

# INTERNATIONAL STANDARD



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



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# INTERNATIONAL STANDARD



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

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

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**This commented version (CMV) of the official standard IEC 62770:2024 edition 2.0 allows the user to identify the changes made to the previous IEC 62770:2013 edition 1.0. Furthermore, comments from IEC TC 10 experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.**

**A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.**

**This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.**

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

This second edition cancels and replaces the first edition published in 2013. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition: **1**

- a) Introduction of IEC 63012 which details other liquids not covered by this document. IEC 63012 was published in 2019 after the first edition of IEC 62770 (2013).
- b) New Table 1 inserted which clarifies definitions.
- c) Appearance and colour requirements now merged.
- d) Pour point: Introduction of the importance of LCSET with advice on cold temperature behaviour of natural esters.
- e) Additives: new agreed wording inserted on the declaration of additives
- f) Flash and fire points: now only determined by Cleveland Open Cup method, since the Pensky-Martens closed cup method was identified as problematic with natural esters.
- g) Toxicity: Aquatic toxicity now emphasized.
- h) Annex B removed as it is no longer needed since the publication of IEC 63012.

The text of this International Standard is based on the following documents:

Draft	Report on voting
10/1215/FDIS	10/1243/RVD

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at [www.iec.ch/members\\_experts/refdocs](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/publications](http://www.iec.ch/publications).

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under [webstore.iec.ch](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

- reconfirmed,
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- revised.

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## INTRODUCTION

Because of their higher fire points and ~~better~~ lower environmental ~~compatibility~~ impact relative to hydrocarbon 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 document 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, for example sealed transformers and reactors because these ~~fluids~~ liquids are ~~prone~~ susceptible to ~~rapid~~ oxidation.

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

Unused natural esters which are the subject of this document 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 document could lead to a hazardous situation. Attention is drawn to the relevant document 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.~~ **2**

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

## 1 Scope

This document describes specifications and test methods for unused natural esters in transformers and similar ~~oil-impregnated~~ liquid-immersed electrical equipment in which a liquid is required as an insulating and heat transfer medium. The exposure of natural ester to air leads to deterioration of the insulating liquid. Use of natural esters is ~~not recommended for electrical equipment that is open to the atmosphere~~ therefore restricted to sealed units, or with the conservator tank protected from the contact with atmosphere by a membrane or other suitable system. **3**

In this document the term "natural esters" applies to insulating ~~fluids~~ liquids for transformers and similar electrical equipment with suitable biodegradability and lower environmental ~~compatibility~~ impact. 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 document. Because of their different chemical composition, natural esters differ from insulating mineral oils and other insulating ~~fluids~~ liquids that have high fire points, such as synthetic esters or silicone fluids.

Natural ester-derived insulating ~~fluids~~ liquids with low viscosity have been introduced but are not covered by this document. ~~Pertinent properties of such fluids are given in Annex B.~~ IEC 63012 covers these liquids. **4**

This document is applicable only to unused natural esters. Reclaimed natural esters and natural esters blended with ~~non-natural esters fluids~~ other insulating liquids are beyond the scope of this document.

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

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. **5**

~~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 ( $\tan \delta$ ) and d.c. 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~~ insulating liquids*

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<sup>1</sup>~~

IEC 61125:1992, ~~Unused hydrocarbon-based insulating fluids~~ *Insulating liquids – Test methods for oxidation stability – Test method for evaluating the oxidation stability of insulating liquids in the delivered state*

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<sup>2</sup>*

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

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

ISO 2049, *Petroleum products – Determination of colour (ASTM scale)*

ISO 2592, *Petroleum and related products – Determination of flash and fire points – Cleveland open cup method*

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

ISO 3016, *Petroleum and related products from natural or synthetic sources – 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*

<sup>1</sup> ~~Withdrawn in 2009 and partially replaced by IEC 61039.~~

<sup>2</sup> ~~To be published.~~

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

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

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

~~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~~

### 3 Terms, definitions and abbreviated terms

#### 3.1 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses: **6**

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

##### 3.1.1

##### **additives**

~~suitable~~ chemical substances which are deliberately added to natural ester insulating fluids liquids 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"]~~

##### 3.1.2

##### **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]~~