भारतीय मानक

Indian Standard

IS 16838 : 2018
IEC 60836 : 2015

विद्युत्त तकनीकी प्रयोजनार्थ अप्रयुक्त सिलिकॉन विद्युतरोधी द्रव्य की विशिष्टियाँ

Specifications for Unused Silicone Insulating Liquids for Electrotechnical Purposes

ICS 29.040.10

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Fluids for Electrotechnical Applications Sectional Committee, ETD 03

NATIONAL FOREWORD

This Indian Standard which is identical with IEC 60836 : 2015 ‘Specifications for unused silicone insulating liquids for electrotechnical purposes’ issued by the International Electrotechnical Commission was adopted by the Bureau of Indian Standards on the recommendation of the Fluids for Electrotechnical Applications Sectional Committee and approval of the Electrotechnical Division Council.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminology and conventions are however not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words ‘International Standard’ appear referring to this standard, they should be read as ‘Indian Standard’.
b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to the following International Standards for which Indian Standards also exist. The corresponding Indian Standards, and documents under print which are to be substituted in their places, are listed below alongwith their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 60156 : 1995 Insulating liquids — Determination of the breakdown voltage at power frequency — Test method	IS 6792 : 2015 Insulating liquids — Determination of the breakdown voltage at power frequency — Test method (*second revision*)	Identical with IEC 60156 : 1995
IEC 60247 Insulating liquids — Measurement of relative permittivity, dielectric dissipation factor (tan δ) and d.c. resistivity	IS 16840 : 2018 Insulating liquids — Measurement of relative permittivity, dielectric dissipation factor (tan δ) and d.c. resistivity	Identical with IEC 60247 : 2004
IEC 60475 Method of sampling insulating liquids	IS 6855 : 2017 Method of sampling insulating liquids (*second revision*)	Identical with IEC 60475 : 2011
IEC 60628 Gassing of insulating liquids under electrical stress and ionization	IS 12475 (Part 1) : 1988 Specification for gassing of insulating liquid under electric stress and ionization : Part 1 Method of determination of gassing rate under hydrogen atmosphere	Technically Equivalent
	IS 12475 (Part 2) : 1988 Specification for gassing of insulating liquids under electric stress and ionization : Part 2 Method of determination of gassing rate under nitrogen atmosphere	Technically Equivalent
IEC 60814 Insulating liquids — Oil-impregnated paper and pressboard — Determination of water by automatic coulometric Karl Fischer titration	IS 13567 : 2018 Insulating liquids — Oil impregnated paper and pressboard — Determination of water by automatic coulometric Karl Fischer titration (*first revision*)	Identical with IEC 60814 : 1997
IEC 60944 Guide for the maintenance of silicone transformer liquids	IS 16841 : 2018 Guide for the maintenance of silicone transformer liquids	Identical with IEC 60944 : 1988

(*Continued on third cover*)

Indian Standard

SPECIFICATIONS FOR UNUSED SILICONE INSULATING LIQUIDS FOR ELECTROTECHNICAL PURPOSES

1 Scope

This International Standard covers specifications and test methods for unused silicone liquids intended for use in transformers and other electrotechnical equipment.

The specified characteristics of silicone transformer liquid classified as L-NTUK-8360300 (in accordance with IEC 61039) are described in Table 1.

Besides the standard transformer applications there are other applications of silicone liquids, such like cable accessories, capacitors, electrical magnets etc. The specified characteristics and minimum requirements for these liquids are described in Table 2.

NOTE Maintenance of used silicone liquid in electrotechnical equipment is covered in a separate publication IEC 60944.

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 60156:1995, *Insulating liquids – Determination of the breakdown voltage at power frequency – Test method*

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

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

IEC 60475, *Method of sampling insulating liquids*

IEC 60628, *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 60944, *Guide for the maintenance of silicone transformer liquids*

IEC 61039:2008, *Classification of insulating liquids*

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

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 5661, *Petroleum products – Hydrocarbon liquids – Determination of refractive index*

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

3 Terms and definitions

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

3.1
silicone insulating liquids
liquid organopolysiloxanes whose molecular structure consists mainly of linear chains of alternating silicon and oxygen atoms, with hydrocarbon groups attached to the silicon atoms

3.2
silicone transformer liquid
polydimethyl siloxane, without additives, primarily for use in transformers

Note 1 to entry: According to IEC 61039, this type is classified as L-NTUK-8360300.

3.3
other silicone liquids for electrotechnical purposes
polydimethyl siloxane, without additives, applied for electrotechnical purposes

Note 1 to entry: Classification of other fluids for electrotechnical purposes according to IEC 61039 shall be made in relation to their main application and their fire point, e.g. a liquid for capacitors with a fire point of less than 300 °C is classified as L-NCUO-8360300.

4 Properties

4.1 General properties

As defined in 3.2, silicone liquid for transformers has high flash and fire points and is therefore difficult to ignite. If combustion occurs, heat release rate is much lower than that of hydrocarbon oils.

In addition to use at similar working temperatures to those of transformers containing mineral transformer oil, silicone insulating liquids may also be used in appropriately designed electrotechnical equipment operating at higher temperatures.

The solubility of water in silicone liquids is greater than in mineral oils. Other physical characteristics which are important for the design of electrotechnical equipment, e.g. heat transfer, may also be different from those of mineral transformer oil and will need to be taken fully into account by the designer.

4.2 Properties relating to health, safety and environment (HSE)

4.2.1 Handling

Silicone liquids ultimately degrade in nature to simple, naturally occurring substances. Their handling is not hazardous to health.

Direct contact with the eyes may cause slight irritation. Safety glasses should be worn to avoid splashing the eyes. In the case of eye contact, irrigation with large quantities of clean running water should relieve any irritation. If irritation persists, seek medical advice.

Detailed information on safe handling of these liquids can be obtained from manufacturers or suppliers.

4.2.2 Disposal

Local regulations shall be complied with. The preferred means of disposal is recycling by a qualified contractor. Waste liquid may be incinerated. Spillages should be cleaned using adsorbent media. Small quantities of liquid entering the environment present no special hazard.

5 General delivery requirements and identification

Transport of silicone insulating liquid shall be in clean hermetically sealed containers whose lining does not interact with the contents.

Each container shall display the following information:

– number of this standard;
– supplier’s designation;
– batch number;
– any notices required by local regulatory authorities.

Electrotechnical equipment filled with silicone insulating liquid should be labelled for identification with respect to the insulation used.

6 Storage and maintenance

Storage should preferably be indoors and shall be in sealed containers to prevent ingress of moisture and dirt. If accidentally contaminated by water and/or solid particles during storage, the liquid can usually be restored to acceptable quality by the procedures described in IEC 60944.

7 Sampling

The liquid shall be sampled in accordance with IEC 60475, using the procedure consistent with the density of the liquid being sampled. Isopropyl alcohol is suitable for cleaning the sampling equipment.

8 Properties and test methods

8.1 Colour and appearance

8.1.1 Colour

This property shall be measured according to ISO 2211.

8.1.2 Appearance

This property shall be evaluated by examining a representative sample of approximately 100 mm in thickness, in transmitted light and at ambient temperature.

8.2 Density

This property shall be measured at 20 °C according to ISO 3675 but measurement according to ISO 12185 is accepted as well.

8.3 Kinematic viscosity

This property shall be measured at 40 °C according to ISO 3104.

8.4 Flash point

This property shall be measured according to ISO 2719.

8.5 Fire point

This property shall be measured according to ISO 2592.

8.6 Refractive index

This property shall be measured according to ISO 5661.

8.7 Pour-point

This property shall be measured according to ISO 3016.

8.8 Water content

This property shall be measured according to IEC 60814.

8.9 Acidity

This property shall be measured according to IEC 62021-3.

8.10 Breakdown voltage

This property shall be measured according to IEC 60156 and with particular attention to IEC 60156:1995, 3.4.2.

8.11 Dielectric dissipation factor, permittivity, d.c. resistivity

These properties shall be determined at 90 °C by the methods described in IEC 60247. Isopropyl alcohol or acetone are suitable for cleaning the test cell.

8.12 Gassing under electrical stress and ionization

This property shall be measured according to IEC 60628.

8.13 Flammability

Fire hazard measurement of insulating liquids is now studied by IEC technical committee 89.

9 Individual specifications

9.1 General

The specifications given in Table 1 and Table 2 applies only to unused silicone liquids intended for use in electrotechnical equipment, as received from the supplier and before any treatment or introduction into electrotechnical equipment. The liquid sampled in accordance with Clause 7 shall be tested in accordance with the appropriate test methods given in Clause 8. The characteristics of the liquid when tested shall comply with the requirements given in Table 1 and Table 2.

9.2 Silicone transformer liquid

This liquid is polydimethyl siloxane without additives, primarily for use in transformers. According to IEC 61039, it is classified as L-NTUK-8360300.

When tested in accordance with the methods specified in Clause 8, the properties of silicone transformer liquid shall meet the requirements given in Table 1.

Table 1 – Specification of silicone transformer liquid

Property	Test method (clause or subclause)	Permissible values	Notes
Colour	8.1.1	Max.35	
Appearance	8.1.2	Clear, free from suspended matter and sediment	
Density at 20 °C (kg/dm^3)	8.2	0,955 to 0,970	
Kinematic viscosity at 40 °C (mm^2/s)	8.3	40 ± 4	
Flash point (°C)	8.4	Min. 240	
Fire point (°C)	8.5	Min. 340	
Refractive index at 20 °C	8.6	1,404 ± 0,002	
Pour point (°C)	8.7	Max. –50	
Water content (mg/kg)	8.8	Max. 50	see NOTE
Acidity (mg KOH/g)	8.9	Max. 0,01	see NOTE
Breakdown voltage (kV)	8.10	Min. 40	see NOTE
Dielectric dissipation factor (DDF) at 90 °C and 50 Hz	8.11	Max. 0,001	see NOTE
Permittivity at 90 °C	8.11	2,55 ± 0,05	see NOTE
DC resistivity at 90 °C (GΩ × m)	8.11	Min. 100	see NOTE
NOTE For untreated liquid, as received.			

9.3 Other silicone liquids for electrotechnical purposes

Other silicone liquids are available and may be used for electrotechnical purposes. These liquids are polydimethyl siloxanes without additives and may have either a higher or a lower viscosity than liquids as per 9.2.

When tested in accordance with the methods specified in Clause 8, the properties of these liquids shall meet the minimum requirements given in Table 2.

Table 2 – Minimum requirements for silicone liquids

Property	Test method (clause or subclause)	Permissible values	Notes
Fire point (°C) [a]	8.5	As a function of the target classification according to IEC 61039	
Pour point (°C)	8.7	< –50	
Water content (mg/kg)	8.8	Max. 50	see NOTE
Acidity (mg KOH/g)	8.9	Max. 0,01	see NOTE
Breakdown voltage (kV)	8.10	Min. 40	see NOTE
Dielectric dissipation factor (DDF) at 90 °C and 50 Hz	8.11	Max. 0,001	see NOTE
DC resistivity at 90 °C (GΩ × m)	8.11	Min. 100	see NOTE
NOTE For untreated liquid, as received.			
[a] The minimum value of the fire point shall be selected as a function of the target classification according to IEC 61039. If classification "class K" is required the fire point shall be above 300 °C; fluids with a fire point of less than or equal to 300 °C shall be classified "class O"; silicone liquids with a lower viscosity exhibit a lower fire point; selection shall be made with respect to local standards and minimum requirements for the intended application of the liquid; the minimum flash point of the chosen liquid shall be in accordance with IEC 60296.			

Bibliography

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

IEC 60695-1-40, *Fire hazard testing – Part 1-40: Guidance for assessing the fire hazard of electrotechnical products – Insulating liquids*

IEC TS 60695-8-3, *Fire hazard testing – Part 8-3: Heat release – Heat release of insulating liquids used in electrotechnical products*

(*Continued from second cover*)

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
IEC 61039 : 2008 Classification of insulating liquids	IS 13503 : 2013 Classification of insulating liquids (*first revision*)	Identical with IEC 61039 : 2008
IEC 62021-3 Insulating liquids — Determination of acidity — Part 3: Test methods for non-mineral insulating oils	IS 16863 (Part 3) : 2018 Insulating liquids — Determination of acidity : Part 3 Test methods for non-mineral insulating oils	Identical with IEC 62021-3 : 2014
ISO 2592 Determination of flash and fire points — Cleveland open cup method	IS 1448 (Part 69) : 2013 Methods of test for petroleum and its products : Part 69 Determination of flash and fire points — Cleveland open cup method (*first revision*)	Identical with ISO 2592 : 2000
ISO 2719 Determination of flash point — Pensky Martens closed cup method	IS 1448 (Part 21) : 2012 Methods of test for petroleum and its products : Part 21 Determination of flash point — Pensky-martens closed cup method (*third revision*)	Identical with ISO 2719 : 2002
ISO 3016 Petroleum products — Determination of pour point	IS 1448 (Part 10/Sec 2) : 2013 Methods of test for petroleum and its products : Part 10 Cloud point and pour point, Section 2 Determination of pour point (*second revision*)	Identical with ISO 3016 : 1994
ISO 3104 Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity	IS 1448 (Part 25/Sec 1) : 2017 Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity	Identical with ISO 3104 : 1994
ISO 3675 Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method	IS 1448 (Part 16) : 2014 Methods of test for petroleum and its products : Part 16 Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method (*fourth revision*)	Identical with ISO 3675 : 1998
ISO 5661 Petroleum products — Hydrocarbon liquids — Determination of refractive index	IS 1448 (Part 158) : 2016 Methods of test for petroleum and its products: Part 158 Hydrocarbon liquids — Determination of refractive index	Identical with ISO 5661 : 1983

The technical committee has reviewed the provisions of the following International Standard referred in this adopted standard and has decided that it is acceptable for use in conjunction with this standard:

International Standard	*Title*
IEC 60296	Fluids for electrotechnical applications — Unused mineral insulating oils for transformers and switchgear
ISO 2211	Liquid chemical products — Measurement of colour in Hazen units (platinum-cobalt scale)
ISO 12185	Crude petroleum and petroleum products — Determination of density — Oscillating U-tube method

Only the English text of the IEC standard has been retained while adopting it is an Indian Standard and as such the page numbers given here are not same as in IEC standard.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

This Indian Standard has been developed from Doc No. : ETD 03 (11061).

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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