Synthetic lubricants for use in rolling element bearings

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Editor's Note: PDFs of this article are available in English and Spanish in the "Resource Library" at **www.easa.com**.

My first exposure to synthetic lubricants for rolling element bearings was during repair of high-speed, automotive engine-test dynamometers. For several years, our service center had repaired similar machines with rolling element bearings, but they were all oil lubricated by pump systems with specially-selected fittings near the bearings to deliver only small amounts of oil per minute.

We began to see rolling-element-bearing machines in for repair that were grease lubricated, and these displayed a specific make and type of lubricant on the nameplate. We purchased what was specified on the nameplate and all was well. Over time, we began to see more machines specifying the same make of grease, but a different grade or type. This led me to begin looking into the differences in the products, since each one was fairly costly and had a limited shelf life (for instance 24 months if in an unopened container).

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In the process of studying the maker's selection information, I saw that for many products, the speed factor "n*dm" was a key selection criteria to determine the base oil viscosity at maximum speed. This factor is the product of the speed (n) in rpm and the mean diameter (dm) of the bearing in millimeters (outside diameter plus bore divided by two). As an example, consider a 6316 bearing in a 3590 rpm motor. The calculation would be:

3590 x ((170 + 80)/2) = 448,750

This factor is a way of stating the linear speed of the rotating elements.

Details of the process

I had the opportunity to arrange a technical presentation for our local vibration chapter by engineers from a well-known manufacturer of traditional and synthetic lubricants. The manufacturer described details of the processes that produce both. As a simple summary, mineral oil begins as a component of crude oil and goes through a subtraction process where most impurities are removed and an end product of similarly-sized molecules is the result. The synthetic lubricant is the result of an additive process, has molecules of more consistent shape and virtually no impurities. An illustration similar to **Figure 1** was presented, and for me suddenly the advantage of the synthetic lubricant became much clearer. The molecular structure of the synthetic lubricant enables it to better keep the metal parts separated, resulting in less friction, less heat and longer life for the lubricant.

> *"When selecting a lubricant, viscosity is the single most important criteria. Regardless of type, the viscosity of a lubricant changes with load, temperature and speed. For each of these, synthetic lubricants vary less than the mineral oil lubricants they may replace. As an example, for many of the dynamometers we repaired, the lubricant needs to be suitable for any speed in a very wide operating range, from 800 rpm to 8000 rpm, or even higher."*

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Given that synthetic lubricant makers publish viscosity ranges that are wider than mineral oil lubricants, it is possible that fewer products may need to be used for a range of applications. Due to synthetic lubricant temperature and efficiency advantages, their manufacturers claim longer life, as much as 4 to 5 times compared to mineral oil lubricants. These factors help to offset

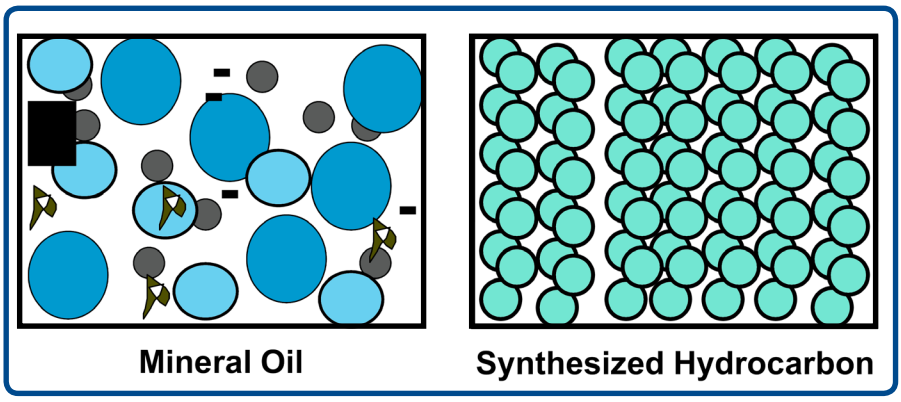

Figure 1. Molecular level image of mineral oil (left) and synthesized (synthetic) hydrocarbon (right).

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the increased cost of synthetic greases that are 10 to 20 times more in this author's experience.

My exposure to the "n*dm factor" and its logic was helpful in diagnosing bearing faults in more generic equipment. For instance, one customer had several 2-pole chiller motors with a 6316 bearing on the drive end. The customer experienced less than normal bearing life. That motor manufacturer recommended a mineral-oil based grease. The "n*dm" factor is the same as used in the example above (448,750), a value near the stated upper limit for any mineral-oil-based grease I had seen. As part of the repair, we instead used a synthetic grease easily capable of the calculated "n*dm" factor. More normal bearing life was obtained.

Range of synthetic greases

In this author's experience with a range of synthetic greases, the data published by the manufacturer includes the thickener used. For mineral oil greases, there are guidelines for compatibility of greases based on the thickeners. If one desires to add a synthetic to a machine having some mineral oil grease, I would check with the manufacturer of the synthetic before proceeding. Otherwise, if adding grease, I'd try hard to get the identical product; if that's not possible, adhere to existing guidelines on grease compatibility based on the thickener.

> ***"I would encourage all to consider synthetic lubricants for tough applications and where their price premium can be well justified. A well-respected vibration analyst I know once stated that the synthetic lubricants were all smoke and mirrors. I can confidently state that was not my experience."***

Now, lest anyone think I am getting synthetic lubricants without cost for my cars for the rest of my life, I have no such reason to promote synthetic lubricants. I can only report that the specified synthetic lubricants we encountered worked for years and years in machines where the speed factors were 1,000,000 or more, clearly beyond the range of mineral-oil lubricants. In our service center, I recommended a review of the lubricant we would use for any bearing with an "n*dm" factor greater than 400,000.

Also, once one considers lubricants beyond the mineral oil standard variety that have been around for many years, some caution is advised. This author has seen: customers sold "extreme-pressure" lubricants for rolling element bearings, which then sounded like a handful of sand was tossed into the bearings; marine duty grease sold for routine industrial motor use—there was no reason to expect any better results; a purple product for a 5000 rpm dynamometer application, nice color but not suitable for the resultant "n*dm." I took these examples as evidence that a wide range of industrial applications demand a wide range of lubricants, and users are wise not to be fooled to believe otherwise.

Consider use carefully

Due to their cost, I would consider the use of synthetic lubricants carefully. Most of my experience was speed-related. I can imagine hard-to-reach locations where their use might be advantageous with longer re-greasing capabilities. Some manufacturers offer products designed for food-grade, higher temperature or high-pressure (gearbox) use.

I would encourage all to consider synthetic lubricants for tough applications and where their price premium can be well justified. A well-respected vibration analyst I know once stated that the synthetic lubricants were all smoke and mirrors. I can confidently state that was not my experience. ●