

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Insulating liquids – Specifications for unused synthetic organic esters for electrical purposes

(standards.iteh.ai)

Liquides isolants – Spécifications relatives aux esters organiques de synthèse neufs destinés aux matériels électriques

IEC 61099:2010
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INSULATING LIQUIDS –
SPECIFICATIONS FOR UNUSED SYNTHETIC
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International Standard IEC 61099 has been prepared IEC technical committee 10: Fluids for electrotechnical applications.

This second edition cancels and replaces the first edition published in 1992 and constitutes a technical revision.

The main changes with respect to the previous edition relate to the aim of giving a more updated specification of synthetic organic esters when used as insulating liquids.

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

FDIS	Report on voting
10/813/FDIS	10/821/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

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INTRODUCTION

Health and safety

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 limitations prior to use.

Unused synthetic esters which are the subject of this standard should be handled with due care with regard to personal hygiene. Direct contact with eyes may cause slight irritation. In the case of eye contact, irrigation with copious quantities of clean running water should be carried out and medical attention sought.

Some of the tests specified in this standard involve the use of processes that could lead to a hazardous situation. Attention is drawn to the relevant standard for guidance.

Environment

The disposal of synthetic esters, chemicals and sample containers mentioned in this standard should be carried out in accordance with local regulations with regard to their environmental impact. Precautions should be taken to prevent the release of synthetic esters into the environment.

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INSULATING LIQUIDS – SPECIFICATIONS FOR UNUSED SYNTHETIC ORGANIC ESTERS FOR ELECTRICAL PURPOSES

1 Scope

This International Standard covers the specification and test methods for unused synthetic organic esters.

It applies to synthetic organic esters, delivered to the agreed point and time of delivery intended, for use in transformers, switchgear and similar related equipment in which synthetic organic esters are required as an insulant and for heat transfer. These unused synthetic organic esters are obtained by chemical processing and physical treatments of fatty acids and polyols.

NOTE Maintenance of synthetic organic esters in equipment is covered in a separate standard (IEC 61203).

2 Normative references

The following referenced documents are indispensable for the application 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.

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

IEC 61099:2010

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IEC 60247, *Insulating liquids – Measurement of relative permittivity, dielectric dissipation factor ($\tan \delta$) and d.c. resistivity*

IEC 60475, *Method of sampling liquid dielectrics*

IEC 60628:1985, *Gassing of insulating liquids under electrical stress and ionization*

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

IEC 61039, *Classification of insulating liquids*

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

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

IEC 62021-1, *Insulating liquids – Determination of acidity – Part 1: Automatic potentiometric titration*

IEC 62021-2, *Insulating liquids – Determination of acidity – Part 2: Colourimetric titration*

ISO 2211, *Liquid chemical products – Measurement of colour in Hazen units (platinum-cobalt scale)*

ISO 2592, *Determination of flash and fire-points – 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 liquids – 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*

OECD 301:1992, *OECD guideline for testing of chemicals – Ready biodegradability*

3 Terms and definitions

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

3.1

unused synthetic organic esters

liquid based on synthetic organic esters as delivered by the supplier

3.2

additive

substance/s which is/are deliberately added to a synthetic organic ester in order to improve certain characteristics, e.g. pour point, viscosity, foaming, oxidation stability

NOTE If additives are used, these should be mentioned by the supplier to the user, if requested. This may involve issues of confidentiality in an agreement. Additives, if used, need to comply with local regulations.

4 General remarks

The unused synthetic organic esters to which this standard applies are liquids which contain only carbon, hydrogen and oxygen. They are prepared from mono- or polyhydric alcohols and mono- or polybasic aliphatic or aromatic acids. Commercial products may be based on single esters or a mixture of esters and may contain oxidation inhibitors and other additives.

Unused synthetic organic esters selected for use in transformers have high flash and fire points and are therefore relatively difficult to ignite. They may, however, have slightly higher viscosities than mineral insulating oils.

Unused synthetic organic esters are more hygroscopic than mineral oils and this aspect will need to be considered in their use and maintenance.

NOTE Such a liquid, by definition, has not been used in, nor been in contact with, electrical equipment or other equipment not required for manufacture, storage or transport. The manufacturers and suppliers of unused synthetic organic esters will have taken all reasonable precautions to ensure that the liquid is not contaminated with polychlorinated biphenyls or terphenyls (PCB, PCT); used, reclaimed or dechlorinated oils; or other contaminants.

5 Health, safety and environment (HSE) properties (liquid properties related to safe handling and environment protection)

5.1 Flash point and fire point

The safe operation of electrical equipment requires an adequately high fire point that is measured in accordance with ISO 2592 (Cleveland open cup). Flash point is measured with ISO 2719 (Pensky-Martens closed cup procedure).

5.2 Biodegradation

Unused synthetic organic esters as supplied in electrical applications are of interest because of their higher fire points and better environmental compatibility, relative to petroleum derived insulating mineral oil. Specific tests need to be undertaken to demonstrate biodegradability of these liquids. Tests include OECD 301 / OPPTS 835.3110 (US EPA). The biodegradability of unused synthetic ester fluids can be classified using OECD 301 according to the IEC 61039.

5.3 Toxicity

Unused synthetic organic esters are considered non-toxic and suppliers shall supply assays that define the product as non-toxic.

NOTE Toxicity of unused synthetic organic ester can be assessed with test methods such as modified Ames assay or other suitable internationally recognized assays.

6 Classification, identification, general delivery requirements, sampling, packaging and disposal

6.1 Classification

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For the purpose of this standard, unused synthetic ester insulating liquids are classified into a single class: less flammable synthetic organic ester liquids.

6.2 Identification and general delivery requirements, sampling, packaging and disposal

Requirements shall be as follows:

- a) Unused synthetic organic esters are normally delivered in bulk, in rail tank cars, tank containers or packed in drums or intermediate bulk containers. These shall be clean and suitable for this purpose to avoid any contamination.
- b) Liquid drums and sample containers shall carry at least the following markings:
 - supplier's designation;
 - classification;
 - liquid net weight.
- c) Unused synthetic organic ester delivery shall be accompanied by a document from the supplier specifying at least: supplier's designation, liquid classification and quality certificate. At the purchaser's request, the supplier shall indicate the presence of any additive.

6.3 Storage

Storage should preferably be indoors and in suitable closed containers to prevent ingress of contamination. In the event of accidental contamination by water and/or solid particles during storage, the liquid can normally be restored to an acceptable quality by vacuum treatment followed by filtration or by using solid drying agents such as molecular sieves, followed by filtration.

6.4 Representative sampling

Representative sampling shall be carried out in accordance with the procedure described in IEC 60475.

6.5 Disposal and spillages

Synthetic organic esters should be disposed of in accordance with local regulations. Spillages should be cleaned according to the directions given in the materials safety data sheet.

7 Properties of synthetic organic esters

NOTE Characteristics are listed in specification Sheet 1.

7.1 Physical properties, significance and test methods

7.1.1 Colour

Colour shall be measured according to ISO 2211.

7.1.2 Appearance

A visual inspection of synthetic ester liquids (oil sample in transmitted light under a thickness of approximately 10 cm and at ambient temperature) indicates the presence of visible contaminants, free water and suspended matter.

7.1.3 Density

Density of the liquid shall be measured in accordance with ISO 3675 or ISO 12185.

7.1.4 Kinematic viscosity

Kinematic viscosity shall be measured according to ISO 3104.

NOTE The cold start behaviour of synthetic organic esters may be different from mineral oil.

7.1.5 Flash point and fire point

The safe operation of electrical equipment requires an adequately high flash and fire point. The flash point is measured by ISO 2719 (Pensky-Martens closed cup procedure), and the fire point is measured in accordance with ISO 2592 (Cleveland open cup).

7.1.6 Pour point

The pour point shall be determined according to ISO 3016.

7.1.7 Crystallization

Crystallisation shall be determined according to the test method description in Annex A.

7.1.8 Water content

Water content shall be measured in accordance with IEC 60814.

7.1.9 Acidity

The acidity should be determined in accordance with IEC 62021-1 or IEC 62021-2.

NOTE Precision data reported in these methods do not apply to synthetic esters.

7.1.10 Oxidation stability

Oxidation stability of synthetic organic esters can be assessed with IEC 61125:1992, Method C for 164 h. There is also the option to test at 500 h to allow for the extra stability of synthetic organic esters. This extra test is optional with no requirement in this standard.

8 Electrical properties

8.1 Breakdown voltage

Breakdown voltage of unused synthetic esters insulating liquid shall be measured in accordance with IEC 60156. However, because of the different properties of synthetic esters as compared to mineral oil, an extended initial set up time is required.

NOTE To include the wait time for the extra viscosity of synthetic ester, some modification of the method may be needed. This is an extension of the time between pouring into the test cell and testing to allow gas bubbles to come out of the fluid. It is recommended that a wait period of at least 1 h between loading the cell and the first breakdown arc is recommended. Also to ensure that there are no visible bubbles in the liquid.

8.2 Dielectric dissipation factor, permittivity and d.c. resistivity

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

8.3 Gassing tendency

Gassing tendency shall be measured according to Method A of IEC 60628:1985 but there is no requirement in this standard.

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9 Specifications for synthetic organic esters used in transformers

When tested in accordance with the methods specified in this standard, the properties of the unused liquid shall comply with the requirements given in specification sheet 1.