

BS 148:2020 — **Tracked Changes**

compares BS 148:2020
with BS 148:2009



BSI Standards Publication

Recycled mineral insulating oil for transformers and switchgear — Specification

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About Tracked Changes

This document is a PDF containing a Tracked Changes version of BS 148, which compares BS 148:2020 with BS 148:2009.

The original version of BS 148:2020, appended at the end of this document, should be considered the version of record for this publication.

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Summary of pages

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on ~~28 February 2009~~ 31 March 2020. It was prepared by Technical Committee GEL/10, *Fluids for electrotechnical applications*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes ~~BS 148:1998~~ BS 148:2009, which is withdrawn.

~~BS 148:1998 was the specification for unused and reclaimed mineral insulating oil for transformers and switchgear. the specification for unused mineral insulating oil is now covered in BS EN 60296. due to the continued market requirement for reclaimed oil to an agreed specification, BS 148 is now dedicated to reclaimed mineral insulating oil only.~~

Information about this document

The limits given in this British Standard are based on BS EN 60296. For ease of cross-reference, the clause numbering of this standard follows that of BS EN 60296 as far as possible. This standard differs from BS EN 60296 in specifying limits for total furans. The increasing use of total furfural/furans measurements as an in-service diagnostic tool has brought about the necessity to impose limits on reclaimed oil, which is continued in this edition. This British Standard acknowledges UK practice whereby the limiting values for reclaimed mineral insulating oils are based on those for unused mineral insulating oils for transformers and switchgear while having due regard for the variability of used oil feedstock from which reclaimed oil ~~will be~~ is produced.

Use of this document

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is “shall”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Requirements in this standard are drafted in accordance with *Rules for the structure and drafting of UK standards*, subclause G.1.1, which states, “Requirements should be expressed using wording such as: ‘When tested as described in Annex A, the product shall ...’”. This means that only those products that are capable of passing the specified test will be deemed to conform to this standard.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard specifies requirements for ~~reclaimed~~ recycled oxidation inhibited and uninhibited mineral insulating oils, as delivered, for use in transformers, switchgear and similar electrical equipment in which oil is required as an insulant ~~and~~ or for heat transfer.

Oils with and without additives are within the scope of this standard. This standard does not differentiate between ~~the~~ methods used to ~~reclaim~~ recycle used mineral insulating oil, thus ~~it is also applicable to oils having undergone a~~ reclaimed or regenerated oil ~~re-refining process~~, re-refined oil, dechlorinated oil and reconditioned oil are all considered recycled oil for the purposes of this standard.

This standard does not apply to mineral insulating oils used as impregnates in cables or capacitors, or to hydrocarbon insulating liquids obtained by synthesis.

NOTE 1 Oils conforming to the requirements of this standard, and containing no additives, are considered to be compatible with one another and can be mixed in any proportion. This does not necessarily apply to oils containing additives, and where the user wishes to mix such oils a check should be made to ensure that the mixture conforms to the requirements of this standard.

NOTE 2 — Reclaimed mineral insulating oil is produced by the processing, to a greater or lesser extent, of service degraded used mineral insulating oil. Such oil will have been originally supplied in compliance with either BS 148:1998 (or earlier editions) or BS EN 60296. Due to the variability of service conditions and the changes in original specification since the first edition of BS 148, reclaimers may reserve the right to reject used oil if it is considered unsuitable as a feedstock to produce a reclaimed oil in accordance with this specification.

2 Normative references

The following ~~referenced~~ documents are ~~indispensable for the application~~ referred to in the text in such a way that some or all of their content constitutes provisions 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.

~~BS 2000-15, Methods of test for petroleum and its products — Part 15: Petroleum products — Determination of pour point~~

~~BS 5263, Method for sampling liquid dielectrics~~

~~BS 5984, Method for detection and determination of specified anti-oxidant additives in insulating oils~~

ASTM E1687-10, Standard test method for determining carcinogenic potential of virgin base oils in metalworking fluids

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

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

BS EN 60475, Method for sampling liquid dielectrics

BS EN 60666, Detection and determination of specified additives in mineral insulating oils

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

~~BS EN 61125~~ BS EN IEC 61125, ~~Unused hydrocarbon-based insulating~~ 2018, Insulating liquids – Test methods for ~~oxidation stability – Test method for~~ evaluating the oxidation stability of insulating liquids in the delivered state

BS EN 61198, *Mineral insulating oils – Methods for the determination of 2-furfural and related compounds*

BS EN 61619, *Insulating liquids – Contamination by polychlorinated biphenyls (PCBs) – Method of determination by capillary column gas chromatography*

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

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

BS EN 62535, *Method for detection of potentially corrosive sulfur in used and unused mineral insulating oils¹⁾*

BS EN 62697-1, *Test methods for quantitative determination of corrosive sulphur compounds in unused and used insulating liquids – Test method for quantitative determination of dibenzyl disulfide (DBDS)*

BS EN IEC 62961, *Insulating liquids – Test methods for the determination of interfacial tension of insulating liquids – Determination with the ring method*

BS EN ISO 2719, *Determination of flash point – Pensky-Martens closed cup method*

BS EN ISO 3104, ~~*Methods of test for petroleum and its products – Part 71: Section 1: Petroleum products – Transparent and opaque liquids*~~. Determination of kinematic viscosity and calculation of dynamic viscosity *of transparent and opaque liquids*

BS EN ISO 3675, *Methods of test for petroleum and its products – BS 2000-160: Crude petroleum and liquid petroleum products. Laboratory determination of density – Hydrometer method* ~~*IEC 60475, Method for sampling liquid dielectrics*~~

BS EN ISO 12185, *Methods of test for petroleum and its products – Crude petroleum and petroleum products. Determination of density. Oscillating U-tube method*

DIN 51353, *Testing of insulating oils; detection of corrosive sulfur; silver strip test (Foreign Standard)*

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

3 Terms and definitions

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

3.1 mineral insulating oil

insulating liquid obtained by refining, modifying and blending of petroleum products

3.2 uninhibited oil

mineral insulating oil to which no anti-oxidants or metal deactivating agents have been added but which might contain other additives

3.3 inhibited oil

mineral insulating oil containing an anti-oxidant

3.4 passivated oil

mineral insulating oil containing a metal deactivating agent

¹⁾ ~~in preparation.~~

3.5 unused oil

mineral insulating oil, obtained by refining, modifying and/or blending of petroleum products and other hydrocarbons.

NOTE Such an oil has not been used in, nor been in contact with electrical equipment or other equipment not required for manufacture, storage or transport.

3.6 recycled oil

mineral insulating oil previously used in electrical equipment that has been subjected to an off-site recycling process

NOTE A blend of unused and recycled oils in any proportion is regarded as being recycled oil.

3.7 reclaimed (regenerated) oil

recycled oil which has been subjected to chemical and physical processing to reduce soluble and insoluble contaminants

3.8 re-refined oil

recycled oil which has been subjected to a process similar to that used for the production of unused oil from virgin feedstock to reduce the level of undesired compounds

NOTE Such re-refined oils are often produced from mixtures of mineral insulating oils of different origins including processes such as distillation and hydrotreatment.

3.9 reconditioned oil

recycled oil which has been subjected to a physical process to remove insoluble contaminants and free water and to reduce the levels of dissolved moisture and gases

3.10 dechlorinated oil

recycled oil which has been subjected to decontamination from PCBs

~~3.13~~ 3.11 additive

suitable substance ~~deliberately~~ added to an insulating liquid ~~in small proportion in order~~ to improve certain characteristics

~~3.2~~ 3.12 anti-oxidant

additive incorporated ~~in~~ into an insulating liquid to reduce or delay its degradation by oxidation

~~3.3~~ ~~inhibited oil~~

~~mineral insulating oil which contains an anti-oxidant~~

3.13 metal deactivating agent

additive introduced to suppress catalytic activity of metals in insulating liquid; classified into two major groups, either passivators or chelating agents

NOTE In reducing the catalytic activity, metal deactivators might have an antioxidant effect.

~~3.4~~ 3.14 passivator

~~additive~~ metal deactivating agent incorporated ~~in~~ into an insulating liquid to reduce the chemical reactivity of metallic surfaces within oil filled equipment

~~3.5~~ ~~passivated oil~~

~~mineral insulating oil which contains a passivator~~

3.6 3.15 pour point depressant

additive that enables the pour point of a mineral insulating oil to be lowered

3.7 ~~reclaimed oil~~

~~mineral insulating oil used in electrical equipment which has been subjected to chemical and/or physical processing to eliminate soluble and insoluble contaminants~~

3.8 ~~reconditioned oil~~

~~mineral insulating oil used in electrical equipment which has been subjected to physical processing to remove contaminants~~

3.9 ~~re-refined oil~~

~~mineral insulating oil used in electrical equipment which has been subjected to extensive chemical and/or physical processing, similar to that used for the initial production of such oils, to eliminate soluble and insoluble contaminants~~

3.10 uninhibited oil

~~mineral insulating oil containing no added anti-oxidant but which may contain other additives~~

3.11 ~~unused oil~~

~~mineral insulating oil which has not been used in, or been in contact with, electrical equipment or other equipment not required for manufacture, storage or transport~~

4 Identification and delivery

- 4.1** Road or rail tank wagons and drums used for the delivery of oil shall be specially cleaned for this purpose.
- 4.2** Oil drums and containers ~~of oil samples~~ shipped by the oil supplier shall carry at least the following markings:
- a) **the** supplier's designation;
 - b) **the type of oil: whether inhibited (I), trace inhibited (T) or uninhibited (U); and**
 - ~~b) c)~~ **the** number and date of this British Standard, i.e. ~~BS 148:2009~~ **BS 148**²⁾
- 4.3** Each oil delivery shall be covered by a document from the supplier ~~stating~~ **declaring** at least the following:
- a) **the** supplier's designation;
 - b) **the** function and ~~generic nature~~ **chemical family** of ~~any~~ **all** additives present;
 - c) that the oil conforms to ~~BS 148:2009~~ **BS 148**.

NOTE *A pour point depressant should only be included in the oil formulation if this is agreed between supplier and purchaser.*

- 4.4** Health and safety information, in line with current legislation, shall be available to the purchaser.

²⁾ Marking ~~BS 148:2009~~ **BS 148:2020** on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third party certification of conformity, ~~which might also be desirable.~~

5 Sampling

Sampling shall be carried out in accordance with ~~BS 5263~~ the relevant procedure described in ~~BS EN 60475~~.

NOTE — As a general rule, oil samples should be taken where the oil is presumed to be more contaminated, e.g. at the lowest point of the container; however, contaminants at the surface or in the body of the oil should not be overlooked.

6 Properties of the oils

~~Uninhibited and inhibited oils shall be in accordance with the limiting values specified in table 1 and table 2, respectively, when tested in accordance with Clause 7.~~

~~The limits for water content, breakdown voltage and dielectric dissipation factor for oil packed in drums shall apply only to oils delivered in drums of 200 L nominal capacity and to tests carried out within two weeks following delivery.~~

NOTE 1 — There is a tendency for water absorption to occur and for the electrical characteristics to deteriorate in oil stored in drums.

NOTE 2 — Oil in drums cannot be expected to retain the breakdown voltage shown at the time of filling and attention is drawn to the risk of deterioration of electrical properties, which is greater in smaller drums (less than 200 L). It is recommended that the breakdown voltage is checked on oil that has been drummed for more than three months and/or if the drum has been damaged.

~~Reclaimed uninhibited oil shall meet the limiting values in table 1 and reclaimed inhibited oil shall meet the limiting values in table 2.~~

NOTE 3 — Precision data given in the specified methods are to be used solely as a guide to the expected agreement between duplicate measurements of the property and are not to be regarded as tolerances applicable to the limits specified in Table 1 and Table 2.

7 Test methods

7.1 Appearance

~~To test appearance, a representative sample of the oil shall be examined in transmitted light under an oil depth of approximately 100 mm and at ambient temperature.~~

7.2 Density

~~Density shall be measured using any recognized standard test method or, in the event of a dispute, the method specified in BS EN ISO 3675.~~

~~Density shall be measured at 20 °C.~~

NOTE — Density values can be converted to 20 °C using Table 59 D of Petroleum measurement paper No.3: Computer implementation procedures for correcting densities and volumes to 20 °C [1].

7.3 Kinematic viscosity

~~Kinematic viscosity shall be measured by the method described in BS EN ISO 3104.~~

7.4 Flash point

~~Flash point shall be determined by the method described in BS EN ISO 2719.~~

7.5 Pour point

~~Pour point shall be determined by the method described in BS 2000-15.~~

~~7.6 Neutralization value~~

~~Neutralization number of the oil shall be determined in accordance with BS EN 62021-1 or BS EN 62021-2.~~

~~7.7 Corrosive sulfur~~

~~Corrosive sulfur shall be determined by the method described in BS EN 62535.~~

~~7.8 Passivator content~~

~~Passivator content shall be determined by the method described in annex a.~~

~~7.9 Water content~~

~~Water content shall be determined by the method described in BS EN 60814.~~

~~7.10 Anti-oxidant additives~~

~~Specified anti-oxidant additives shall be detected and determined quantitatively by the methods described in BS 5984.~~

~~7.11 Oxidation stability~~

~~Oxidation stability shall be determined by Method C of BS EN 61125.~~

~~7.12 Breakdown voltage~~

~~Breakdown voltage shall be determined by the method described in BS EN 60156.~~

~~7.13 Dielectric dissipation factor~~

~~Dielectric dissipation factor shall be measured at 90 °C by the method described in BS EN 60247.~~

~~7.14 Polychlorinated biphenyls (PCBs)~~

~~PCBs shall be determined by BS EN 61619.~~

~~7.15 Total furans~~

~~The 2-furaldehyde and furan derivatives shall be determined by the methods described in BS EN 61198.~~

Table 1 Uninhibited mineral insulating oils

Property	Test method	Limiting values for measured characteristics
Appearance	7.1	Clear, free from sediment and suspended matter
Density, kg/dm ³ at 20 °C	7.2	≤ 0.895 ^{A)}
Kinematic viscosity	7.3	
mm ² /s 40 °C ^{B)}		≤ 13
–15 °C		≤ 800
Flash point, °C	7.4	≥ 135
Pour point, °C	7.5	≤ –30
Neutralization value, mg KOH per g of oil	7.6	≤ 0.03
Corrosive sulfur	7.7	Non-corrosive
Passivator content	7.8	Not detectable ^{C)}
Water content, mg/kg	7.9	
bulk delivery		≤ 20
drum delivery		≤ 30
Anti-oxidant additives	7.10	Not detectable ^{D)}
Oxidation stability, 164 h	7.11	
total acidity, mg KOH per g of oil		≤ 1.2
sludge, % by mass		≤ 0.8
Breakdown voltage, as delivered, kV	7.12	≥ 30
Dielectric dissipation factor, at 90 °C and 40 Hz to 62 Hz	7.13	≤ 0.005
Total PCB content mg/kg	7.14	To be agreed ^{E)}
Total furans mg/kg	7.15	< 0.2

^{A)} The corresponding viscosity value at 20 °C is approximately 40 mm²/s.

^{B)} A maximum limit for density is specified in an attempt to minimize the risk of ice crystals floating in the oil where oil-insulated equipment is exposed to very low temperatures.

^{C)} Subject to agreement between purchaser and supplier, a metal passivator may be incorporated in the oil to a maximum concentration of 100 mg/kg as measured by the method given Annex A.

^{D)} No anti-oxidant shall be included in uninhibited oils.

^{E)} To be agreed between supplier and purchaser but not more than 10 mg/kg.

NOTE 1 The purchaser might wish to agree with the supplier limits for sulfur content and resistivity at 90 °C.

NOTE 2 A pour point depressant should only be included in the oil formulation if this is agreed between supplier and purchaser.

NOTE 3 In the present context, “bulk” refers to shipments made in breather-protected vehicles or containers and does not apply to oil carried in ships or barges or by pipeline.