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Upper Operating Temperature of Grease: Too Hot To Handle?

Introduction

The definition of high temperature performance for lubricating grease needs to be divided into two parts. *The upper temperature limit* which can be defined as the temperature at which the grease can function for a very short period of time. And *the upper operating temperature* which states the highest temperature for which lubrication can be maintained for a longer period of time.

In general there seems to be a very large difference in how manufacturers determine the upper operating temperature. Looking at product data sheets for similar mineral oil based lithium EP2 greases we find upper operating temperatures range from 120 to 250°C. In a fairly recent paper Coe discussed the inconsistency in how the industry reports the upper operating temperature and showed that different tests may lead to different conclusions concerning the upper operating temperature (1).

In Europe two standards are generally accepted to classify lubricating grease: DIN 51502 and ISO 6743-9 (2,3). ISO 6743 specifies that the operating temperature should be determined by either a grease-life test according to ASTM D3336 or a FAG FE-9 test. DIN 51502 describes that the upper operating temperature should be determined by either a SKF R2F-B or FAG FE-9 test.

Lugt describes the use of the SKF R0F- or SKF R2F-test for determining the High Temperature Performance Limit, which he defined in a similar manner as the above-mentioned definition of the upper operating temperature (4).

Not all grease types are fit to run in these tests. The softer greases (NLGI 0 and lower) will tend to leak out of the bearing during the test, causing the test to fail not because of grease degradation but merely as a direct consequence of the grease-leakage. Other greases might have excellent high temperature stability, but may not lubricate properly in these type of bearing tests.

In this article the author will describe a combination of high temperature tests under suitable conditions which may be used to develop an alternative to determining *the upper operating temperature* of lubricating greases.

Grease Degradation

In order to be able to define an alternative test or combination of tests that might be used to determine the upper operating temperature for those greases that cannot be run in either the R2F-B- or the FE-9 test, we need to understand the parameters that play a role in grease degradation and the effect it has on the properties of the grease.

Cann et al showed that the oxidation of grease in rolling bearings varies with the location of the grease in the bearing and that degradation of the grease does not necessarily have a negative influence on the lubricity, but that some degree of degradation of the grease will facilitate track replenishment (5,8). For example several authors identified oil loss through evaporation as a critical process leading to loss of lubricity and eventually bearing failure (6,7). Komatsuzaki et al found that lithium thickened greases lose their lubricity in roller bearings when the grease loses 50-60% of its base oil (7). Another study showed that besides base oil oxidation, oil evaporation and thickener degradation, the anti-wear/boundary properties also play an important role in bearing failure (8).

Experiments

A selection of 7 commercially available greases (see table 1) were compared in a number of tests.

Code	Thickener	Oil Type	NLGI Grade
Grease 1	Lithium	Mineral	2
Grease 2	Lithium complex	Synthetic	2
Grease 3	Calcium sulfonate complex (CaSX)	Mineral	2
Grease 4	Bentonite Clay	Synthetic	2
Grease 5	Anhydrous Calcium	Mineral	2
Grease 6	Lithium-Bismuth Complex	Mineral	1.5
Grease 7	Polypropylene	Synthetic	1.5

Table 1. *Description of tested greases*

The oil separation and oil evaporation of these greases were tested according to ASTM D6184 (30 hours at 100°C). The oxidation stability of these greases was compared in a PDSC,