Designation: D471 – 16

Standard Test Method for Rubber Property—Effect of Liquids[1]

This standard is issued under the fixed designation D471; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers the required procedures to evaluate the comparative ability of rubber and rubber-like compositions to withstand the effect of liquids. It is designed for testing: (*1*) specimens of vulcanized rubber cut from standard sheets (see Practice D3182), (*2*) specimens cut from fabric coated with vulcanized rubber (see Test Methods D751), or (*3*) finished articles of commerce (see Practice D3183). This test method is not applicable to the testing of cellular rubbers, porous compositions, and compressed sheet packing, except as described in 12.2.2.

1.2 Periodically, it is necessary to produce a new lot of an IRM oil to replace the dwindling supply of the current product. The Chairman of the subcommittee shall have the authority to approve the production of a replacement lot. Once produced, the technical data of the new lot shall be presented, in a comparative fashion, to that of the existing lot and balloted upon by the membership of the D11.15 subcommittee and, either subsequently or concurrently, balloted upon by the membership of the D11 main committee for approval to release the new lot for distribution.

1.3 In the event that an IRM oil becomes unavailable for distribution due to depletion, the Chairman of the subcommittee shall have the authority to approve production of a new lot and, after a meeting of the task group, regularly scheduled, or not, to release a quantity of the product for distribution sufficient enough only to address a backlog. Once the backlog is addressed, the process described in 1.2 shall be followed.

1.4 ASTM Oils No. 2 and No. 3, formerly used in this test method as standard test liquids, are no longer commercially available and in 1993 were replaced with IRM 902 and IRM 903, respectively (see Appendix X1 for details).

1.5 ASTM No. 1 Oil, previously used in this test method as a standard test liquid, is no longer commercially available and in 2005 was replaced with IRM 901; refer to Table 1 and Appendix X3 for details.

1.6 ASTM No. 5 Oil was accepted into Specification D5900 as an industry reference material in 2010 and designated as IRM 905. The composition, and properties of this immersion oil were not changed and the data in Table 1 remains current. Refer to Appendix X4 for other details.

1.7 The specifications and properties listed in Table 1 for IRM 901, IRM 902, IRM 903, and IRM 905 are also maintained in Specification D5900.

1.7.1 The subcommittee responsible for maintaining Test Method D471, presently D11.15, shall review the data in Specification D5900 to ensure that it is identical to that which appears in Test Method D471. This shall be accomplished at the time of the 5 year review or more frequently when necessary.

1.8 Historical, technical, and background information regarding the conversion from ASTM No. 1, ASTM No. 2, and ASTM No. 3 Oils to IRM 901, IRM 902, and IRM 903 immersion oils is maintained in Practice D5964.

1.8.1 The subcommittee responsible for maintaining Test Method D471, presently D11.15, shall review the data in Practice D5964 to ensure that it is identical to that which appears in Test Method D471. This shall be accomplished at the time of the 5 year review or more frequently when necessary.

1.9 This test method includes the following:

1.10 The values stated in SI units are to be regarded as the standard. The values in parentheses are for information only.

1.11 *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] This test method is under the jurisdiction of ASTM Committee D11 on Rubber and is the direct responsibility of Subcommittee D11.15 on Degradation Tests.

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TABLE 1 Specifications and Typical Properties of IRM Reference Oils

Property	IRM 901[A]	IRM 902	IRM 903	IRM 905	ASTM Method
Specified Properties:					
Aniline Point, °C (°F)	124 ± 1 (255 ± 2)	93 ± 3 (199 ± 5)	70 ± 1 (158 ± 2)	115 ± 1 (239± 2)	D611
Kinematic Viscosity (mm^2/s [cSt])					
38°C (100°F)		...	31.9–34.1	...	D445
99°C (210°F)	18.12–20.34	19.2–21.5	...	10.8–11.9	D445
Gravity, API, 16°C (60°F)	28.8 ± 1	19.0–21.0	21.0–23.0	...	D287
Viscosity-Gravity Constant	0.790–0.805	0.860–0.870	0.875–0.885	...	D2501
Flash Point COC, °C (°F)	243(469) min	232 (450) min	163 (325) min	243 (469) min	D92
Naphthenics, C_N (%)	27 (avg)	35 min	40 min	...	D2140
Paraffinics, C_P (%)	65 min	50 max	45 max	...	D2140
Typical Properties:					
Pour Point, °C (°F)	−12 (10)	−15 (5)	−42.8 (−45)	−15 (5)	D97
ASTM Color	*L* 3.5	*L* 2.0	*L* 0.5	*L* 1.0	D1500
Refractive Index	1.4848	1.5083	1.5004	1.4808	D1747
UV Absorbance, 260 nm	0.8	1.43	1.43	...	D2008
Aromatics, C_A (%)	3	10	12	4	D2140

[A] Refer to Appendix X3. Table X3.1 reflects the differences in the properties between ASTM No. 1 Oil and IRM 901 for reference purposes.

TABLE 2 IRM 901 – 2012 Batch Test Results

Property	Method	2005 Batch COA	2005 Batch Current	2012 Sample Data				2012 Batch Average
Viscosity, cSt @99°C	D445	19.58	19.5	18.8 18.8	18.7 18.8	18.8 18.9	18.7 18.7	18.8
Gravity, API @16°C	D287	28.6	28.9	28.9 28.9	28.9 28.9	28.8 28.9	28.9 28.9	28.9
Flash Point COC, °C	D92	287	313	306 299	289 303	292 294	288 294	296
Aniline Point, °C	D611	123.8	124.7	124.8 124.8	124.8 124.8	124.7 124.9	124.3 124.6	124.5
Viscosity-Gravity Constant	D2501	0.796	0.798	0.799 0.799	0.799 0.799	0.800 0.799	0.799 0.799	0.799
Naphthenics, Cn%	D2140	—	24	26 26	26 26	27 27	28 29	27
Paraffinics, Cp%	D2140	70	72	71 71	71 71	69 71	70 70	71

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D92 Test Method for Flash and Fire Points by Cleveland Open Cup Tester

D97 Test Method for Pour Point of Petroleum Products

D287 Test Method for API Gravity of Crude Petroleum and Petroleum Products (Hydrometer Method)

D412 Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension

D445 Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)

D611 Test Methods for Aniline Point and Mixed Aniline Point of Petroleum Products and Hydrocarbon Solvents

D751 Test Methods for Coated Fabrics

D865 Test Method for Rubber—Deterioration by Heating in Air (Test Tube Enclosure)

D975 Specification for Diesel Fuel Oils

D1217 Test Method for Density and Relative Density (Specific Gravity) of Liquids by Bingham Pycnometer

D1415 Test Method for Rubber Property—International Hardness

[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.

D1500 Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)
D1747 Test Method for Refractive Index of Viscous Materials
D2008 Test Method for Ultraviolet Absorbance and Absorptivity of Petroleum Products
D2140 Practice for Calculating Carbon-Type Composition of Insulating Oils of Petroleum Origin
D2240 Test Method for Rubber Property—Durometer Hardness
D2501 Test Method for Calculation of Viscosity-Gravity Constant (VGC) of Petroleum Oils
D2699 Test Method for Research Octane Number of Spark-Ignition Engine Fuel
D3182 Practice for Rubber—Materials, Equipment, and Procedures for Mixing Standard Compounds and Preparing Standard Vulcanized Sheets
D3183 Practice for Rubber—Preparation of Pieces for Test Purposes from Products
D4483 Practice for Evaluating Precision for Test Method Standards in the Rubber and Carbon Black Manufacturing Industries
D4485 Specification for Performance of Active API Service Category Engine Oils
D4806 Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel
D5900 Specification for Physical and Chemical Properties of Industry Reference Materials (IRM)
D5964 Practice for Rubber IRM 901, IRM 902, and IRM 903 Replacement Oils for ASTM No. 1, ASTM No. 2, ASTM No. 3 Oils, and IRM 905 formerly ASTM No. 5 Oil
E145 Specification for Gravity-Convection and Forced-Ventilation Ovens

2.2 *SAE Standards:*[3]
J 300 Engine Oil Viscosity Classification

3. Summary of Test Method

3.1 This test method provides procedures for exposing test specimens to the influence of liquids under definite conditions of temperature and time. The resulting deterioration is determined by measuring the changes in physical properties, such as stress/strain properties, hardness, and changes in mass, volume, and dimension, before and after immersion in the test liquid.

3.2 The precision statement in Section 20 is based on an interlaboratory test program run in 1981, using six different rubbers with ASTM Reference Fuels B, C, D[4] and ASTM Oils No. 1 and No. 3.

3.3 The precision statement in Appendix X2 is based on an interlaboratory test program conducted in 1993 to establish replacements for ASTM Oils No. 2 and No. 3. Because of the limited number of participating laboratories, only repeatability could be evaluated, and it was necessary to use pooled values of four No. 2 type oils (No. 2 plus three candidate replacement oils) and four No. 3 type oils (No. 3 plus three candidate replacement oils). Twelve rubbers were tested in this program.

3.4 ASTM Oils No. 1, No. 2, and No. 3 have been replaced by IRM 901, IRM 902, and IRM 903, respectively.

4. Significance and Use

4.1 Certain rubber articles, for example, seals, gaskets, hoses, diaphragms, and sleeves, may be exposed to oils, greases, fuels, and other fluids during service. The exposure may be continuous or intermittent and may occur over wide temperature ranges.

4.2 Properties of rubber articles deteriorate during exposure to these liquids, affecting the performance of the rubber part, which can result in partial failure.

4.3 This test method attempts to simulate service conditions through controlled accelerated testing, but may not give any direct correlation with actual part performance, since service conditions vary too widely. It yields comparative data on which to base judgment as to expected service quality.

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

5. Test Conditions

5.1 *Temperature and Immersion Periods*—Unless otherwise specified the test temperature and immersion period shall be as indicated in Table 3, depending upon the anticipated service conditions, unless otherwise agreed upon between customer and supplier:

5.1.1 When the temperature of the testing room is other than the standard 23 ± 2°C (73 ± 4°F) the temperature of test shall be reported.

5.1.2 When the relative humidity (RH %) of the testing environment is known to effect the performance of a test liquid, the RH % shall be reported.

5.1.3 The choice of the immersion period will depend upon the nature of the vulcanizate, the test temperature, and the liquid to be used. To obtain information on the rate of deterioration it is necessary to make determinations after several immersion periods.

TABLE 3 A: Test Temperatures

Temperature in °C (°F)	
−75 ± 2 (−103 ± 4)	85 ± 2 (185 ± 4)
−55 ± 2 (−67 ± 4)	100 ± 2 (212 ± 4)
−40 ± 2 (−40 ± 4)	125 ± 2 (257 ± 4)
−25 ± 2 (−13 ± 4)	150 ± 2 (302 ± 4)
−10 ± 2 (14 ± 4)	175 ± 2 (347 ± 4)
0 ± 2 (32 ± 4)	200 ± 2 (392 ± 4)
23 ± 2 (73 ± 4)	225 ± 2 (437 ± 4)
50 ± 2 (122 ± 4)	250 ± 2 (482 ± 4)
70 ± 2 (158 ± 4)	

[3] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Drive, Warrendale, PA 15096.

[4] The sole source of supply of the reference fuels known to the committee at this time is Chevron Phillips Chemical Company, LP, 10001 Six Pines Drive, The Woodlands, TX 77380. If you are aware of alternative suppliers, please provide this information to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee,[1] which you may attend.