Technical Topic

Grease High-Temperature Performance

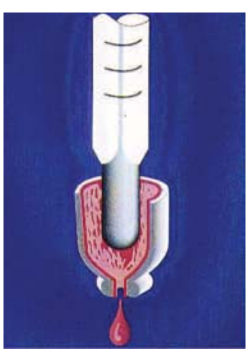
Don't Get Burned by High-Temperature Grease Claims

High-Temperature Claims Can Be Confusing

Grease high-temperature claims based on different standards can vary widely. The range of approaches commonly used in the industry to define the maximum temperature at which a grease will provide adequate lubrication can be confusing for customers wishing to select the best product for their application. A lubrication decision based upon a published grease temperature range can lead to undesired consequences unless the user understands something about the basis for the high-temperature limit being claimed.

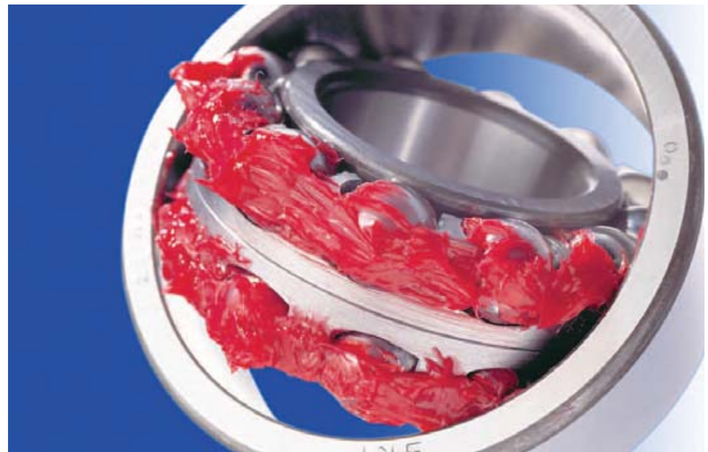
Dropping Point - The Old Way of Doing Things

Historically, high-temperature grease claims were based upon the grease Dropping Point (Figure A). Primarily intended as a manufacturing quality control test to confirm proper thickener formation, rather than a performance indicator, the Dropping Point indicates the temperature at which the grease thickener loses the capacity to retain oil under test conditions. At best, this has a tenuous relationship to real-life high-temperature performance. It is still quite common to define the grease high-temperature limit by subtracting a nominal temperature - often 100°F (55°C) - from the grease Dropping Point.



Dropping Point Test

Figure A



Bearing Tests - A Modern Approach

A better way is to define high-temperature performance capability in terms of a standardized bearing test. Such tests are conducted under accelerated operating conditions to promote grease ageing processes. Factors limiting grease high-temperature performance include degradation resulting from thickener and base oil oxidation, and the loss of base oil due to grease bleed and evaporation. In general, these dynamic grease life determinations better represent what occurs in the field, providing a measure of grease high-temperature performance limits which is more realistic than claims based on Dropping Point. In addition, bearing tests can also provide guidance to required grease re-lubrication intervals at normal operating temperatures.

There are several bearing tests generally employed to evaluate grease high-temperature limits. In all of these tests, bearings mounted in five identical rigs are run in parallel. The hours to grease failure in each rig can be treated using Weibull statistics to determine the time at which 50 percent of the bearings are expected to fail. This defines the "L50" life of the candidate grease at the chosen test temperature.

Industrial High-Temperature Grease Tests

- ASTM Method D3336, commonly known as the "Spindle Life" or "Pope" test, typically operates five 6204 ball bearings at 10,000 rpm under a 20 hours on / 4 hours off duty cycle. Grease failure is detected by temperature excursion or excessive bearing torque.
- The SKF R0F test employs two 6204 test ball bearings in a continuous operating mode in each of the 5 test rigs. Grease failure is detected by bearing temperature excursion. The R0F test has flexibility to vary both speed and load, but a lightly loaded set-up at 10,000 rpm is typical. The upper continuous operating temperature limit for a grease is generally determined by the highest temperature at which the L50 life will exceed 1000 hours.
- The DIN 51821 (or FE9) test (Figure B) uses 7206B angular contact ball bearings which may be run in one of three standard modes. Method A, in which unshielded bearings are packed with 2 ml of grease, is typically run at 6000 rpm with 1500 N axial load to classify a grease's high temperature limit. Grease failure is detected by bearing torque increase, as indicated by an increase in the power requirement of the rig motor. Under the DIN 51825 Type K Grease Classification system, the maximum temperature at which a grease may be used for continuous lubrication is defined as the highest temperature at which an L50 of 100 hours is achieved.

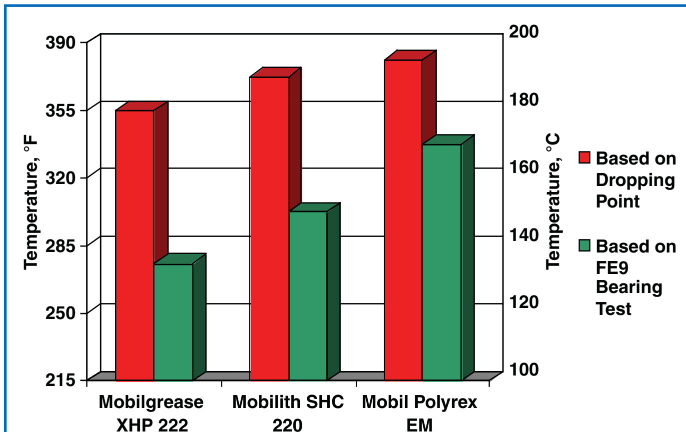
DIN 51821 (FAG FE9) Bearing Test

Figure B

Assessing Grease Performance

Understanding how the temperature capability of a grease has been defined can allow a user to make a better informed lubrication decision. For example, the high-temperature limit of Mobilgrease XHP 222 based upon a Dropping Point criterion might conservatively be given as 350°F (177°C). Mobilith SHC 220, with a similar dropping point, would typically be accorded a higher upper temperature limit by virtue of the improved performance of the synthetic base oil. Mobil Polyrex EM would also be accorded a high-temperature limit approaching 400°F (200°C) on a Dropping Point basis. By sharp contrast, the limiting temperature for continuous operation arrived at through DIN 51821 (FE9) bearing tests would be given as 275°F (135°C) for Mobilgrease XHP 222, 300°F (150°C) for Mobilith SHC 220, and 340°F (170°C) for Mobil Polyrex EM (Figure C). The difference in temperature limits predicted from dropping point and bearing test criteria are thus highly significant, translating into as much as a ten-fold change in expected grease life.

ExxonMobil has chosen to base continuous-operation recommendations upon the results of such bearing tests, at the same time recognizing that operation at temperatures exceeding this recommendation can be tolerated for short periods with appropriate adjustments to relubrication intervals. In assessing the potential of different greases to satisfy the needs of an application, make sure you're comparing "apples to apples."



Bearing tests provide more realistic operating temperature guidelines than can be derived from Dropping Point

Figure C

Don't Forget the Fundamentals

Finally, always remember that the base oil component of the grease is primarily responsible for lubrication. The correct base oil viscosity ensures that an oil film of adequate elastohydrodynamic (EHL) thickness is formed. The end-user should remember that viscosity may well be the limiting factor for a given grease at the equipment operating temperature.

Choosing a grease with the right high-temperature limit, defined by bearing test results, and the right base oil, is the key to successful lubrication in challenging high-temperature environments.

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