Designation: D8120 – 17

Standard Test Method for Ferrous Debris Quantification[1]

This standard is issued under the fixed designation D8120; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method describes a means for quantitative determination of the concentration of ferrous debris in lubricants and greases.

1.2 This test method provides a determination of the concentration of ferrous debris in the lubricant or grease from a nominal 0 mg/kg to 10 000 mg/kg (1 % by mass) or greater.

1.3 This test method is applicable to all types of lubricating fluids (API Group I-V) and greases sampled from machinery and other mechanical equipment, including reciprocating engine oils, turbine oils, hydraulic oils, gear oils, and bearing greases.

1.4 This test method describes a means by which a sample of lubricant or grease is placed in a magnetometer apparatus, which determines the concentration of ferrous debris and provides these readings directly to the operator without further calculation.

1.5 This test method is applicable to in-service lubricants and greases at any stage of degradation.

1.6 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D4057 Practice for Manual Sampling of Petroleum and Petroleum Products

D4177 Practice for Automatic Sampling of Petroleum and Petroleum Products

D5185 Test Method for Multielement Determination of Used and Unused Lubricating Oils and Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)

D5854 Practice for Mixing and Handling of Liquid Samples of Petroleum and Petroleum Products

D6595 Test Method for Determination of Wear Metals and Contaminants in Used Lubricating Oils or Used Hydraulic Fluids by Rotating Disc Electrode Atomic Emission Spectrometry

D7669 Guide for Practical Lubricant Condition Data Trend Analysis

D7690 Practice for Microscopic Characterization of Particles from In-Service Lubricants by Analytical Ferrography

D7718 Practice for Obtaining In-Service Samples of Lubricating Grease

D7720 Guide for Statistically Evaluating Measurand Alarm Limits when Using Oil Analysis to Monitor Equipment and Oil for Fitness and Contamination

D7874 Guide for Applying Failure Mode and Effect Analysis (FMEA) to In-Service Lubricant Testing

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *ferrous debris concentration, n*—the concentration, expressed as milligrams per kilogram or percentage (percent by mass) of ferrous debris in a sample of lubricant across all particle size ranges of the debris, from dissolved to large ferrous debris particles in the millimeter size range. Note that such ferrous debris may exist in a matrix in the lubricant such as when organically combined or as part of a steel alloy.

[1] This test method is under the jurisdiction of ASTM Committee D02 on Petroleum Products, Liquid Fuels, and Lubricants and is the direct responsibility of Subcommittee D02.96.06 on Practices and Techniques for Prediction and Determination of Microscopic Wear and Wear-related Properties.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.1.2 *sample, n*—a portion of in-service oil or grease drawn directly from the machinery without further processing.

4. Summary of Test Method

4.1 A sample of in-service lubricant or grease is taken from the machinery or equipment and transferred into a suitable measurement receptacle. The manufacturer's recommendations should be followed for preferred holders or receptacles but typical container formats include sample bottles, syringes, and grease samplers. The sample holder is then manually placed inside an indicated empty measurement chamber of a magnetometer apparatus. Some instruments may require the sample holder to be removed before the measurement is complete and will prompt accordingly. By measuring the difference in signal between the filled chamber and the empty chamber, the concentration of ferrous debris in milligrams per kilogram or percent by mass is determined.

5. Significance and Use

5.1 By quantifying the concentration of total ferrous debris, this test method provides a direct indication of wear in the machinery by enabling the user to pinpoint when there is a deviation from the normal buildup of ferrous debris shed by the machinery or when the concentration of ferrous debris has exceeded safe operating limits. Specific guidance regarding such procedures may be found in Guides D7669, D7720, and D7874.

5.2 This test method can be performed on-site and can be utilized as a particle-size insensitive, minimum sample preparation alternative to laboratory-based screening for abnormal machinery conditions due to the presence of wear debris by means of ferrography as described in Practice D7690, or elemental analysis methods such as atomic emission spectrometry, described in Test Methods D5185 and D6595.

6. Interferences

6.1 This test method provides a measure of the concentration of ferrous debris by measuring the magnetic susceptibility of the sample under test. Non-ferrous debris, which is ferromagnetic (such as nickel or cobalt), may be reported as ferrous debris using this test method.

7. Apparatus

7.1 The core apparatus consists of a solenoid-style magnetometer with an inner coil diameter of sufficient size to accommodate the sample holder. Standard in-service oil analysis sample bottles (2 oz capacity), syringes (3 mL capacity), and grease pots (5 mL capacity) serve as sample holders. Other sample holders can be accommodated by sleeve adaptors made of non-magnetic materials. The user should consult the manufacturer's literature for guidance in the selection and use of suitable containers for the proposed sampling volumes. An exciting AC magnetic field, with typical frequencies in the range of a few kHz to several tens of kHz and with a peak amplitude in the 0.001 T region, is applied to the lubricant under test. The induced current in either a separate sensing coil, or the excitation coil itself, due to the presence of the ferrous debris is measured. From this induced current, the magnetic susceptibility of the lubricant is determined. This magnetic susceptibility is then correlated to the concentration of ferrous debris in the lubricant by means of the known magnetic susceptibility of such debris.

8. Reagents and Materials

8.1 A disposable, plastic sample container of sufficient capacity to perform the measurement. Consult the instrument manufacturer's instructions for the recommended containers and method of sample presentation.

8.2 At least two calibration standards of uniformly suspended ferrous material that provide equivalent magnetic susceptibilities within the lower and upper quartiles of the selected measurement range. These standards may consistent of, for example, suspended M50 bearing steel in oil or a resin matrix and are to be used as check standards for the purposes of confidence testing. An optional third standard for the mid-range point is useful but not essential. Again, consult the manufacturer's instructions for recommended practices regarding (re)calibration and check intervals.

8.3 A lint-free, oil-absorbent material should be used to clean the apparatus. Some suitable examples would be polypropylene industrial wipes or clean cotton shop rag.

9. Hazards

9.1 All precautions in the sampling and handling of in-service lubricant samples should be followed as appropriate. Please see Practices D4057, D4177, or D7718 for guidance on this point.

10. Sampling, Test Specimens, and Test Units

10.1 A sample of the liquid or grease should be obtained following the guidelines described in Practices D4057, D4177, or D7718. A representative portion of the lubricant and of sufficient volume to fill the measurement bottle, syringe, and so forth should be collected in a clean, dry container. Care should be taken to ensure that the portion collected is as representative of the in-service fluid or grease as possible. Avoid sampling from the bottom of sumps or other similar dead spots, where deposits may have built up over time. Consult the relevant ASTM practices noted above for more guidance on suitable sampling points. Also, check that the sample is at a temperature compatible with the specifications of the sample container before being drawn for analysis.

10.2 Inspect the collected portion for homogeneity and if in doubt, have it re-homogenized to ensure that a representative sample can be measured in the magnetometer. Follow Practice D5854 and ensure that the collected portion is gently inverted back and forth for at least 30 s before drawing or decanting the sample into the measurement syringe or vial before proceeding.

11. Preparation of Apparatus

11.1 Turn on the apparatus and ensure that no alerts, which may indicate faults with the measurement hardware or software, are generated.