Designation: D8240 – 22ε1

Standard Specification for Less-Flammable Synthetic Ester Liquids Used in Electrical Apparatus[1]

This standard is issued under the fixed designation D8240; 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.

ε[1] NOTE—In Table 1, IEC 51125 was corrected editorially to IEC 61125 in the last entry right column and % was added after Dissipation factor (power factor) at 60 Hz, max in the left column in November 2022.

1. Scope

1.1 This specification covers less-flammable (high fire point) synthetic ester insulating liquids for use as a dielectric and cooling in new and existing electrical power apparatus including power and distribution transformers, switchgear, and other associated equipment

1.2 Synthetic ester insulating liquids differ from conventional mineral oil and other less-flammable (high fire point) liquids in that they are products derived from the chemical reaction, processing, and physical treatments of a carboxylic acid and an alcohol.

1.3 This specification is intended to define synthetic ester electrical insulating liquids that are compatible with typical materials of construction of existing apparatus and are expected to maintain their functional characteristics in these applications. The material described in this specification is not always miscible with other electrical insulating liquids. The user should contact the manufacturer of the synthetic ester insulating liquid for guidance in this respect.

1.4 This specification applies only to unused synthetic ester insulating liquids as received prior to any processing. The user should contact the manufacturer of the equipment or liquid, or both, if questions of recommended characteristics or liquid 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 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.*

1.7 *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]

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)

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

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

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

D1816 Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes

D1903 Practice for Determining the Coefficient of Thermal

[1] This specification is under the jurisdiction of ASTM Committee D27 on Electrical Insulating Liquids and Gases and is the direct responsibility of Subcommittee D27.02 on Gases and Non-Mineral Oil Liquids.

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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.

Expansion of Electrical Insulating Liquids of Petroleum Origin, and Askarels

D2129 Test Method for Color of Clear Electrical Insulating Liquids (Platinum-Cobalt Scale)

D2300 Test Method for Gassing of Electrical Insulating Liquids Under Electrical Stress and Ionization (Modified Pirelli Method)

D2717 Test Method for Thermal Conductivity of Liquids (Withdrawn 2018)[3]

D2766 Test Method for Specific Heat of Liquids and Solids (Withdrawn 2018)[3]

D2864 Terminology Relating to Electrical Insulating Liquids and Gases

D3300 Test Method for Dielectric Breakdown Voltage of Insulating Liquids Under Impulse Conditions

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

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)

D5985 Test Method for Pour Point of Petroleum Products (Rotational Method)

D6749 Test Method for Pour Point of Petroleum Products (Automatic Air Pressure Method)

D6892 Test Method for Pour Point of Petroleum Products (Robotic Tilt Method)

D7042 Test Method for Dynamic Viscosity and Density of Liquids by Stabinger Viscometer (and the Calculation of Kinematic Viscosity)

D7346 Test Method for No Flow Point and Pour Point of Petroleum Products and Liquid Fuels

2.2 *IEC Standard:*[4]

International Electrotechnical Commission 61099 Insulating Liquids – Specifications for Unused Synthetic Organic Esters for Electrical Purposes

International Electrotechnical Commission 61125 Test methods for oxidation stability – Test methods for evaluating the oxidation stability of insulating liquids in the delivered state

3. Terminology

3.1 Definitions of terms related to this specification are given in Terminology D2864.

3.2 *Definitions:*

3.2.1 *synthetic ester liquid, n*—an insulating liquid for transformers and similar equipment formed from an esterification reaction of chemicals (not necessarily biological feedstock) involving an alcohol and a carboxylic acid.

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 or IEC test method specified in Table 1.

4.3 If additives are used, the chemical family and function of all additives and maximum concentration of each family shall be declared in product data sheets and certificates of compliance. Information on initial type and concentration of additives is useful for supervision and maintenance guidance during the life of synthetic ester liquids in transformers and similar electrical equipment. Additives, if used, need to comply with local regulations.

5. Property Requirements

5.1 Synthetic ester insulating fluid, as received, shall conform to the requirements of Table 1. The significance of these properties is covered in Guide D117 and Appendixes X2.1 – X2.3.

6. Keywords

6.1 electrical insulating liquid; fire point; flammability; insulating fluid; synthetic ester

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from International Electrotechnical Commission (IEC), 3, rue de Varembé, 1st floor, P.O. Box 131, CH-1211, Geneva 20, Switzerland, https://www.iec.ch.

TABLE 1 Property Requirements

Property	Limit	Test Method
Physical:		
Color, max	200	D2129
Fire point, min, °C	300	D92
Flash point, min, °C	250	D92
Pour point, max, °C	−45	D97[A], D5949, D5950, D5985, D6749, D6892, and D7346
Relative density (specific gravity) 15 °C/15 °C, max	1.00	D1298, D4052
Viscosity, max, mm^2/s at:		D445[B], D7042
100 °C	10	
40 °C	35	
−20 °C	3000	
Visual Examination	Bright and Clear	D1524
Electrical:		
Dielectric breakdown voltage at 60 Hz		
VDE electrodes, min, kV at:		D1816
1 mm gap	20	
2 mm gap	35	
Impulse breakdown conditions, min, kV, 25 °C, needle negative to sphere grounded, 25.4 mm gap	110	D3300
Dissipation factor (power factor) at 60 Hz, max, %		D924
25 °C	0.10	
100 °C	3.0	
Chemical:		
Corrosive sulfur	noncorrosive	D1275
Neutralization number, total acid number, max, mg KOH/g	0.03	D974
PCB content, mg/kg	not detectable	D4059
Water, max, mg/kg	200	D1533
Oxidation Stability (164 h)		IEC 61125
Total acidity (mg KOH/g) max	0.3	
Total sludge (% mass) max	0.02	

[A] ASTM D97 is considered the referee test method for resolving disputes.
[B] ASTM D445 is considered the referee test method for resolving disputes.

APPENDIXES

(Nonmandatory Information)

X1. SUPPLEMENTARY DESIGN INFORMATION

X1.1 The following values are typical for synthetic ester insulating fluids.

Property	Typical Values	ASTM Test Method
Coefficient of Expansion, $°C^{-1}$	0.0007 to 0.0008	D1903
Dielectric Constant, 25 °C	3.1 to 3.3	D924
Specific Heat, J/(kg·°C) 20 °C	1670 to 2300	D2766
Thermal Conductivity, W/(m·°C)	0.1256 to 0.1675	D2717
Gassing tendency, µl/min	≤40	D2300