaluation test. A prime example of this issue is the operating temperature of any equipment for which the lubricant is intended. One lubricant may allow the system to operate at a lower temperature while another may drive the operating higher. Therefore, it is important to include such operating variables into evaluation tests and thus to have appropriate comparisons in performance. In our example here, forcing a lubricant to operate at a fixed operating temperature would not be a fair comparison relative to any lubricant, which on its own, will operate at a much higher temperature.
TEST METHOD PROPOSAL

Any test protocol should give consideration to the above issues. Such considerations should help establish the performance durability of rolling element bearings. What should be done when properties of the lubricants are different? Any test proposal should be a multiple phase evaluation that would give consideration to the lubricant operating characteristics of each lubricant.

LUBRICANT OPERATING CHARACTERISTICS TEST

If a new set of bearings lubricated with a formulation of interest are continuously loaded over time, a response to the loading will be seen in the form of operating temperature and rotational friction (torque to turn). This type of test could then be used to establish the operating temperature for each lubricant in the surface durability test, the second phase of any evaluation. The typical loading cycle for the initial phase is shown in Figure 2.

In order to demonstrate how effective this first phase is in differentiating lubricant operating characteristics, two lubricants were evaluated under this protocol. One was a mineral oil formulation and the second was a synthetic base stock intended for fuel economy gains. The chart shown in Figure 3 compares the results of the evaluation for the initial phase. It is noted the synthetic lubricant initially ran hotter than the mineral oil during the break-in portion of the test but then ran at a lower operating temperature after each had stabilized under the constant load portion of the test program.

SURFACE DURABILITY EVALUATION TEST

As illustrated in the phase-one test program, operating temperature plays an important role in differentiating lubricants. Therefore, any surface durability evaluation should include it as a variable in the test protocol. For the second phase of the evaluation, the loading and operating conditions were selected to recognize the different operating temperature between the two lubricants. This arrangement was used for testing the two lubricants using groups of bearings from the same population.

PERFORMANCE TEST RESULTS

The summary results for the surface durability test program are shown in Figure 4. It is interesting to note that the performance of the synthetic gear lubricant formulation was superior to that of the mineral oil formulation on the order of 2.25 to 1.00 at a 90% confidence level. This performance level was achieved despite the differences in viscosity of the two products. This does illustrate the need to include other operating characteristics in any evaluation.

CONCLUSIONS

It has been demonstrated that the impact of lubricant formulations on rolling element bearings should be evaluated by including additional test parameters. One consideration is to include lubricant operating temperature differences.

REFERENCES