IEC 62770

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Fluides pour applications électrotechniques – Esters naturels neufs pour transformateurs et matériels électriques analogues

IEC 62770:2013

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

FLUIDS FOR ELECTROTECHNICAL APPLICATIONS – UNUSED NATURAL ESTERS FOR TRANSFORMERS AND SIMILAR ELECTRICAL EQUIPMENT

FOREWORD

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International Standard IEC 62770 has been prepared by IEC technical committee 10: Fluids for electrotechnical applications.

The text of this standard is based on the following documents:

FDIS	Report on voting
10/909/FDIS	10/933/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

Because of their higher fire points and better environmental compatibility relative to petroleum derived insulating mineral oil, the use of vegetable oils and other natural esters is on the rise as insulating and heat transfer fluids in electrical devices such as transformers.

This standard sets performance criteria for unused natural esters earmarked for electrical applications. However, the use of natural esters is recommended only for equipment that is not open to the atmosphere, e.g. sealed transformers and reactors because these fluids are prone to rapid oxidation.

This International Standard does not purport to address all the safety problems associated with its use. It is the responsibility of the user of the standard to establish appropriate health and safety practices and determine the applicability of regulatory limitation prior to use.

Unused natural esters which are the subject of this standard should be handled with due regard to personal hygiene. Direct contact with eyes should be avoided. In case of eye contact, irrigation with copious amounts of clean running water should be carried out and medical advice sought.

Performance of some of the tests mentioned in this standard could lead to a hazardous situation. Attention is drawn to the relevant standard test method for guidance.

The disposal of natural esters, chemicals and sample containers mentioned in this standard should be carried out in accordance with current national legislation with regard to the impact on the environment. Every precaution should be taken to prevent the release of natural esters into the environment.

FLUIDS FOR ELECTROTECHNICAL APPLICATIONS – UNUSED NATURAL ESTERS FOR TRANSFORMERS AND SIMILAR ELECTRICAL EQUIPMENT

1 Scope

This International Standard describes specifications and test methods for unused natural esters in transformers and similar oil-impregnated electrical equipment in which a liquid is required as an insulating and heat transfer medium.

Use of natural esters is not recommended for electrical equipment that is open to the atmosphere.

In this standard the term "natural esters" applies to insulating fluids for transformers and similar electrical equipment with suitable biodegradability and environmental compatibility. Such natural esters are vegetable oils obtained from seeds and oils obtained from other suitable biological materials and delivered to an agreed point, at a set time period. These oils are comprised of triglycerides.

Natural esters with additives are within the scope of this standard. Because of their different chemical composition, natural esters differ from insulating mineral oils and other insulating fluids that have high fire points, such as synthetic esters or silicone fluids.

Natural, ester-derived insulating fluids with low viscosity have been introduced but are not covered by this standard. Pertinent properties of such fluids are given in Annex B.

This standard is applicable only to unused natural esters. Reclaimed natural esters and natural esters blended with non-natural esters fluids are beyond the scope of this standard.

The chemical nomenclature and scientific notations used in the standard are in accordance with the IUPAC handbook (Quantities, Units and Symbols in Physical Chemistry).

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60076-14, *Power transformers - Part 14: Liquid-immersed power transformers using high-temperature insulation materials*

IEC 60156, *Insulating liquids – Determination of the breakdown voltage at power frequency – Test method*

IEC 60247, *Insulating liquids – Measurement of relative permittivity, dielectric dissipation factor and DC resistivity of insulating fluids*

IEC 60296, *Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear*

IEC 60475, *Method of sampling liquid dielectrics*

IEC 60666, *Detection and determination of specific additives in mineral insulating oils*

IEC 60814, *Insulating liquids – Oil-impregnated paper and pressboard – Determination of water by automatic coulometric Karl Fischer titration*

IEC 61100, *Classification of insulating liquids according to fire-point and net calorific value*[1]

IEC 61125:1992, *Unused hydrocarbon-based insulating fluids – Test methods for evaluating the oxidation stability*

IEC 61198, *Mineral insulating oils – Methods for the determination of 2-furfural and related compounds*

IEC 61619, *Insulating liquids – Contamination by polychlorinated biphenyls (PCBs) – Method of determination by capillary column gas chromatography*

IEC 61620, *Insulating liquids – Determination of the dielectric dissipation factor by measurement of the conductance and capacitance – Test method*

IEC 62021-3, *Insulating liquids – Determination of acidity – Part 3: Test methods for non mineral insulating oils*[2]

IEC 62535:2008, *Insulating liquids – Test method for detection of potentially corrosive sulfur in used and unused insulating oils*

IEC 62697-1, *Test method for quantitative determination of corrosive sulfur compounds in unused and used insulating liquids – Part 1: Test method for quantitative determination of dibenzyl disulfide (DBDS)*

ISO 2592, *Determination of flash and fire point – Cleveland open cup method*

ISO 2719, *Determination of flash point – Pensky-Martens closed cup method*

ISO 3016, *Petroleum products – Determination of pour point*

ISO 3104, *Petroleum products – Transparent and opaque fluids – Determination of kinematic viscosity and calculation of dynamic viscosity*

ISO 3675, *Crude petroleum and liquid petroleum products – Laboratory determination of density – Hydrometer method*

ISO 12185, *Crude petroleum and petroleum products – Determination of density – Oscillating U-tube method*

ASTM D 1275, *Standard Test Method for Corrosive Sulfur in Electrical Insulating Oils*

OECD 201-203, *Test Guidelines for ecotoxicity*

OECD 301, *Guideline for testing of chemicals adopted by European Council on July 17th 1992*

US EPA, *Office of Prevention, Pesticides and Toxic Substances (OPPTS)*

835.311, *Fate, Transport and Transformation Test Guidelines*

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1 Withdrawn in 2009 and partially replaced by IEC 61039.

2 To be published.

3 Terms and definitions

For the purposes of this document, the following definitions apply.

3.1
additives
suitable chemical substances which are deliberately added to natural ester insulating fluids in order to improve certain characteristics, e.g. pour point, viscosity, foaming, and oxidation stability

Note 1 to entry: Examples include antioxidants, pour-point depressants, electrostatic charging tendency depressant, metal passivator or deactivators, antifoam agent, refining process improver, etc.

3.2
corrosive sulfur
free sulfur and corrosive sulfur compounds detected by subjecting metals such as copper to contact with an insulating liquid under standardized conditions

[SOURCE: IEC 60050-212:2010, definition 212-18-20, modified – inclusion of "metals such as"]

3.3
natural esters
vegetable oils obtained from seeds and oils obtained from other suitable biological materials and comprised of triglycerides

3.4
potentially corrosive sulfur
organo-sulfur compounds present in transformer oils that may cause copper sulfide formation

[SOURCE: IEC 62535:2008, definition 3.1, modified, the NOTE to entry has been omitted]

3.5
unused natural esters
unused natural esters as delivered by the supplier

Note 1 to entry: Such a liquid has not been used in, nor been in contact with electrical equipment or other equipment not required for its manufacture, storage or transport.

Note 2 to entry: The manufacturer and supplier of unused natural esters will have taken all reasonable precautions to ensure that the natural esters are not contaminated with polychlorinated biphenyls, polychlorinated terphenyls or polycyclic aromatics (PCB,PCT, PCAs,) or corrosive sulfur compounds; used, reclaimed, or dechlorinated oils, or other contaminants.

4 Properties, their significance and test methods

4.1 General

Salient characteristics of unused natural esters are listed in Table 1.

NOTE Additional information on natural esters for transformers and similar electrical equipment is available in CIGRE brochure 436 and IEEE report C57.147.

4.2 Physical properties

4.2.1 Appearance

A visual inspection of unused natural esters (with light transmitted through approximately 10 cm thickness of natural esters at ambient temperature) indicates the presence of visible contaminants, free water and suspended matter.

4.2.2 Viscosity

Viscosity influences heat transfer and therefore affects the increase of temperature in the transformer and other equipment. The lower the viscosity, the easier the oil circulates leading to better heat transfer. Viscosities at lower temperatures is a critical factor for cold start of transformers with ON cooling (absence of circulation can lead to possible overheating at hot spots). It can have negative impact on the speed of moving parts such as on-load tap changer mechanism, pumps and regulators. Due consideration should be given to viscosity at the lowest cold start energizing temperature (LCSET). Viscosity at 40 °C and 100 °C shall be measured according to ISO 3104.

4.2.3 Pour point

Pour point of unused natural esters is the lowest temperature at which the natural esters will just flow. Pour point shall be measured in accordance with ISO 3016.

Crystallization behaviour of natural esters depends on time and temperature. Crystals should not be present in liquid at application temperature; precautions shall be taken if oil temperature inside the electrical device is lower than 0 °C. Below this temperature thermal and dielectric behavior of the device with natural esters can be adversely affected. A well-defined method to measure crystallization behavior is not available at present.

4.2.4 Water content

Water content of natural esters affects their dielectric properties. Water content shall be measured in accordance with IEC 60814.

NOTE Due to the moderately polar nature of natural esters, water content at which free water will appear and cause deterioration of electric strength is significantly higher in natural esters than that in mineral insulating oils.

4.2.5 Density

Density of natural esters shall be measured in accordance with ISO 3675 (reference method), but ISO 12185 is also acceptable.

4.3 Electrical properties

4.3.1 Breakdown voltage

Breakdown voltage of unused natural esters shall be measured in accordance with IEC 60156.

Because of the difference in properties of natural esters, an initial set-up time is required; it may range between 15 min and 30 min, when there are no visible bubbles in the liquid before measurements are made.

4.3.2 Dielectric dissipation factor (DDF)

DDF is a measure for dielectric losses caused by the liquid. High DDF can indicate contamination of the liquid with moisture, particles or soluble polar contaminants or poor refining quality. DDF shall be measured in accordance with IEC 60247 or IEC 61620 at 90 °C. In case of dispute, IEC 60247 at 90 °C should be used.

By agreement between parties, DDF may be measured at temperatures other than 90 °C. In such cases the measurement temperature should be stated in the report.