IEC 60867

Edition 3.0 2022-10

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Insulating liquids – Specifications for unused liquids based on synthetic aromatic hydrocarbons

Isolants liquides – Spécifications pour les liquides neufs à base d'hydrocarbures aromatiques de synthèse

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INSULATING LIQUIDS – SPECIFICATIONS FOR UNUSED LIQUIDS BASED ON SYNTHETIC AROMATIC HYDROCARBONS

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IEC 60867 has been prepared by IEC technical committee 10: Fluids for electrotechnical applications. It is an International Standard.

This third edition cancels a replaces the second edition published in 1993. This edition constitutes a technical revision.

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

a) The Scope has been changed from applications in electrical equipment to applications limited to cables and capacitors.
b) IEC 62021-1, IEC 62021-2 and IEC 62021-3 are all acceptable for synthetic aromatic hydrocarbons and references to individual parts have been replaced by references to the IEC 62021 series.

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

Draft	Report on voting
10/1186/FDIS	10/1188/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. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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INTRODUCTION

WARNING – Health and safety

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

The synthetic aromatic hydrocarbon insulating liquids which are the subject of this document should be handled with due regard to personal hygiene. Direct contact with the eyes can cause irritation. In the case of eye contact, irrigation with copious quantities of clean running water should be carried out and medical advice sought. Some of the tests specified in this document involve the use of processes that could lead to a hazardous situation. Attention is drawn to the relevant standard for guidance.

WARNING – Environment

This document is applicable to synthetic aromatic hydrocarbon insulating liquids, chemicals and used sample containers. The disposal of these items can be subject to regulatory requirements with regard to their impact on the environment. Every precaution should be taken to prevent release of insulating liquids into the environment.

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INSULATING LIQUIDS – SPECIFICATIONS FOR UNUSED LIQUIDS BASED ON SYNTHETIC AROMATIC HYDROCARBONS

1 Scope

This document covers specifications and test methods for unused synthetic aromatic hydrocarbons intended for use as insulating liquid in cables and capacitors.

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.

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 (tanδ) and d.c. resistivity*

IEC 60475, *Method of sampling insulating liquids*

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

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

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

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 (all parts), *Insulating liquids – Determination of acidity*

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

ISO 2592, *Petroleum and related products – Determination of flash point – Cleveland open cup method (PMOC)*

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

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ISO 9562, *Water quality – Determination of adsorbable organically bound halogens (AOX)*

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

ASTM D1275, *Standard test method for corrosive sulfur in electrical insulating liquids*

ASTM D4929, *Standard Test Method for Determination of Organic Chloride Content in Crude Oil*

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

ASTM D7536, *Standard Test Method for Chlorine in Aromatics by Monochromatic Wavelength Dispersive X-ray Fluorescence Spectrometry*

DIN 51353, *Testing of insulating oils; detection of corrosive sulfur; Silver strip test*

3 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:

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

3.1
alkylbenzenes
insulating liquids consisting of a benzene ring and an alkyl group where the alkyl group can be a straight chain or a branched-chain type

Note 1 to entry: Examples of IR spectra are given in Annex B.

3.2
alkyldiphenylethanes
insulating liquids consisting of diphenylethanes derivatives where the two aryl groups normally carry short alkyl groups

Note 1 to entry: Examples of IR spectra are given in Annex B.

3.3
alkylnaphthalenes
insulating liquids consisting of a naphthalene structure with substituent alkyl groups

Note 1 to entry: Examples of IR spectra are given in Annex B.

3.4
methylpolyarylmethanes
insulating liquids consisting of methylpolyarylm ethanes derivatives mainly based on a blend of mono/di-benzyl toluene (M/DBT)

Note 1 to entry: Examples of IR spectra are given in Annex B.

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4 Identification and general delivery requirements

Identification and general delivery requirements are as follows:

a) The synthetic aromatic hydrocarbons type of liquid is normally delivered in bulk, rail-tank cars, tank containers or packed in drums or intermediate bulk containers (IBC). These shall be clean and suitable for this purpose to avoid any contamination. The supplier shall take all the precautions to ensure the delivery product will be in accordance with the requirements of this document.

b) Drums and sample containers shall carry at least the following markings:
   - supplier's designation;
   - labelling in accordance with the Globally Harmonized System of Classification and Labelling of Chemicals (GHS);
   - liquid quantity.

c) As agreed between the supplier and purchaser each liquid delivery shall be accompanied by a document specifying the supplier’s designation, labelling and compliance certificate. A delivery shall be traceable to a manufactured batch.

d) The supplier shall declare the generic type of all additives, and the concentrations in the case of antioxidants and passivators.

5 Sampling

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

6 Test methods

6.1 Appearance

Appearance shall be evaluated by examining, in transmitted light, a representative sample of the liquid having a thickness of approximately 10 cm, at ambient temperature.

6.2 Density

Density shall be measured in accordance with ISO 12185 (reference method). ISO 3675 and ASTM D7042 are acceptable.

6.3 Kinematic viscosity

Kinematic viscosity shall be measured according to ISO 3104 (reference method) or ASTM D7042.

6.4 Flash point

Flash point shall be determined according to ISO 2592.

6.5 Pour point

Pour point shall be determined according to ISO 3016.

6.6 Acidity

Acidity shall be measured according to the IEC 62021 series. Any part of the IEC 62021 series (IEC 62021-1 or IEC 62021-2 or IEC 62021-3) can be used.

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6.7 Chlorine content

Chlorine content shall be determined using a test method according to ISO 9562 for the determination of adsorbable organically bound halogens (AOX) or ASTM D4929 for the determination of organic chloride content in crude oil or ASTM D7536 for the determination of chlorine in aromatics by monochromatic wavelength dispersive X-ray fluorescence spectrometry. The method described in Annex A can also be used.

6.8 Water content

Water content shall be determined according to IEC 60814.

6.9 Corrosive and potentially corrosive sulphur

Corrosive and potentially corrosive sulphur shall be determined according to DIN 51353 and ASTM D1275 and IEC 62535.

6.10 Additives

The chemical family of all additives shall be declared in product data sheets and certificates of compliance. For antioxidant additives and passivators (IEC 60666), their concentrations shall also be stated.

6.11 Breakdown voltage

Breakdown voltage shall be determined according to IEC 60156.

6.12 Dielectric dissipation factor and volume resistivity

The properties shall be determined according to IEC 60247 (reference method) or IEC 61620.

6.13 Gassing tendency

The gassing shall be determined by Method A of IEC 60628.

NOTE Synthetic aromatic hydrocarbon compositions have been used as additive to improve the gassing tendency of insulating liquids.

6.14 Polychlorinated biphenyl (PCBs) content

Synthetic aromatic hydrocarbons shall be free from PCBs. The reference test method is IEC 61619.

NOTE Acceptable limits of total or individual PCBs are specified in national and local regulations. Further European specifications are described in Directive 96/59/EC and UN Guidelines for the identification of PCBs and materials containing PCBs.

7 Specifications for capacitor and cable alkylbenzenes

When tested in accordance with the methods specified in Clause 6, the properties of insulating liquids based on alkylbenzenes which are intended for use as impregnant in capacitors and hollow-core cables shall meet the requirements and specifications given in Table 1.

8 Specifications for capacitor alkyldiphenylethanes

When tested in accordance with the methods specified in Clause 6, the properties of insulating liquids based on alkyldiphenylethanes used as impregnant in capacitors shall meet the requirements and specifications given in Table 2.

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9 Specifications for capacitor alkylnaphthalenes

When tested in accordance with the methods specified in Clause 6 the properties of insulating liquids based on alkylnaphthalenes used as impregnant in capacitors shall meet the requirements and specifications given in Table 2.

10 Specifications for capacitor methylpolyarylmethanes

When tested in accordance with the methods specified in Clause 6, the properties of insulating liquids based on methylpolyarylmethanes used as impregnant in capacitors shall meet the requirements and specifications given in Table 3.

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Table 1 – Specifications for capacitor and cable alkylbenzenes

Property	Test method	Permissible value			Permissible value
		Cables type[a]			Capacitors
		Type I	Type II	Type III	
Physical					
– Appearance		Clear, no suspended matter or sediments			Clear, no suspended matter or sediments
– Density at 20 °C (kg/dm^3)	ISO 12185[b], ISO 3675 or ASTM D7042	Max. 0,880	Max. 0,880	Max. 0,885	Max. 0,880
– Kinematic viscosity at 40 °C (mm^2/s)	ISO 3104[b] or ASTM D7042	< 6	6 to 11	11 to 50	Max. 5
– Pour point (°C)	ISO 3016	Max. −45	Max. −45	Max. −30	Max. −45
Chemical					
– Acidity (mg KOH/g)	IEC 62021	Max. 0,03			Max. 0,03
– Chlorine content (mg/kg)	ISO 9562 or ASTM D4929 or ASTM D7536. Method described in Annex A can also be used.	Max. 30			Max. 30
– Water content (mg/kg)	IEC 60814	Max. 75[c]			Max. 75[c]
– Corrosive sulphur	DIN 51353	Not corrosive			Not corrosive
– Corrosive sulphur	ASTM D1275	Not corrosive			Not corrosive
– Potentially corrosive sulphur	IEC 62535	Not corrosive			Not corrosive
– All Additives[d] (%)	IEC 60666	≤ 1,0			≤ 1,0
Electrical					
– Breakdown voltage (kV)	IEC 60156	Min. 35[e] /70[e]			Min. 35[e] /70[e]
– Volume resistivity at 90 °C (GΩ · m)	IEC 60247 or IEC 61620	Min. 500[c]			Min. 500[c]
– Dielectric dissipation factor, tanδ at 90 °C and 40 Hz to 60 Hz	IEC 60247 or IEC 61620	Max. 0,002[c]			Max. 0,002[c]
– Gassing tendency[f] (mm^3/min)	IEC 60628/Method A	Max. −20			Max. −20
– Permittivity[g]	IEC 60247 or IEC 61620	2,20 to 2,40			2,20 to 2,40
Health, safety and environment (HSE)					
– Flash point (°C)	ISO 2592	Min. 110	Min. 130	Min. 150	Min. 110
– PCB content (mg/kg)	IEC 61619	Not-detected (ND) (< 2)			Not detected (ND) (< 2)

[a] Alkylbenzenes can be produced at different density and viscosity levels with their own level of characteristics to be used in different applications (Type I, II and III).

[b] Reference method.

[c] These values relate to liquids as received.

[d] The supplier shall declare the function and chemical family of all additives, and the concentrations in the case of inhibitors, antioxidants and passivators.

[e] The value of 35 kV is for the liquid, as received. The value of 70 kV is for the liquid after laboratory treatment consisting of filtration of liquid at 60 °C by vacuum pressure below 2,5 kPa through sintered glass filtering (with maximum pore size of 2,5 µm). This test shall be conducted in accordance with IEC 60156.

[f] Specification requires the gassing limits as measured by method A.

[g] Shall be reported for information.

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