

Envirotemp™ FR3™ Fluid

Functional Specification Guide

G2050
October 2013



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Functional Specification for New Natural Ester Less-Flammable Transformer Dielectric Coolant

SCOPE

This specification describes a non-toxic*, biodegradable**, fire resistant, bio-based*** natural ester dielectric fluid. It is intended for use in electrical equipment as an environmentally preferred, less-flammable insulating and cooling medium.

REQUIREMENTS

Fluid Manufacturer

Fluid manufacturer shall have a minimum of ten (10) years' experience producing and testing dielectric coolants. Manufacturer shall have at least two operating production sites to assure continuity of supply. Manufacturer upon request should provide AC withstand and impulse withstand for both transformer relevant fluid gaps from 3mm to 150mm and insulation creep from 3mm to 35mm.

Dielectric Coolant

The dielectric coolant shall be bio-based, biodegradable, be Factory Mutual Global Approved Less Flammable fluid, and be UL® Classified EOVK "less-flammable liquid" Transformer Fluid. It shall meet the property limits listed below. The base fluid shall be 100% oil from plants and/or seeds.

The dielectric coolant should have undergone accelerated aging studies via sealed tube and Locke test methods, and have published its A & B factors.

Environmental and Health Third Party Validations

The fluid shall have a U.S. EPA Environmental Technology Verification (ETV) Statement and be a USDA Certified Biobased Product. The fluid shall meet the following test limits:

Property	Specification Limits	Test Method
Aquatic Biodegradation [%]	>99	U.S. EPA OPPTS 835.3100 OECD 301b or U.S. EPA OPPTS 835.3110 (ii)
Ready Biodegradation [%]	>99	
Acute Aquatic Toxicity	Non-toxic (NOAE > 10 000 mg/L)	OECD 203, ASTM D6081
Acute Oral Toxicity	Non-toxic (NOAE > 2 000 mg/kg)	OECD 420

* Per OECD 203 Method B and OECD 420

** Per US EPA OPPTS 835.3100 and US EPA OPPTS 835.8110 (ii)

*** Per USDA BioPreferred minimum bio-based content for Fluid-Filled Transformers - Vegetable Oil-Based

Acceptable values for receipt of shipments of new FR3 fluid

PROPERTY	Standard test methods		ASTM D6871	IEC 62770
	ASTM	ISO/IEC	As-received new fluid property requirements	Unused new fluid property requirements
Physical				
Color	D1500	ISO 2211	≤1.0	
Flash Point PMCC (°C)	D93	ISO 2719		≥250
Flash Point COC (°C)	D92	ISO 2592	≥275	
Fire Point (°C)	D92	ISO 2592	≥300	>300
Pour Point (°C)	D97	ISO 3016	<-10	≤-10
Density at 20°C (g/cm ³)		ISO 3675		
Relative Density (Specific Gravity) 15°C	D1298		≤0.96	≤0.96
Viscosity (mm ² /sec)	D445	ISO 3104		
	100 °C		≤15	≤15
	40 °C		≤50	≤50
	0 °C		≤500	
Visual Examination	D1524	IEC 61099 9.2	bright and clear	clear, free from sediment and suspended matter
Biodegradation		OECD 301	readily biodegradable	readily biodegradable
Electrical				
Dielectric Breakdown (kV)	D877		≥30	
Dielectric Breakdown (kV)				
	1mm gap	D1816	≥20	
	2mm gap	D1816	≥35	
	2.5mm gap			≥35
Gassing Tendency (mm/min)	D2300		≤0	
Dissipation Factor				
	25°C (%)	D924	≤0.20	
	90°C (tan δ)			≤0.05
	100°C (%)	D924	≤4.0	
Chemical				
Corrosive Sulfur	D1275	IEC 62697	non-corrosive	non-corrosive
Water Content (mg/kg)	D1533	IEC 60814	≤200	≤200
Acid Number (mg KOH/g)	D974	IEC 62021.3	≤0.06	≤0.06
PCB Content (mg/kg)	D4059		not detectable	free from PCBs
Oxidation Stability (48 hrs, 120°C)		IEC 61125C		
	Total Acidity (mg KOH/g)			≤0.6
	Viscosity at 40°C (mm ² /sec)	ISO 3104		≤ 30% increase over initial
	Dissipation Factor at 90°C (tan δ)	IEC 60247		≤ 0.5

NOTE: Specifications should be written referencing only the defined ASTM or IEC industry standard acceptance values and test methods. The listed 'typical' values are average values summarized from a significant number of data points over many years; they are not to be identified as acceptance values.

ASTM D6871 Standard Specification for Natural (Vegetable Oil) Ester Fluids Used in Electrical Apparatus.

IEC 62770: Fluids for electrotechnical applications – Unused natural esters liquids for transformers and similar electrical equipment.

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Packaging

The electrical insulating fluid shall be furnished in sealed vessels suitable for the purpose, including 19 liter containers, 208 liter drums, 1,250 liter totes, 21,000 liter bulk (ISO) tanker, or in 75,000 liter rail car.

RECOMMENDED CUSTOMER RECEIVING QUALITY CONTROL

Inspection

Each lot received shall be visibly inspected for container integrity, and no leaks are visible.

Receiving Tests

Samples shall be taken from containers per ASTM D-923 Section 2.2, as follows:

Lot Size (Liters)	Number of Containers Sampled
2275 or less	1
2276 to 11,360	2-6
11,361 or more	6 minimum (10% of quantity of containers recommended)

When fluid will be combined for production, samples may be mixed together in equal proportions to create a composite sample for testing. Minimum tests required are water content, dielectric strength and visual inspection. Dissipation factor test is highly recommended, although not essential.

IMPORTANT INFORMATION

Storage

Do not store drums and totes outdoors. Extreme temperature variations can stress the integrity of container protective seals. Exposure of totes to sunlight can cause fluid discoloration. See the FR3 fluid Storage and Handling Guide

Intended Use

The use of electrical insulating and cooling fluid is generally dictated by the engineering design of the electrical apparatus. The electrical insulating fluid covered by this specification is intended for use as an insulating and cooling medium in electrical equipment.

Fluid Transfer

When transferring electrical insulating fluid from its original container, take precautions to prevent contamination with moisture, dust, and foreign matter. These impurities can cause deterioration of the dielectric strength and electrical performance.

Partial Containers

Provide a nitrogen blanket for partially filled containers, and properly seal to prevent contamination.

Applicable Specifications or Reference Standards

All characteristics, definitions and terminology, except those specifically covered in this specification shall be in accordance with the latest revisions of the following documents:

IEEE / ANSI Design

IEEE C57.12.00 – General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

IEEE C57.147 – Acceptance and Maintenance of Natural Ester Fluids in Transformers

IEEE C57.154 – Design, Testing, and Application of Liquid-Immersed Distribution, Power, and Regulating Transformers Using High-Temperature Insulation Systems and Operating at Elevated Temperatures

IEC Design

IEC 60076-1 – Power Transformers – Part 1: General

IEC 60076-14 – Power transformers – Liquid-immersed power transformers using high-temperature insulation materials

IEC 62770 – Fluids for electrotechnical applications – Unused natural esters for transformers and similar electrical equipment