Designation: D5222 – 23

Standard Specification for Less Flammable High Molecular Weight Hydrocarbon Mineral Electrical Insulating Liquids[1]

This standard is issued under the fixed designation D5222; 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 specification describes a less flammable mineral electrical insulating liquid, for use as a dielectric and cooling medium in new and existing power and distribution electrical apparatus, such as transformers and switchgear.

1.2 Less flammable insulating liquid differs from conventional mineral insulating liquid by possessing a fire-point of at least 300 °C. This property is necessary in order to comply with certain application requirements of the National Electrical Code (Article 450-23) or other agencies. The material discussed in this specification is miscible with other petroleum based insulating liquids. Mixing less flammable liquids with lower fire point hydrocarbon insulating liquids (for example, Specification D3487 mineral liquid) may result in fire points of less than 300 °C.

1.3 This specification is intended to define a less flammable electrical mineral insulating liquid that is compatible with typical material of construction of existing apparatus and will satisfactorily maintain its functional characteristic in this application. The material described in this specification may not be miscible with electrical insulating liquids of non-petroleum origin. The user should contact the manufacturer of the less flammable insulating liquid for guidance in this respect.

1.4 This specification applies only to new electrical insulating liquid as received prior to any processing. Information on in-service maintenance testing is available in appropriate guides.[2] The user should contact the manufacturers of the equipment or liquid if questions of recommended characteristics or maintenance procedures arise.

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 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]

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

D97 Test Method for Pour Point of Petroleum Products

D117 Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids

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

D664 Test Method for Acid Number of Petroleum Products by Potentiometric Titration

D923 Practices for Sampling Electrical Insulating Liquids

D924 Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids

D971 Test Method for Interfacial Tension of Insulating Liquids Against Water by the Ring Method

D974 Test Method for Acid and Base Number by Color-Indicator Titration

D1275 Test Method for Corrosive Sulfur in Electrical Insulating Liquids

D1298 Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method

D1500 Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)

D1524 Test Method for Visual Examination of Used Electrical Insulating Liquids in the Field

D1533 Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration

[1] This specification is under the jurisdiction of ASTM Committee D27 on Electrical Insulating Liquids and Gases and is the direct responsibility of Subcommittee D27.01 on Mineral.

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[2] Refer to IEEE C57.121.

[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.

D1816 Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes
D2112 Test Method for Oxidation Stability of Inhibited Mineral Insulating Oil by Pressure Vessel
D2300 Test Method for Gassing of Electrical Insulating Liquids Under Electrical Stress and Ionization (Modified Pirelli Method)
D2440 Test Method for Oxidation Stability of Mineral Insulating Oil
D2668 Test Method for 2,6-*di-tert*-Butyl- *p*-Cresol and 2,6-*di-tert*-Butyl Phenol in Electrical Insulating Oil by Infrared Absorption
D2864 Terminology Relating to Electrical Insulating Liquids and Gases
D3487 Specification for Mineral Insulating Oil Used in Electrical Apparatus
D4052 Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter
D4059 Test Method for Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography
D4768 Test Method for Analysis of 2,6-Ditertiary-Butyl Para-Cresol and 2,6-Ditertiary-Butyl Phenol in Insulating Liquids by Gas Chromatography
D5949 Test Method for Pour Point of Petroleum Products (Automatic Pressure Pulsing Method)
D5950 Test Method for Pour Point of Petroleum Products (Automatic Tilt Method)
D7042 Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

2.2 *National Fire Protection Association Standards:*
National Electrical Code, Article 450-23[4]

2.3 *Institute of Electrical and Electronics Engineers Standard:*
C57.121 Guide for Acceptance and Maintenance of Less-Flammable Hydrocarbon Fluid in Transformers[5]

3. Terminology

3.1 Definitions of terms related to this specification are given in Terminology D2864. Significance of tests related to this specification can be found in Guide D117 and Specification D3487.

4. Sampling and Testing

4.1 Take all liquid samples in accordance with Practices D923.

4.2 Perform each test in accordance with the ASTM test method specified in Table 1.

4.3 Make known to the user the generic type and amount of any additive used, for assessing any potential detrimental reaction with other materials in contact with the oil.

TABLE 1 Property Requirements

Property	Limit	ASTM Test Method
Physical:		
Visual examination	Bright and clear	D1524
Color, ASTM units, max	2.5	D1500
Fire point, min, °C	300	D92
Flash point, min, °C	275	D92
Interfacial tension, min, mN/m	40	D971
Pour point, max °C	–21	D97 or D5949 or D5950^A
Relative density, 15/15 °C, max	0.91	D1298 or D4052^B
Viscosity, max, mm^2/s at:		D445 or D7042
100 °C	14	
40 °C	130	
0 °C	2500	
Electrical:		
Dielectric breakdown voltage at 60 Hz		D1816
VDE electrodes, min kV at:		
1 mm gap	20^C	
2 mm gap	35^C	
Gassing tendency, max, µL/minute	+30	D2300
Dissipation factor at 60 Hz, max, %		D924
25 °C	0.05	
100 °C	0.30	
Chemical:		
Corrosive sulfur	non-corrosive	D1275
Acid number, max, mg KOH/g	0.03	D664 or D974
Water content, max, mg/kg	35	D1533
Oxidation stability^D, 72 h:		D2440
sludge, max % by mass	0.1	
acid number, max, mg KOH/g	0.3	
Oxidation stability^D, 164 h		
sludge, max, % by mass	0.2	
acid number, max, mg KOH/g	0.4	
Oxidation stability (pressure vessel test), min, minutes^D	195	D2112
Oxidation inhibitor content, max, % by mass	0.40	D2668 or D4768
PCB content, mg/kg	non-detectable	D4059

^{A} In case of a dispute, Test Method D97 shall be used as the referee method.
^{B} In case of a dispute, Test Method D1298 shall be used as the referee method.
^{C} These test limits by Test Method D1816 are applicable only to as received unused liquids.
^{D} The values for oxidation tests are typical requirements expected from type II liquid (according to Specification D3487). All of the commercially available less flammable insulating liquids contain ≤ 0.4 % antioxidant.

NOTE 1—Because of the different needs of various users, items relating to packaging, labeling, and inspection are considered to be subject to supplier-user agreement.

NOTE 2—In addition to all other tests listed herein, it is sound engineering practice for the apparatus manufacturer to perform an evaluation of insulating liquids in insulation systems, prototype structures, or full-scale apparatus, or any combination thereof, to ensure suitable service life.

5. Property Requirements

5.1 Less flammable mineral insulating liquid, as received, shall conform to the requirements of Table 1. The significance of these properties is covered in Guide D117.

6. Keywords

6.1 electrical insulating liquid; fire point; flammability; insulating liquid; mineral insulating liquid

[4] Available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.
[5] Available from Institute of Electrical and Electronics Engineers, Inc. (IEEE), 445 Hoes Ln., Piscataway, NJ 08854-4141, http://www.ieee.org.