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Electrical insulating oils

ICS 29.040.10

Descriptors : insulating oils, mineral oils, liquid electrical insulating materials, electrical insulation, electrical insulating materials, capacitors, electric cables, transformers, oil circuit-breakers

Reference number : JIS C 2320 : 1999 (E)

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently **JIS C 2320 : 1993** is replaced with **JIS C 2320 : 1999**.

In the International Standard corresponding to this Standard, sampling methods and test methods of electrical insulating oils are also specified, but in this Standard, the quality of oils and the like are specified. The sampling methods and test methods are specified in **JIS C 2101** *Testing method of electrical insulating oils*.

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In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

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Electrical insulating oils

Introduction This Japanese Industrial Standard has been prepared based on the corresponding International Standards

- IEC 60296 : 1982 *Specification for unused mineral insulating oils for transformers and switchgear Amendment No. 1 (1986)*
- IEC 60465 : 1988 *Specification for unused insulating mineral oils for cables with oil ducts*
- IEC 60836 : 1988 *Specification for silicone liquids for electrical purposes*
- IEC 60867 : 1993 *Insulating liquids—Specifications for unused liquids based on synthetic aromatic hydrocarbons*
- IEC 60963 : 1988 *Specification for unused polybutenes*

in such a manner that the insulating oils specified in the former **JIS** are specified in the text and the specifications in these corresponding International Standards are adopted in the Annex.

1 Scope This Japanese Industrial Standard specifies electrical-insulating oils before use for oil-impregnated capacitors, oil-filled cables, oil-immersed transformers, oil circuit breakers, etc. (hereafter referred to as “insulating oils”).

Remarks : The International Standards corresponding to this Standard are given below.

- IEC 60296 : 1982 *Specification for unused mineral insulating oils for transformers and switchgear Amendment No. 1 (1986)*
- IEC 60465 : 1988 *Specification for unused insulating mineral oils for cables with oil ducts*
- IEC 60836 : 1988 *Specification for silicone liquids for electrical purposes*
- IEC 60867 : 1993 *Insulating liquids—Specifications for unused liquids based on synthetic aromatic hydrocarbons*
- IEC 60963 : 1988 *Specification for unused polybutenes*

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards indicated below shall be applied.

- JIS C 2101 *Testing methods of electrical insulating oils*
- JIS Z 1601 *Steel drums for liquid*
- JIS Z 1602 *18 liter metal cans*
- JIS Z 1620 *Steel pails*

3 Definitions For the purposes of this Standard the following principal definitions apply.

a) **mineral oil** A kind of oil which is produced by purifying crude oil and the main composition of which is hydrocarbon.

b) **alkylbenzene** A benzene derivative consisting of benzene ring with alkyl radical.

There are straight-chain alkylbenzene and branched-chain alkylbenzene. Straight-chain alkylbenzene means a kind of benzene the main composition of which is benzene with straight-chain alkyl radical, and branched-chain alkylbenzene means another kind of benzene the main composition of which is benzene with branched-chain alkyl radical.

c) **polybutene** A copolymer of *n*-butene and isobutene.

d) **alkylnaphthalene** A naphthalene compound which has alkyl radical in the naphthalene ring.

e) **alkyldiphenylalkane** A diphenylalkane which has alkyl radical.

f) **silicone oil** An oil composed of dimethylpolysiloxane.

g) **additive** Substance to be added in a small amount for the purpose of improving a specific characteristic of insulating oil.

1) **fluid electrification depressant** An additive to depress fluid electrification produced by circulation of insulating oil in a transformer, and benzotriazole is used.

2) **pour point depressant** An additive to decrease the pour point of oil, and in general ethylene-propylene copolymer, polymethacrylate, etc. are used.

4 Classification Insulating oils are classified principally according to the composition as given in Tables 1 and 2. As for class B insulating oils, the specifications are given in the Annex.

Table 1 Insulating oils A

Classification		Main composition			Principal service
Class 1	No. 1	Mineral oil			Oil-impregnated capacitors, oil-filled cables
	No. 2 ⁽²⁾				Oil-immersed transformers, oil circuit breakers
	No. 3 ⁽²⁾				Oil-immersed transformers, oil circuit breakers which are used at a place other than a very cold place
	No. 4 ⁽²⁾				Oil-immersed transformers of high voltage and large capacity
Class 2	No. 1	Alkyl-benzene	Branched-chain type	Low viscosity	Oil-impregnated capacitors, oil-filled cables
	No. 2			High viscosity	
	No. 3		Straight-chain type	Low viscosity	
	No. 4			High viscosity	
Class 3	No. 1	Polybutene		Low viscosity	Oil-impregnated capacitors, oil-filled cables
	No. 2			Medium viscosity	
	No. 3			High viscosity	
Class 4	No. 1	Alkyl-naphthalene		Low viscosity	Oil-impregnated capacitors
	No. 2			High viscosity	
Class 5	No. 1	Alkyldiphenylalkane		Low viscosity	Oil-impregnated capacitors
	No. 2			High viscosity	
Class 6		Silicone oil			Oil-immersed transformers
Class 7 ⁽¹⁾	No. 1	Mineral oil, alkylbenzene			Oil-impregnated capacitors, oil-filled cables
	No. 2 ⁽²⁾				Oil-immersed transformers, oil circuit breakers
	No. 3 ⁽²⁾				Oil-immersed transformers, oil circuit breakers which are used at a place other than a very cold place
	No. 4 ⁽²⁾				Oil-immersed transformers of high voltage and large capacity

Notes (1) The class 7 insulating oil is a mixed oil of class 1 insulating oil and class 2 insulating oil, and the composition of this mixed oil is expressed in accordance with 10 b). The ratio of mixing shall be subjected to the agreement between the parties concerned with acceptance.

(2) Addition or no addition of fluid electrification depressant and/or pour point depressant, and the amount of additive are subject to agreement between the parties concerned with acceptance, and insulating oil with such additive shall be marked in accordance with 10 b).

Remarks : Class A means the kinds of oils which are customarily specified by JIS.

Table 2 Insulating oil B

Classification			Main composition		Service	IEC Standard (informative)
Class 1 IEC No. 1	Class I		Mineral oils		Oil-filled cables	IEC 60465 : 1988
	Class II					
	Class III					
Class 1 IEC No. 2	Class I		Mineral oils		Oil-immersed transformers, Oil circuit breakers	IEC 60296 : 1982
	Class II					
	Class III					
Class 1 IEC No. 2A	Class IA		Inhibited oil		Oil-immersed transformers, Oil circuit breakers	IEC 60296 : 1982
	Class IIA					
	Class IIIA					
Class 2 IEC	Class I		Alkylbenzene		Oil-impregnated capacitors, Oil-filled cables	IEC 60867 : 1993
	Class II					
	Class III					
Class 3 IEC	Class I		Poly-butene	Low viscosity	Oil-impregnated capacitors, Oil-filled cables	IEC 60963 : 1988
	Class II	Type I		High viscosity		
		Type II				
Class 4 IEC			Alkyl-naphthalene		Oil-impregnated capacitors	IEC 60867 : 1993
Class 5 IEC No. 1			Methylpolyaryl-methane		Oil-impregnated capacitors	IEC 60867 : 1993
Class 5 IEC No. 2			Alkyldiphenyl-ethane		Oil-impregnated capacitors	IEC 60867 : 1993
Class 6 IEC			Silicone oil		Oil-immersed transformers	IEC 60836 : 1988

5 Quality When the tests are made in accordance with clause 6, the results shall comply with the provision stated in Table 3.

Table 3 Quality

Classification	Principal composition		Appearance	Density (15 °C) kg/l	Kinematic viscosity mm ² /s		Four point °C	Flowability at low tempera- ture ⁽⁵⁾	Flash point °C		Flam- mability mm/s	Evapora- tion % 150 °C 24 h	Specific disper- sion (25 °C) (25 °C)	Total acid number mg KOH/g	Corrosive sulfur	Oxidation stability 120 °C, 75 h	Bro- mine number gBr/ 100 g	Water content mg/kg	Amount of benzo- triazole added (⁶)	Dielec- tric break- down voltage kV 2.5 mm	Dielectric dissipa- tion factor % 80 °C 50 Hz or 60 Hz	Dielectric constant 80 °C 50 Hz or 60 Hz	Volume resis- tivity TΩ·m (80 °C)																							
					(40 °C)	(100 °C)			Open type	Closed type														Sludge %	Total acid number mg KOH/g																					
Class 1	No. 1	Mineral oil	Shall be transparent, free from suspended matters and deposit	0.91 max.	13 max.	4 max.	-27.5 max.	—	130 min.	—	—	—	110 min.	0.02 max.	Non-corrosive	—	—	—	—	40 min.	0.1 max.	—	0.5 min.																							
	No. 2																																													
	No. 3																																													
	No. 4																																													
Class 2	No. 1	Alkyl- benzene	Low viscosity	—	Less than 10 max.	3 max.	-45 max.	—	150 min.	130 min.	150 min.	130 min.	130 min.	130 min.	—	—	30 max. ⁽³⁾ 40 max. ⁽⁴⁾	Subject to agree- ment between the parties concerned with acceptance	40 min.	0.1 max.	0.05 max.	1 min.																								
	No. 2																						High viscosity																							
	No. 3	Straight- chain type	Low viscosity																				Less than 5 max.	2 max.	-45 max.	—	150 min.	130 min.	130 min.	130 min.	130 min.	130 min.	130 min.	—	—	30 max. ⁽³⁾ 40 max. ⁽⁴⁾	Subject to agree- ment between the parties concerned with acceptance	40 min.	0.1 max.	0.05 max.	1 min.					
	No. 4																																									High viscosity				
Class 3	No. 1	Polybutene	Low viscosity	Less than 300 min.	Less than 400 max.	0 max.	—	130 min.	130 min.	130 min.	130 min.	130 min.	130 min.	130 min.	—	—	30 max. ⁽³⁾ 40 max. ⁽⁴⁾	Subject to agree- ment between the parties concerned with acceptance	30 min.	0.1 max.	2.50 ± 0.05	0.5 min.																								
	No. 2																																									Medium viscosity				
	No. 3																						High viscosity																							
Class 4	No. 1	Alkyl-naphthalene	Low viscosity																				8 max.	Less than 2 max.	-40 max.	140 min.	140 min.	140 min.	140 min.	140 min.	140 min.	140 min.	140 min.	—	—	60 max.	50 min.	2.55 ± 0.05	2.55 ± 0.05	2.55 ± 0.05	2.55 ± 0.05					
	No. 2			High viscosity																																										
Class 5	No. 1	Alkyl-diphenyl- alkane	Low viscosity	Less than 4 max.	2 max.	-50 max.	130 min.	130 min.	130 min.	130 min.	130 min.	130 min.	130 min.	130 min.	—	—	60 max.	40 min.	0.1 max.	0.1 max.	0.1 max.	0.1 min.																								
	No. 2																																									High viscosity				
Class 6	Silicone oil	—	36 to 42 incl.																				13 to 19 incl.	-50 max.	300 min.	300 min.	300 min.	300 min.	300 min.	300 min.	300 min.	300 min.	300 min.	300 min.	300 min.	300 min.	300 min.	300 min.	300 min.	300 min.	300 min.	300 min.				
																																											Class 7	Mineral oil Alkylbenzene	0.91 max.	13 max.
				No. 1																																										
				No. 2																																										
No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	No. 12	No. 13	No. 14	No. 15	No. 16	No. 17	No. 18	No. 19	No. 20	No. 21	No. 22	No. 23	No. 24																									

Notes (3) In the case of tank car

(4) In the case of drum

(5) Applicable for oils to which pour point depressant is added.

(6) Applicable for oils to which fluid electrification depressant is added.

(7) TΩ·m : 10¹²Ω·m

6 Test methods

- 6.1 Test conditions** The test conditions shall follow 4 of JIS C 2101.
- 6.2 Sampling** The sampling shall follow 5 of JIS C 2101.
- 6.3 Appearance test** The appearance test shall follow 6 of JIS C 2101.
- 6.4 Density test** The density test shall follow 8 of JIS C 2101.
- 6.5 Kinematic viscosity test** The kinematic viscosity test shall follow 9 of JIS C 2101.
- 6.6 Pour point test** The pour point test shall follow 10 of JIS C 2101.
- 6.7 Flowability test at low temperature** The flowability test at low temperature shall follow 11 of JIS C 2101.
- 6.8 Flash point test** The flash point test shall follow 12 of JIS C 2101.
- 6.9 Flammability test** The flammability test shall follow 13 of JIS C 2101.
- 6.10 Evaporation test** The evaporation test shall follow 14 of JIS C 2101.
- 6.11 Specific dispersion test** The specific dispersion test shall follow 15 of JIS C 2101.
- 6.12 Total acid number test** The total acid number test shall follow 16 of JIS C 2101.
- 6.13 Corrosive sulfur test** The corrosive sulfur test shall follow 17 of JIS C 2101.
- 6.14 Oxidation stability test** The oxidation stability test shall follow 18 of JIS C 2101.
- 6.15 Bromine number test** The bromine number test shall follow 19 of JIS C 2101.
- 6.16 Water content test** The water content test shall follow 20 of JIS C 2101.
- 6.17 Benzotriazole determination test** The benzotriazole determination test shall follow 21 of JIS C 2101.
- 6.18 Dielectric breakdown voltage test** The dielectric breakdown voltage test shall follow 22 of JIS C 2101.
- 6.19 Dielectric dissipation factor and dielectric constant tests** The dielectric dissipation factor and dielectric constant tests shall follow 23 of JIS C 2101.
- 6.20 Volume resistivity test** The volume resistivity test shall follow 24 of JIS C 2101.