



Designation: D6871 – 26

Standard Specification for Natural (Vegetable Oil) Ester Fluids Used in Electrical Apparatus¹

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1. Scope

1.1 This specification covers a high fire point natural vegetable oil ester insulating fluid for use as a dielectric and cooling medium in new and existing power and distribution electrical apparatus such as transformers and attendant equipment.

1.2 Natural vegetable oil ester insulating fluid differs from conventional mineral oil and other high fire point (or “less-flammable”) fluids in that it is an agricultural product derived from vegetable oils rather than refined from petroleum base stocks or synthesized from organic precursors.

1.3 This specification is intended to define a natural vegetable oil ester electrical insulating fluid that is compatible with typical materials 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 some synthetic electrical insulating liquids. The user should contact the manufacturer of the natural ester insulating fluid for guidance in this respect.

1.4 This specification applies only to new insulating fluid as received prior to any processing. The user should contact the manufacturer of the equipment or fluid if questions of recommended characteristics or maintenance procedures arise.

1.5 *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.*

1.6 *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.*

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. Referenced Documents

2.1 ASTM Standards:²

- D88/D88M Test Method for Saybolt Viscosity
- 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)
- D877/D877M Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
- 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
- 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
- D1816 Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes
- D1903 Practice for Determining the Coefficient of Thermal Expansion of Electrical Insulating Liquids of Petroleum Origin, and Askarels
- D2300 Test Method for Gassing of Electrical Insulating Liquids Under Electrical Stress and Ionization (Modified Pirelli Method)

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

TABLE 1 As-Received New Fluid Property Requirements

Property	Limit	ASTM Test Method
<i>Physical:</i>		
Color, max	1.0	D1500
Fire point, min, °C	300	D92
Flash point, min, °C	275	D92
Pour point, max, °C	–10	D97
Relative density (specific gravity) 15 °C/15 °C, max	0.96	D1298
Viscosity, max, cSt at:		D445 or D88/D88M
100 °C (212 °F)	15	
40 °C (104 °F)	50	
0 °C (32 °F)	500	
Visual examination	Bright and clear	D1524
<i>Electrical:</i>		
Dielectric breakdown voltage at 60 Hz		
Disk electrodes, min, kV	30	D877/D877M
VDE electrodes, min, kV at:		D1816
1 mm (0.04 in.) gap	20	
2 mm (0.08 in.) gap	35	
Dielectric breakdown voltage, impulse conditions	130	D3300
25 °C, min, kV, needle negative to sphere grounded,		
1 in. (25.4 mm) gap		D924
Dissipation factor (or power factor) at 60 Hz, max, %		
25 °C	0.20	
100 °C	4.0	
Gassing tendency, max, µl/min	0	D2300
<i>Chemical:</i>		
Corrosive sulfur	Not corrosive	D1275
Neutralization number, total acid number, max,	0.06	D974
mg KOH/g		
PCB content, ppm	Not detectable	D4059
Water, max, mg/kg	200	D1533 ^A

^A As stated in Test Method D1533 Annex A1 “Alternative Solvent Systems,” alternate reagents may be needed for certain natural ester formulations. Consult the manufacturer for recommendations. Reagents for aldehydes and ketones (such as Coulomat AK and CG-K) should be used if the additives are unknown. When alternate reagents are needed, using the Test Method D1533 reagents may yield elevated and erratic water content results.

[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](#)

[D4059 Test Method for Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography](#)

2.2 *National Fire Protection Association Standard:*

[National Electrical Code Article 450-23](#)⁴

3. Terminology

3.1 *Definitions*—Definitions of terms related to this specification are given in Terminology [D2864](#). Vegetable oil natural

ester: vegetable oil containing ester linkages, typically triglycerides. Most often obtained from seed crops (a “natural” source of esters, as opposed to synthesized esters).

4. Sampling and Testing

4.1 Take all fluid samples in accordance with Practices [D923](#).

4.2 Perform each test in accordance with the ASTM test method specified in [Table 1](#).

5. Property Requirements

5.1 Natural ester insulating fluid, as received, shall conform to the requirements of [Table 1](#). The significance of these properties is covered in Guide [D117](#) and [X2.1 – X2.3](#).

6. Keywords

6.1 electrical insulating fluid; fire point; flammability; insulating fluid; natural ester

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

⁴ *National Electrical Code*, NFPA 70, National Fire Protection Association Inc.