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Standard Test Method for Determining Automotive Engine Oil Compatibility with Typical Seal Elastomers[1]

This standard is issued under the fixed designation D7216; 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.

INTRODUCTION

Any properly equipped laboratory, without outside assistance, can use the test method described in this standard. However, the ASTM Test Monitoring Center (TMC)[2] provides a reference oil (TMC 1006-1) and an assessment of the test results obtained with this oil and the reference elastomers. By these means, the laboratory will know whether their use of the test method gives results statistically similar to those obtained by other laboratories.

The TMC also uses the reference oil results on different batches of elastomers from different laboratories to update continually the total and within-laboratory standard deviation estimates. Some specifications, for example, Specification D4485, use the updated TMC standard deviation estimates, pertaining at the time test oils are evaluated, to adjust specification limits for the effects of the industry test variability.

Various agencies require that a laboratory utilize the TMC services in seeking qualification of oils against specifications. For example, the U.S. Army imposes such a requirement in connection with several Army engine lubricating oil specifications.

Accordingly, this test method is written for use by laboratories that utilize the TMC services. Laboratories that choose not to use those services may simply ignore those portions of the test method that refer to the TMC.

This test method may be modified by means of information letters issued by the TMC. In addition, the TMC may issue supplementary memoranda related to this test method.

1. Scope*

1.1 This test method covers quantitative procedures for the evaluation of the compatibility of automotive engine oils with several reference elastomers typical of those used in the sealing materials in contact with these oils. Compatibility is evaluated by determining the changes in volume, Durometer A hardness, and tensile properties when the elastomer specimens are immersed in the oil for a specified time and temperature.

1.2 Effective sealing action requires that the physical properties of elastomers used for any seal have a high level of resistance to the liquid or oil in which they are immersed. When such a high level of resistance exists, the elastomer is said to be compatible with the liquid or oil.

NOTE 1—The user of this test method should be proficient in the use of Test Methods D412 (tensile properties), D471 (effect of rubber immersion in liquids), D2240 (Durometer hardness), and D5662 (gear oil compatibility with typical oil seal elastomers), all of which are involved in the execution of the operations of this test method.

1.3 This test method provides a preliminary or first order evaluation of oil/elastomer compatibility only. Because seals might be subjected to static or dynamic loads, or both, and they can operate over a range of conditions, a complete evaluation of the potential sealing performance of any elastomer-oil combination in any service condition usually requires tests additional to those described in this test method.

1.4 The several reference elastomer formulations specified in this test method were chosen to be representative of those used in both heavy-duty diesel engines (detailed in Annex A1) and passenger-car spark-ignition engines (the latter are covered in Annex A2). The procedures described in this test method can, however, also be used to evaluate the compatibility of automotive engine oils with different elastomer types/

[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.B0.07 on Development and Surveillance of Bench Tests Methods.

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[2] Until the next revision of this test method, the ASTM Test Monitoring Center updates changes in the test method by means of information letters. Information letters can be obtained from the ASTM Test Monitoring Center, 203 Armstrong Drive, Freeport, PA 16229. (www.astmtmc.org) Attention: Director. This edition incorporates revisions in all information letters through No. 21-1.

*A Summary of Changes section appears at the end of this standard

formulations or different test durations and temperatures to those employed in this test method.

NOTE 2—In such cases, the precision and bias statement in Section 12 does not apply. In addition to agreeing acceptable limits of precision, where relevant, the user and supplier should also agree: *(1)* test temperatures and immersion times to be used; *(2)* the formulations and typical properties of the elastomers; and *(3)* the sourcing and quality control of the elastomer sheets.

NOTE 3—The TMC may also issue Information Letters on this matter.

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

1.6 This test method is arranged as follows:

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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, health, and environmental 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:*[3]

D297 Test Methods for Rubber Products—Chemical Analysis

D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

D471 Test Method for Rubber Property—Effect of Liquids

D1193 Specification for Reagent Water

D1566 Terminology Relating to Rubber

D2240 Test Method for Rubber Property—Durometer Hardness

D4175 Terminology Relating to Petroleum Products, Liquid Fuels, and Lubricants

D4485 Specification for Performance of Active API Service Category Engine Oils

D5662 Test Method for Determining Automotive Gear Oil Compatibility with Typical Oil Seal Elastomers

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E178 Practice for Dealing With Outlying Observations

2.2 *SAE Standard:*[4]

SAE J2643 Standard Reference Elastomers (SRE) for Characterizing the Effect of Liquids on Vulcanized Rubbers

3. Terminology

3.1 *Definitions:*

3.1.1 *automotive, adj*—descriptive of equipment associated with self-propelled machinery, usually vehicles driven by internal combustion engines. **D4175**

3.1.2 *candidate oil, n*—an oil that is intended to have the performance characteristics necessary to satisfy a specification and is to be tested against that specification. **D4175**

3.1.3 *elastomer, n*—a natural or synthetic polymer having the rubber-like property of substantially recovering its size and shape after removal of a deforming force. **D4175**

3.1.4 *engine oil, n*—a liquid that reduces friction or wear, or both, between the moving parts within an engine; removes heat particularly from the underside of pistons; and serves as combustion gas sealant for the piston rings.

3.1.4.1 *Discussion*—It may contain additives to enhance certain properties. Inhibition of engine rusting, deposit formation, valve train wear, oil oxidation and foaming are examples. **D4175**

3.1.5 *formulation, n*—the specific chemical composition used in manufacturing a seal elastomer or a reference oil. **D5662**

3.1.6 *hardness, n—of an elastomer*, the resistance to deformation or indentation.

3.1.6.1 *Discussion*—In this test method the hardness of an elastomer is measured with a Shore Durometer A (see Test Method D2240). **D4175**

3.1.7 *heavy-duty engine, n—in internal; combustion engine types*, one that is designed to allow operation continuously at or close to its peak output.

3.1.7.1 *Discussion*—This type of engine is typically installed in large trucks and buses as well as farm, industrial, and construction equipment. **D4485**

3.1.8 *non-reference oil, n*—any oil other than a reference oil, such as a research formulation, commercial oil, or candidate oil. **D4175**

3.1.9 *reference oil, n*—an oil of known performance characteristics, used as a basis for comparison.

3.1.9.1 *Discussion*—Reference oils are used to calibrate testing facilities, to compare the performance of other oils, or to evaluate other materials (such as seals) that interact with oils. **D4175**

[3] 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.

[4] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

TABLE 1 Immersion Temperatures and Times for the Reference Elastomers[A]

Elastomer	Immersion Test Temperature, °C	Immersion Test Time, h
Nitrile (NBR)	100 ± 1	336.0 ± 0.5
Polyacrylate (ACM)	150 ± 1	336.0 ± 0.5
Fluoroelastomer (FKM)	150 ± 1	336.0 ± 0.5
Silicone (VMQ)	150 ± 1	336.0 ± 0.5
VAMAC (MAC)	150 ± 1	336.0 ± 0.5

[A] Some lubricant specifications might require immersion times other than 336 h. For times <70 h the tolerance is ±0.25 h and for times ≥70 h the tolerance is ±0.5 h (see also 1.4).

3.1.10 *tensile strength, n*—the maximum tensile stress applied in stretching a specimen to rupture. **D1566**

3.1.11 *test oil, n*—any oil subjected to evaluation in an established procedure. **D4175**

3.1.12 *ultimate elongation, n*—the elongation at which rupture occurs in the application of continued tensile stress. **D1566**

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *compatibility, n—of an engine oil/elastomer combination*, a characteristic that signifies a complete or high level of resistance of the elastomer to deleterious effects imparted by contact with, or immersion in, the oil.

3.2.1.1 *Discussion*—The phrase "high compatibility" indicates that after contact or immersion, the elastomer properties are maintained at or near their initial level. The terms "lack of compatibility" and "low compatibility" indicate that after contact or immersion, the elastomer properties are adversely affected to an extent that could be detrimental to sealing performance.

3.2.2 *immersion test, n*—an operation to evaluate compatibility by determining the effect of a liquid on elastomer test specimens submerged in the liquid for a specified time and at a specified temperature.

3.2.2.1 *Discussion*—The effect of the liquid is evaluated by the difference in (typical) elastomer physical properties pre- and post-immersion.

3.2.3 *reference elastomer, n*—an elastomer compound prepared using a specified formulation; its immersion test properties with selected oils have been well established by the use of recognized and accepted testing and documentation procedures.

3.2.4 *tensile stress at 50 % elongation, n*—the stress required to stretch the uniform cross section of a test specimen to 50 % elongation.

4. Summary of Test Method

4.1 Measurements of initial volume, hardness (Durometer A) and tensile properties are made on specimens of specified dimensions cut from sheets of reference elastomers.

4.1.1 Table 1 shows the types of elastomers involved, typical of those used in heavy-duty diesel engines.

4.2 The elastomer specimens are immersed in both non-reference oil(s) and a reference oil and aged for 336 h at specified temperatures.

4.3 The effects of the test oils on the elastomers are determined by measuring the changes in volume, hardness, and tensile properties resulting from the immersion in the oil.

5. Significance and Use

5.1 Some engine oil formulations have been shown to lack compatibility with certain elastomers used for seals in automotive engines. These deleterious effects on the elastomer are greatest with new engine oils (that is, oils that have not been exposed to an engine's operating environment) and when the exposure is at elevated temperatures.

5.2 This test method requires that non-reference oil(s) be tested in parallel with a reference oil known to be aggressive for some parameters under service conditions. This *relative* compatibility permits decisions on the anticipated or predicted performance of the non-reference oil in service.

5.3 Elastomer materials can show significant variation in physical properties, not only from batch to batch but also within a sheet and from sheet to sheet. Results obtained with the reference oil are submitted by the test laboratories to the TMC to allow it to update continually the total and within-laboratory standard deviation estimates. These estimates, therefore, incorporate effects of variations in the properties of the reference elastomers on the test variability.

5.4 This test method is suitable for specification compliance testing, quality control, referee testing, and research and development.

5.5 The reference elastomers, reference oil, and the physical properties involved in this test method address the specific requirements of engine oils. Although other tests exist for compatibility of elastomers with liquids, these are considered too generalized for engine oils.

6. Apparatus

6.1 The testing equipment as specified in Test Methods D412, D471, D2240, and D5662 is required for the use of this test method.

6.2 *Balance*—Use any commercially available balance capable of weighing to the nearest 0.1 mg. Equip the balance with a suspension hook and a platform to locate a hydrostatic-weighing beaker above the balance pan.

6.2.1 *Calibration*—Calibrate the balance annually as described in Test Method D5662.

6.3 *Hardness Durometer A*—See Test Method D2240. Use a stand-mounted Durometer.

6.3.1 *Calibration*—Calibrate the hardness Durometer annually as described in Test Method D2240. Use an outside source, with standards traceable to the National Institute for Standards Technology (NIST), for annual calibration. Perform checks with internal standards weekly. Checks with internal standards shall be within ±3 points. Calibrate internal standards annually, using an outside source, with standards traceable to NIST.

6.4 *Tension Testing Machine*—See the appropriate sections of Test Methods D412. The rate of grip separation for the tension testing shall be (8.5 ± 0.8) mm/s.