Grease Test Method Write Ups for High-Performance Multiuse (HPM) grease specifications

Note to reader: This document was prepared by Chuck Coe of Grease Technologies, LLC for the NLGI specification work being conducted in 2019 and 2020. Questions or comments can be sent to ChuckCoe@grease-tech.com.

High-Performance Multiuse (HPM) Core Specification

Cone Penetration worked 60x (ASTM D217) [r=7, R=20]

Grease hardness or softness (consistency) is quantified by this test by measuring the depth in dmm that a cone penetrates a grease sample under standard conditions. The 60 stroke worked penetration value (used to assign an NLGI consistency grade) is measured after shearing the grease with a plunger assembly sixty double strokes.

Prolonged Worked Penetration (ASTM D217) [r=15, R=27]

Shear stability or mechanical stability is the ability of a grease to resist changing consistency during mechanical working, such as what may be encountered in the field. A variety of laboratory tests evaluate shear stability. In this test, the grease is subjected to shear by extended working in a grease worker and the change in penetration after the test is reported.

Elastomer compatibility (ASTM D4289) [volume change: r=0.84% , R=3.45%; hardness change: r=1.5%, R=11.5 units]

This test method determines the compatibility of a lubricating grease with reference elastomers. By using this method as a guide, the compatibility of a grease with other elastomers may be estimated. This method is most applicable for greases in contact with elastomeric seals, o-rings and similar applications. ISO 13226 and SAE 2643 define Standard Reference Elastomers which may be selected for testing. As of June 2020, NLGI is checking on availability of a peroxide-cured nitrile rubber, SRE-NBR 28/PX as defined in ISO 13226)

Oxidation Stability (pressure drop) (ASTM D942) [r=2kPa ,R=3kPa]

The reaction with oxygen will cause a grease to deteriorate. This test evaluates the resistance of a grease to oxidation under specific conditions of static exposure.

Water Washout @ 79 °C (ASTM D1264) [r= 0.6 (X + 4.6), R = 1.1 (X + 4.6)]

The ability of a grease to resist washout under conditions where water may splash or impinge directly on a bearing is an important property for such applications. Comparative results between different greases under prescribed test conditions can be obtained with this test, but may not necessarily predict field performance. In this method, a ball bearing equipped with shields is packed with grease and rotated while a jet of water impinges on the bearing housing. After testing the bearing is dried and the amount of grease removed during this test is reported as wt% loss.

Low Temperature Torque @ -20 °C (ASTM D1478) [starting torque: r=34% of mean, R=78% of mean; running torque: r=79% of mean, R=132% of mean]

Greases designed for low temperature service should not stiffen and offer excessive resistance to rotation of bearings after soaking at low temperatures. This test measures starting and running torques of small, lightly loaded fully packed 6204 bearings at temperatures down to -54 °C.

Static Oil Bleed (ASTM D1742) [r=10% of mean, R=17% of mean] and **High Temperature Oil Bleed** (ASTM D6184) [r=1.151 x $(M)^{0.5}$, R=1.5173 x $(M)^{0.5}$]

Greases vary considerably in their tendency to bleed, or release oil in service or in storage. Most applications require a slow, controlled rate of oil release. These are two of the most commonly used methods for evaluating oil bleed. D1742 evaluates the effect of mild pressure and is intended to predict the tendency of a grease to release oil during storage in containers. D6184 evaluates the effect of heat on the oil separation tendency of a grease, but has not been found to correlate with dynamic service oil bleed.

Roll Stability (ASTM D1831) [r=15 , R=27]

Shear stability or mechanical stability is the ability of a grease to resist changing consistency during mechanical working, such as what may be encountered in the field. A variety of laboratory tests evaluate shear stability. In this method, the grease is rolled inside a tubular chamber containing a heavy solid cylindrical roller and the change in penetration after the test is reported.

4-Ball Wear and EP tests (ASTM D2266 and ASTM D2596) [D2266: r=0.20mm, R=0.37mm; D2596: r=14% of mean, R=44% of mean]

The 4-Ball Wear test is one of several wear tests used for lubricating greases. Each uses a different configuration of test parts and different types of motion. This test uses 4 steel balls, with three locked in a cup filled with grease, and the 4th ball is rotated against them in point contact, under an applied load. The sizes of the wear scars are measured after a prescribed time at elevated temperature. It is useful for comparing the relative wear preventive characteristics of greases in sliding steel-on-steel applications.

The 4-Ball EP test is one of several tests used to evaluate the load-carrying capability of greases. Its configuration is similar to the 4-Ball Wear test, but the loads applied are progressively increased in a non-linear fashion until welding occurs. A load wear index is calculated from the wear scars at each stage, and reported along with the weld load and last non-seizure load. This test is useful for comparing greases having different levels of EP protection, but may not correlate with field service. This test is run at a much higher load and speed than the 4-ball wear test.

Rust test (ASTM D1743) [precision not applicable]

Tapered roller bearings are packed with a small amount of grease and rotated under prescribed conditions to distribute the grease in the bearing. The bearings are then dipped in distilled or deionized water and then stored under controlled conditions for 2 days. Then the bearings are cleaned and inspected for the presence of rust spots. The amount of rust is rated as pass or fail according to a rating system based on the size of any corrosion spots.

Dynamic (EMCOR) Rust Test with distilled water (ASTM D6138) [r=1, R=1]

This test method covers the determination of corrosion preventive properties of greases using grease-lubricated ball bearings under dynamic wet conditions. New, cleaned, and lubricated bearings are tested partially immersed in distilled water (Grade 2 of ISO 3696) under prescribed conditions in a predetermined sequence of running and stopping for a period of approximately one week. After cleaning, the bearing rings are examined and rated according to the degree of corrosion.

Copper Corrosion (ASTM D4048) [precision not applicable]

Since copper and copper alloys are widely used in bushings and bearing cages, greases must not corrode such materials, sometimes known as "yellow metals". This method detects the presence of substances in a grease which would chemically attack copper and its alloys. In the method, a polished copper specimen is immersed in the grease and stored in an oven at a prescribed temperature for a prescribed period of time, then removed, cleaned, and evaluated against visual standards.

<u>High-Performance Multiuse Plus Water Resistance (HPM + WR)</u>

Water Washout @ 79 °C (ASTM D1264) [r= 0.6 (X + 4.6), R = 1.1 (X + 4.6)]

See HPM tests

Water Spray Off (ASTM D4049) [r=6.0%, R=18.0%]

This method evaluates the ability of a thin layer of grease to adhere to a metal surface when subjected to an intense, direct water spray under specified conditions of water pressure, temperature, and time. Spray off resistance is reported as the wt% grease removed by the spray. Although water spray off is a function of both water solubility and cohesive/adhesive strength, the latter is the dominant factor. There is some correlation between performance in steel mill rolling mills and the data obtained by this method.

Wet Roll Stability (ASTM D8022) [r=22 units, R=36 units]

It is known that contamination by water can affect the shear stability of some greases in service. This test method is widely used to determine the wet shear stability of greases in service. A number of grease specifications include procedures to evaluate wet shear stability, although no accurate correlation is established between the test results and wet shear stability of grease in actual service. In D8022, a small amount of water in mixed into a grease sample, then subjected to testing in the D1831 Roll Stability test. The change in penetration is an indicator of wet shear stability.

<u>High-Performance Multiuse Plus Corrosion Resistance (HPM + CR)</u>

Bearing Rust test using 10% synthetic seawater (ASTM D5969) [precision not applicable]

This test method covers the determination of the corrosion-preventive properties of greases using grease lubricated tapered roller bearings exposed to various concentrations of dilute synthetic sea water stored under wet conditions. It is based on Test Method D1743, which is practiced using a similar procedure and distilled or deionized water. The reported result is a pass or fail rating as determined by at least two of three bearings. Comparative results between different greases under the prescribed test conditions can be obtained with this test, but may not necessarily predict field performance.

Dynamic (EMCOR) Rust Test with Synthetic Sea Water and with 0.5 N NaCl Solution (ASTM D6138) [r=1, R=2]

This test method covers the determination of corrosion preventive properties of greases using grease-lubricated ball bearings under dynamic wet conditions. New, cleaned, and lubricated bearings are tested partially immersed in water (in this case, synthetic sea water, or sodium chloride solution) under prescribed conditions in a predetermined sequence of running and stopping for a period of approximately one week. After cleaning, the bearing rings are examined and rated according to the degree of corrosion.

<u>High-Performance Multiuse Plus High Load Carrying Capacity (HPM + HL)</u>

SRV EP Test procedure B (ASTM D5706) [procedure A @ 80 °C: r=.0.6(X+122), R=1.2(X+122) – precision for procedure B not established]

This test method covers a procedure for determining extreme pressure properties of lubricating greases under high frequency linear-oscillation motion using the SRV test machine. The test uses a bearing steel test ball oscillating against a stationary bearing steel test disk with lubricant between them. Test load is increased in 100 N increments until seizure occurs. The load, immediately prior to the load at which seizure occurs, is measured, and reported. Test frequency, stroke length, temperature, and ball and disk material can be varied to simulate field conditions. The test ball yields point-contact geometry. To obtain line or area contact, test pieces of differing configurations can be substituted for the test balls.

Fretting Wear (ASTM D4170) [r+1.4$(X)^{1/2}$, R=3.0$(X)^{1/2}$]

The test method is used to evaluate the property of lubricating greases to protect oscillating bearings from fretting wear. The tester is operated with two ball thrust bearings, lubricated with the test grease, oscillated through a specified arc, at a specified frequency, under a specified load, for 22 h at room temperature. No variation in test conditions is permitted. Fretting wear is determined by measuring the mass loss from the bearing races. This method, used for specification purposes, differentiates among greases allowing low, medium, and high amounts of fretting wear under the prescribed test conditions.

Fretting Wear Scar by SRV @ 50 °C (ASTM D7594) [r=<0.051mm, R=<0.207mm]

This test method covers a procedure for determining the lubricating action of greases in order to prevent “fretting” wear under linear oscillation with associated low strokes and high Hertzian contact pressures under high-frequency linear-oscillation motion using the SRV test machine. The resulting wear scar is reported in µm.

<u>High-Performance Multiuse Plus Low Temperature (HPM + LT)</u>

Low Temperature Torque @ -30 °C (ASTM D1478) [starting torque: r=34% of mean, R=78% of mean; running torque: r=79% of mean, R=132% of mean]

See HPM tests.

Grease Mobility @ -30 °C (U.S. Steel method LT-37) [precision TBD]

This method measures the resistance to grease flow at prescribed conditions of temperature and pressure. It is used to evaluate pumpability characteristics which are useful for predicting handling and dispensing of greases at low temperatures.

Flow Pressure @ -30 °C (Kesternich Method DIN 51805) [precision TBD – see DIN standard]

Central lubrication systems typically offer reduced maintenance costs and increased reliability over conventional grease application methods. To start the grease flowing, pressure is applied to the system - lower temperatures normally require higher pressures than higher temperatures. This test determines the pressure required to start grease flowing at low temperatures under standardized conditions.