

**BUREAU OF INDIAN STANDARDS**

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भारतीय मानक मसौदा

कटिंग के प्रयोग के लिए  
घुलनशील एवं साफ़ तेल की  
विशिष्टि

*(IS 9611 का पहला पुनरीक्षण)*

*Draft Indian Standard*

**SPECIFICATION FOR CUTTING OIL, SOLUBLE, CLEAR**

*(First Revision of IS 9611)*

(ICS 75.100)

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Lubricants and their Related Products Sectional Committee,  
PCD 25

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**FOREWORD**

*(Formal clause will be added later)*

Cutting oils are used for lubrication and cooling of metal surfaces during metal cutting operations. There are different kinds of cutting oils used for this purpose depending upon the job required such as neat cutting oils (IS 3065), which is immiscible with water, and soluble cutting oils (IS 1115), which give a milky white aqueous emulsion (non-transparent). The present specification covers soluble cutting oils, which form clear or translucent aqueous emulsion.

The standard was originally published in 1980. This first revision has been brought out to keep pace with the latest technological developments and international practices. The major changes incorporated in this revision are:

- a) Test methods have been updated for emulsion and frothing tests, and thermal stability test; and
- b) pH and test method for pH has been included, keeping in view the requirement of condition monitoring of the aqueous emulsion during its usage.

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 : 2022 'Rules for rounding off numeric values (*second revision*)'. The number of significant places retained in the rounding off value should be the same as that of the specified value in this standard.

## 1 SCOPE

This standard prescribes the requirements and methods of sampling and test for cutting oil, soluble, clear type, intended for use in grinding, cutting and other operations where a translucent emulsion is required for clear visibility of the workpiece and tools.

## 2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent editions of these standards.

<i>IS No.</i>	<i>Title</i>
IS 210 : 2009	Grey iron castings— Specification ( <i>fifth revision</i> )
IS 460 (Part 1) : 2020	Test Sieves — Specification Part I Wire Cloth Test Sieves ( <i>fourth revision</i> )
IS 1447 (Part 1) : 2021	Methods of Sampling of Petroleum and its Products Part 1 Manual Sampling ( <i>second revision</i> )
IS 1448	Methods of test for petroleum and its products
Part 4/Sec 1 : 2021	Determination of Ash ( <i>third revision</i> )
(Part 15) : 2004 / ISO 2160 : 1998	Petroleum Products — Corrosiveness to Copper—Copper Strip Test ( <i>third revision</i> )
(Part 40) : 2015 / ISO 3733 :1999	Petroleum Products and Bituminous Materials—Determination of Water— Distillation Method ( <i>fourth revision</i> )
(Part 69) : 2019 / ISO 2592 : 2017	Determination of Flash and Fire Points- Cleveland Open Cup Method ( <i>second revision</i> )
(Part 98) :1981	Determination of Emulsion Stability of Emulsifiable Cutting Oils
(Part 99) : 1981	Determination of Frothing Characteristics of Emulsifiable Cutting Oils
(Part 100) : 1980	Determination of Thermal Stability of Emulsifiable Cutting Oils
IS 2062 : 2011	Hot Rolled, Medium and High Tensile Structural Steel — Specification ( <i>seventh revision</i> )

## 3 REQUIREMENTS

### 3.1 General Requirements

**3.1.1** The material shall be prepared from mineral lubricating oil having a flash point of 150 °C, *Min*, when tested by IS 1448 (Part 69), combined with emulsifiers, bactericides, stabilizers and other additives, if necessary.

**3.1.2** The oil shall be clear, homogeneous and free from foreign matter, sediment and visible impurities. It shall not contain any ingredients injurious to persons using or handling it either in the original state or in the form of an emulsion. The oil should also be free from any pungent or unpleasant odour.

**3.2 Specific Requirements** — The material shall comply with the requirements prescribed in Table 1 when tested according to the test methods prescribed in col 4 of Table 1.

**TABLE 1 REQUIREMENTS FOR CUTTING OIL, SOLUBLE, CLEAR**

(Clause 3.2, 4.1, 6.2, and B-2.2)

SI No.	CHARACTERISTIC	REQUIREMENT	METHOD OF TEST
(1)	(2)	(3)	(4)
i)	Appearance	Clear, without any settling, impurities and sediments	Visual
ii)	Ash, percent by mass, <i>Max</i>	7.0	IS 1448 (Part 4/Sec 1)
iii)	Water, percent by mass, <i>Max</i>	10.0	IS 1448 (Part 40)
iv)	Emulsion test, 5 : 1 and 20 : 1 ratio in water of 400 ppm hardness as CaCO <sub>3</sub>	No oil or cream separation. Emulsion shall remain clear to translucent	IS 1448 (Part 98)
v)	Frothing test, 5 : 1 and 20 : 1 ratio in water of 200 ppm hardness as CaCO <sub>3</sub>	No froth after 15 min	IS 1448 (Part 99)
vi)	Cast iron corrosion test, 20 : 1 ratio emulsion with 400 ppm hard water as CaCO <sub>3</sub> , <i>Max</i>	0/1-1	Annex A
vii)	Copper strip corrosion test at 100 °C for 3 h	Not worse than No. 1	IS 1448 (Part 15)
viii)	Thermal stability test	Shall pass the test	IS 1448 (Part 100)
ix)	Flash point, COC, °C, <i>Min</i>	150	IS 1448 (Part 69) (see Note)
x)	pH value of 5 percent oil in distilled water	8.8 - 9.5	Annex B

NOTE — Take 200 g of soluble oil test sample. Add 50 g anhydrous sodium sulphate. Stir thoroughly for 5 min, keep it in oven at 40 °C for one hour. Decant oil and subject it to flash point determination by Cleveland (open) cup method.

## 4 KEEPING PROPERTIES

**4.1** The material, when stored in original sealed containers under ambient temperature conditions, in shade, shall retain the properties prescribed in Table 1 for a period of not less than 6 months from the date of manufacture.

## 5 PACKING AND MARKING

**5.1 Packing** — The material shall be packed in securely closed metal drums or any other suitable containers of appropriate size and strength as agreed to between the purchaser and the supplier.

**5.2 Marking** — Each container shall be marked with the following information:

- a) Name of the material;
- b) Manufacturer's name, initials or trade-mark, if any;
- c) Quantity of the material; and
- d) Batch number and year of manufacture.

### 5.2.1 *BIS Certification Marking*

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the Bureau of Indian Standards Act, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the standard mark.

## 6. SAMPLING

**6.1** Representative samples of the material shall be drawn as prescribed in IS 1447 (Part 1).

**6.2 Number of Tests and Criteria for Conformity** — Tests for emulsion, frothing, cast iron corrosion and thermal stability shall be conducted on three individual samples each, and there shall be no failure if the lot is to be accepted as satisfactory in respect of the above characteristics. For the remaining characteristics prescribed in Table 1 the tests shall be conducted on the composite sample prepared according to IS 1447 (Part 1) and no failure shall be reported for the acceptance of the lot.

ANNEX A  
[Table 1, Sl No. (vi)]  
CAST IRON CORROSION TEST

## A-1 SCOPE

**A-1.1** Cutting oils which are used in the form of aqueous dispersions or solutions should not readily permit corrosion of equipment with which they come into contact. This method is accordingly designed to assess the behavior of such fluids in contact with a typical metal, such as cast iron; and is applicable to samples submitted either in the form of an aqueous fluid as used in practice or as a concentrate requiring dilution with water.

## A-2 OUTLINE OF THE METHOD

**A-2.1** Steel millings are placed on the cleaned surface of a cast-iron plate and emulsion of the cutting oil under test is poured on to them. After 24 h the millings are removed and the surface of the plate is examined for corrosion.

## A-3 APPARATUS

**A-3.1 Test Plate** — Conforming to Grade FG-250 of IS 210, 10 cm × 10 cm × 6 mm (originally) of grey cast iron, the surface being ground to a smooth finish.

**A-3.2 Steel Millings** — Approximately 6 mm long and 1.5 mm to 3 mm wide prepared by dry-milling the steel conforming to IS 2062.

**A-3.3 Test Chamber** — No dimensional limits are prescribed for the chamber. The temperature shall be maintained at  $(27 \pm 3)$  °C and the humidity at  $(52 \pm 5)$  percent. The required level of humidity can be obtained by placing at the bottom of the cabinet at least one open dish of minimum 150 mm diameter per test plate containing a saturated solution of sodium bisulphate in distilled water in contact with an excess of solid bisulphate at the bottom of the chamber. Lumps of solid bisulphate should stand out of the liquid. The nominal humidity given by this solution is 52 percent at  $(27 \pm 3)$  °C. If a large chamber is used with several plates under test, several dishes may be desirable. Alternatively, separate chambers, each with a dish of bisulphate can be used (one for each test plate).

**A-3.4 Pipette** — Calibrated to deliver 2 ml of the fluid.

## A-4 PREPARATION OF SAMPLE

**A-4.1** For carrying out this test the 20:1 ratio emulsion shall be prepared with 400 ppm hard water as CaCO<sub>3</sub> in accordance with the method given for emulsion and frothing tests.

## A-5 PREPARATION OF APPARATUS

**A-5.1** If the surface of any plate is corroded or pitted, regrind the plate to a smooth surface. Do not allow the plate to become burnished.

**A-5.2** If the thickness of the plate is reduced to 3 mm, discard it.

**A-5.3** Immediately prior to test, prepare the ground surface of the test plate as follows and do not touch the surface subsequently. Carry out this procedure irrespective of whether or not the plate has been used before, and whether or not it is new or reground:

- a) Wipe with cotton wool soaked in toluene;
- b) Wash with acetone from a wash-bottle;
- c) Wipe dry with cotton wool;
- d) Rub the plate on a new piece of No. 0 emery cloth placed on a flat surface (plate glass for example), rubbing heavily by hand for 30 double-strokes without lifting in each of two directions at right angles. A hand magnet may be convenient to hold the plate for this operation. If stain marks are still apparent, treat the plate as pitted and regrind it;
- e) Wipe with clean filter paper soaked in acetone; and
- f) Rub with successive pieces of dry clean filter paper until no marks are apparent on the paper.

## **A-6 PROCEDURE**

**A-6.1** Make the test in a room free from corrosive fumes.

**A-6.2** Take the millings and sieve with a standard 710-micron IS sieve [*see* IS 460 (Part 1) Test Sieves — Specification Part 1 Wire Cloth Test Sieves]. Discard the dust and retain the millings. Discard all the millings if any rust is present.

**A-6.3** Wash the millings in acetone and allow to dry in air. Thereafter, the millings should remain untouched by hand.

**A-6.4** With the aid of a spatula, place 4 portions each of approximately 2 g of steel millings in a single layer each centrally in a quarter of the prepared surface of the plate. Each portion shall be so disposed that the edges are not in contact either with adjacent portions or the edges of the plate.

**A-6.5** Pipette the fluid to be tested on to each portion of millings, so that the millings are thoroughly wetted. The fluids on adjacent portions shall not run together. About 2 ml of the fluid will be required per portion of millings. If testing several fluids at once, put the 4 portions on different plates as far as possible, so that each plate has several fluids on it. This minimizes error due to possible variations in plates.

**A-6.6** Transfer the plate to the test chamber, the temperature and humidity of which is maintained as specified in **A-3.3**.

**A-6.7** After 24 h, remove the plate from the cabinet, remove the millings from the plate and discard them. Wash the surface of the plate with acetone, then with toluene and finally rub gently with a filter paper soaked in toluene.

**A-6.8** Inspect the surface areas of the plate for corrosion, and record pitting and staining results separately for each test area, for example, the areas previously covered by 2 g of steel milling as follows:

- i) *Pitting* — Record the number of pits present (e.g. 0, 1, 2 etc.).
- ii) *Staining* — Record the extent of test area stained and intensity of staining using the following numbers:

<i>Proportions of Test Area Stained</i>		<i>Intensity of Staining</i>	
<i>Percent</i>	<i>Rating</i>	<i>Observation</i>	<i>Rating</i>
Nil	0	Nil	0
Less than 10	1	Hardly perceptible	1
Between 10 and 25	2	Slight staining	2
Between 25 and 50	3	Heavy staining	3
Between 50 and 75	4	Surface damage (not including pits)	4
Over 75	5		

NOTE— If staining is not uniform record the maximum intensity observed.

## **A-7 REPORTING**

The results should be reported by three numbers e.g. 0/1-1, 5/0-0, 0/3-2 etc., the first being the number of pits observed (e.g. 0, 1, 2 etc.) followed by an oblique stroke (/); the second, the rating of the stained area (e.g. 0, 1, 2 etc.), hyphen (-); and third, the rating of maximum intensity of staining (e.g. 0, 1, 2 etc.).

**A-7.1** Also report relevant test details, as follows:

- a) Nature of added water used, and
- b) Dilution if known and method of preparation, if relevant.

## **A-8 PRECISION**

**A-8.1** The precision cannot be expressed in a useful form to cover all cases. Extensive investigations have shown that it is very poor when the corrosion probability is of the order of 50 percent, but that it is better when either very little or considerable corrosion occurs. The use of statistically designed programmes is recommended whenever comparative test are to be made.

**ANNEX B**  
[Table 1, Sl No. (x)]  
**DETERMINATION OF pH**

**B-1 SUMMARY OF METHOD**

**B- 1.1** 5 percent emulsion of the cutting oil is prepared in distilled water and placed in a beaker and the pH is measured with a pH meter and associated glass-saturated calomel electrode pair.

**B-2 SIGNIFICANCE AND USE**

**B-2.1** pH is a measure of the hydrogen ion concentration and indicates whether a soluble cutting oil solution is acidic, alkaline, or neutral.

**B-2.2** pH is sometimes used for production quality control. It is generally desirable that soluble cutting oil should have an alkaline pH as indicated in Table 1.

**B-2.3** pH is not significant from the stand point of predicting service life.

**B-3 APPARATUS**

**B-3.1 pH Meter** — The pH meter shall be of portable, table or stationary models having minimum scale not more than 0.1 pH and a repeatability of  $\pm 0.05$ .

The pH meter essentially consists detection part, amplification part and indication part as follows:

- i) *Detection Part* – It consists of glass electrode, comparison electrode, temperature compensation, temperature sensitive element and holders retaining them.
- ii) *Amplification Part* – It has the capability of amplifying the electromotive force of detection part, carrying out operation for temperature compensation, and of converting it to the electric signal of the level necessary for indication part.
- iii) *Indication Part* – It is either of indicator or recorder indicating measured results, or that using both instruments. The indication system is either of analog type or digital one, or that using both types.

**B-3.2 Glass Electrode** —Having pH measuring range of 0 to 14.

**B-3.3 Reference Electrode (Calomel Electrode)** — Glass electrode having 0 to 14 pH measuring range.

**B-4 REAGENTS**

**B-4.1 Purity of Reagents** — Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the relevant specifications where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

**B-4.2 Purity of Water** — Unless otherwise indicated, references to water shall be understood to mean distilled water or water of equal purity. Distilled water shall be boiled thoroughly, or purged with carbon



dioxide free air to remove carbon dioxide, and shall be protected with a soda-lime tube or its equivalent while cooling and in storage. The pH of the water shall be between 6.2 and 7.2 at 25 °C.

**B-4.3 Standard Buffer Solutions** —The buffer solutions for calibrating the pH meter and electrode pair shall be prepared from salts sold specifically for use, either singly or in combination, as pH standards. The salts shall be dried for 1 h at 100 °C before use except in the case of borax which shall be used as the decahydrate. The solutions with pH less than 9.5 shall be stored in chemically resistant bottles. The alkaline phosphate solution shall be stored in glass bottles coated on the side with paraffin.

NOTE— Commercially available buffer tablets or prepared buffer solution may be used.

**B-4.4 Potassium Hydrogen Phthalate Buffer Solution (0.05 M, pH = 4.01 at 25 °C)** —Dissolve 10.21 g of potassium hydrogen phthalate ( $\text{KHC}_6\text{H}_4\text{O}_4$ ) in water and dilute to 1 litre.

**B-4.5 Neutral Phosphate Buffer Solution (0.025 M with respect to each phosphate salt, pH = 6.86 at 25 °C)** — Dissolve 3.40 g of potassium dihydrogen phosphate ( $\text{KH}_2\text{PO}_4$ ) and 3.55 g of anhydrous disodium hydrogen phosphate ( $\text{Na}_2\text{HPO}_4$ ) in water and dilute to 1 litre.

**B-4.6 Borax Buffer Solution (0.01M, pH = 9.18 at 25 °C)** — Dissolve 3.81 g of disodium tetraborate decahydrate ( $\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$ ) in water, and dilute to 1 litre. Protect this solution from atmospheric carbon dioxide, stopper the bottle at all times except when actually in use.

**B-4.7 Alkaline Phosphate Buffer Solution (0.01 M, Trisodium Phosphate, pH = 11.72 at 25 °C)** — Dissolve 1.42 g of anhydrous disodium hydrogen phosphate ( $\text{Na}_2\text{HPO}_4$ ) in 100 ml of a 0.1 M carbonate-free solution of sodium hydroxide and dilute to 1 litre with water.

**B-4.8 Potassium Chloride Electrolyte** — Prepare a saturated solution of potassium chloride (KCl) in water.

## **B-5 STORING METHOD OF pH STANDARD SOLUTION**

Prepared standard solution shall be stored in an air tight hard glass or polyethylene bottle. Because the pH value of prepared pH standard solution is occasionally changed due to long storage period, the prepared pH standard solution for which long time has elapsed after preparation shall be used after its pH value is confirmed to be same by comparing it with that freshly prepared.

Further, prepared pH standard solution once exposed to the atmosphere shall not be used.

NOTE— The pH values of borate-prepared pH standard solution and carbonate-prepared pH standard solution are decreased due to the absorption of carbon-dioxide or the like.

## **B-6 PREPARATION OF ELECTRODE SYSTEM**

**B-6.1 Maintenance of Electrodes** — Clean the glass electrode at frequent intervals (not less than once every week during continual use) by immersing in cold chromic-acid cleaning solution. Drain the calomel electrode atleast once each week and fill with KCl electrolyte. Keep the electrolyte level in the calomel electrode above that of the solution being tested at all times. When not in use, immerse the lower halves of the electrodes in distilled water and do not immerse in the solution being tested for any appreciable period of time between determinations. Although the electrodes are not extremely fragile, they should be handled carefully at all times.

**B-6.2 Preparation of Electrodes** — Before and after using, wipe the electrode thoroughly with a clean cloth, or a soft absorbent issue, and rinse with distilled water. Follow the manufacturer's recommendations if further preparation is required. Prior to each pH determination, soak the prepared electrode in distilled water for at least 2 min. Immediately before use, touch the tips of the electrodes with a dry cloth or tissue to remove excess water.

## **B-7 TEST OF THE pH METER**

**B-7.1 Repeatability Test** — The detection part of the pH meter prepared according to **B-8.1** and **B-8.2** is dipped into one pH standard solution and the indication of pH meter is read after 10 min. Then, the detection part is sufficiently washed with water, water content being wiped and it is again dipped in the same pH standard solution. After 10 min, the indicated value of pH meter is read. The pH of the standard solution is measured 3 times by operating in this way. All those indicated values shall conform to the repeatability limit of  $\pm 0.05$ .

**B-7.2 Linearity Test** — After calibrating the detection part of the pH meter prepared according to **B-8.1** using neutral phosphate pH standard solution and phthalate pH standard solution according to **B-8.2**, the detection part is sufficiently washed with water and water content is wiped. Then, it is dipped into borate pH standard solution and its value is read. Thereafter, the detection part is again sufficiently washed with water and water content is wiped. It is again dipped in the same borate standard solution and the indicated value is read. It is measured 3 times for borate pH standard solution by operating in this way and the results are averaged. The difference between this average value and the pH value of used borate pH standard solution shall confirm to the linearity of  $\pm 0.06$  and under.

## **B-8 PROCEDURE**

**B-8.1 Preparation** — The power source of pH meter is preliminarily applied before use, and the detection part is repeatedly washed with water not less than 3 times and wiped with clean filter paper, absorbent cotton etc. However, when specially soiled, it is washed with detergent, hydrochloric acid of 0.1 N, etc., for a short time as required and further sufficiently washed with running water. The glass electrode being under dry condition for a long time shall be used after preliminary dipping it into water overnight.

**B-8.2 Calibration** — The calibration of pH meter shall be carried out by zero calibration and span calibration. By alternately carrying out zero calibration and span calibration, it shall be calibrated until the pH values agree with the repeatability of  $\pm 0.05$ .

**B-8.2.1 Zero Calibration** — For zero calibration, the pH meter shall be calibrated by dipping the detection part into neutral phosphate pH standard solution and by regulating the zero regulation dial at the value corresponding to the temperature of pH standard solution.

**B-8.2.2 Span Calibration** — The span calibration shall be carried out as follows:

- a) When pH value of sample solution is not more than 7 — The pH meter shall be calibrated by dipping the detection part into phthalate pH standard solution or oxalate pH standard solution and by regulating the span regulating dial at the value corresponding to the temperature of pH standard solution.

- b) When pH value of sample solution exceeds 7 — The detection part is dipped into phosphate pH standard solution or borate pH standard solution or carbonate pH standard solution and the operation shall be carried out in the same way as that of (a).

**B-8.3 Measurement** — After calibrating pH meter, the electrode is washed and immediately pH of sample solution shall be measured. The amount of sample solution shall be sufficient so that the measured value is not changed.

NOTE— For the measurement of pH value of not less than 11, there is a fear of generating alkali error by ordinary glass electrode and lowering its measured value. Especially when the ionic concentration of alkali metal is high, its error becomes larger. It is, therefore, preferable that the electrode having little alkali error is used and further necessary correction is carried out.