भारतीय मानक
Indian Standard

IS 16868 : 2018
IEC 61144 : 1992

विद्युतरोधी द्रव्य की ऑक्सीजन सूचकांक ज्ञात करने के लिए परीक्षण की प्रणाली

Test Method for the Determination of Oxygen Index of Insulating Liquids

ICS 17.220.99 ; 29.035.40

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NATIONAL FOREWORD

This Indian Standard which is identical with IEC 61144 : 1992 'Test method for the determination of oxygen index of insulating liquids' 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 along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 4589 : 1984 Plastics — Determination of flammability by oxygen index	IS 13360 (Part 6/Sec 6) : 2001 Plastics — Methods of testing : Part 6 Thermal properties, Section 6 Flammability by oxygen index — Guidance (*first revision*)	Identical with ISO 4589-1 : 1996
	IS 13360 (Part 6/Sec 19) : 2001 Plastics — Methods of testing : Part 6 Thermal properties, Section 19 Flammability by oxygen index — Ambient temperature test	Identical with ISO 4589-2 : 1996
	IS 13360 (Part 6/Sec 20) : 2001 Plastics — Methods of testing : Part 6 Thermal properties, Section 20 Flammability by oxygen index — Elevated temperature test	Identical with ISO 4589-3 : 1996

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.

In reporting the result of a test or analysis made in accordance with this standard, it is to be rounded off which shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

TEST METHOD FOR THE DETERMINATION OF OXYGEN INDEX OF INSULATING LIQUIDS

1 Scope

1.1 This International Standard describes a method for measuring the oxygen index of insulating liquids.

1.2 The general principles of this test method as applied to solids are described in ISO 4589.

1.3 This method is generally considered as a method describing one of the combustion characteristics of products.

1.4 This test method is applicable to all liquids, the viscosity of which is lower than or equal to 50 mm^2/s at 40 °C ± 1 °C.

WARNING: When burning a liquid, hazardous gases and/or vapours may be evolved. Adequate precaution shall be taken to protect the operator.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was valid. All normative documents are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 4589: 1984, *Plastics – Determination of flammability by oxygen index.*

3 Definition

Oxygen index is defined in ISO 4589 as the minimum concentration of oxygen, by percentage volume in a mixture of oxygen and nitrogen, introduced at 23 °C ± 2 °C, that will just support combustion of a material under specified test conditions.

4 Summary of method

A small quantity of a liquid sample in a borosilicate glass cup is placed in a test chimney containing an upwardly flowing mixture of oxygen and nitrogen, then ignited. The minimum concentration of oxygen that will just support combustion of the liquid for 60 s or more is taken as the oxygen index.

5 Apparatus

The following apparatus shall be arranged as indicated by the diagram in figure 1.

5.1 *Test chimney*

The chimney shall be a heat-resistant glass tube of 75 mm minimum inside diameter and 450 mm minimum height. The bottom of the chimney or the base to which the tube is attached shall contain non-combustible material to mix and distribute evenly the gas mixture entering at this base. Glass beads 3 mm to 5 mm in diameter in a bed 80 mm to 100 mm deep have been found suitable. Chimneys of other dimensions may be used, if shown to give equivalent results.

5.2 *Test cup*

A test cup made of borosilicate glass. The inside dimensions of the cup shall be 22 mm diameter and 4 mm high. The wall thickness shall be 1,5 mm. The cup shall be so designed as to permit exterior handling (figure 2).

5.3 *Cup holder*

A cup holder made of stainless steel suitable for supporting the borosilicate cup in the centre of the chimney, approximately 20 cm below the top.

5.4 *Gas supply*

Commercial grade oxygen and nitrogen shall be used.

5.5 *Ignition source*

The igniter shall be a copper tube having an inside diameter of 1,5 mm. The flame source shall be propane, without premixed air. The shape of the tube is represented in figure 3. A gas flow rate of 3 cm^3/s is suitable to produce a flame 40 mm high when the igniter is upright.

Experience shows that minor changes in the flame height are not significant in their effect on test results.

5.6 *Flow measurement and control devices*

Suitable flow measurement and control devices shall be available in each line that will allow monitoring the volumetric flow of each gas into the chimney within 1 % in the range being used. After the flow is measured in each line, the lines shall be joined to allow the gases to mix before being fed into the chimney.

5.7 *Paramagnetic oxygen analyzer*

For accurate measurement of the oxygen concentration in the flowing mixture.

5.8 *Timer*

A suitable timer capable of indicating at least 10 min and accurate to 1 s shall be used.

5.9 *Soot, fumes and heat removal*

To ensure the removal of noxious fumes, soot, heat and other possible products, the chimney shall be installed in a hood or other facilities providing adequate exhaust.

NOTE - If soot-generating specimens are being tested, the glass chimney becomes coated on the inside with soot and should be cleaned as often as necessary to maintain good visibility.

6 Test specimens

The liquid samples shall be stored in a clean container and conditioned at 23 °C ± 2 °C for at least 24 h.

7 Procedure

7.1 *Calibration*

7.1.1 Calibrate the flow-measuring system using a soap bubble flowmeter or by equivalent calibration devices. It is recommended that this calibration will be repeated at least every six months.

NOTE - One step in the calibration should be to check all joints carefully for leaks.

7.1.2 Calibrate the paramagnetic oxygen analyzer according to the instrument's operating manual.

7.1.3 Adjust the flame size of the igniter as illustrated in figure 3.

7.2 The test shall be conducted at room temperature, 23 °C ± 2 °C.

7.3 Remove the glass chimney and secure the cup holder in the centre of the chimney as shown in figure 1. Place a clean cup on top of the cup holder.

7.4 Use a pipette to fill the cup with liquid sample such that the upper meniscus of the liquid is 1 mm below the top of the cup.

7.5 Select the desired initial concentration of oxygen based on experience with similar liquids. If there is no experience with similar liquids, ignite the sample in air and note the burning behaviour. If the sample burns, start at an oxygen concentration of about 18 %; but if the sample does not burn, start at about 25 %.

7.6 Adjust the oxygen and nitrogen regulators to give the desired oxygen concentration. The gas velocity in the chimney shall be 4 cm/s ± 1 cm/s as calculated from the total flow of gas in cm^3/s divided by the area of the chimney in cm^2. Purge the system for at least 30 s.

7.7 Apply the igniter so that the flame covers the entire surface area of the liquid sample until the liquid ignites (see figure 3). Then remove the igniter.

7.8 *Preliminary adjusting*

7.8.1 If the flame extinguishes before 60 s, the oxygen concentration is too low and shall be increased. Repeat test at a higher oxygen concentration using a fresh liquid sample.

NOTE - If there is no ignition, the same sample may be used again.

7.8.2 If steady state burning is obtained and it continues beyond 60 s, the oxygen concentration is too high and shall be reduced. Repeat test at a lower oxygen concentration using a clean cup and a fresh liquid sample.

7.9 Perform steps 7.6 to 7.8 until the minimum oxygen concentration that will just support combustion of the liquid for 60 s or more is obtained. At the next lower oxygen concentration (that will give a difference in oxygen index of about 0,5 %), the sample shall not burn for more than 60 s.

NOTE - Silicon liquids exhibit sporadic burning accompanied by silicon dioxide ash formation and glowing ash with occasional flame renewal.

7.10 Test five specimens at the critical oxygen concentration obtained from 7.9. When three or more specimens burn more than 60 s, this is taken as the oxygen index.

8 Calculations

In case a paramagnetic oxygen analyzer is not available, the oxygen concentration as defined in 7.6 shall be calculated as follows:

$$\%\, O_2 = \frac{V_O}{V_O + V_N} \times 100$$

where

V_O is the volumetric flow rate of oxgen (in cm^3/s)

V_N is the volumetric flow rate of nitrogen (in cm^3/s)

9 Report

The report shall include the following:

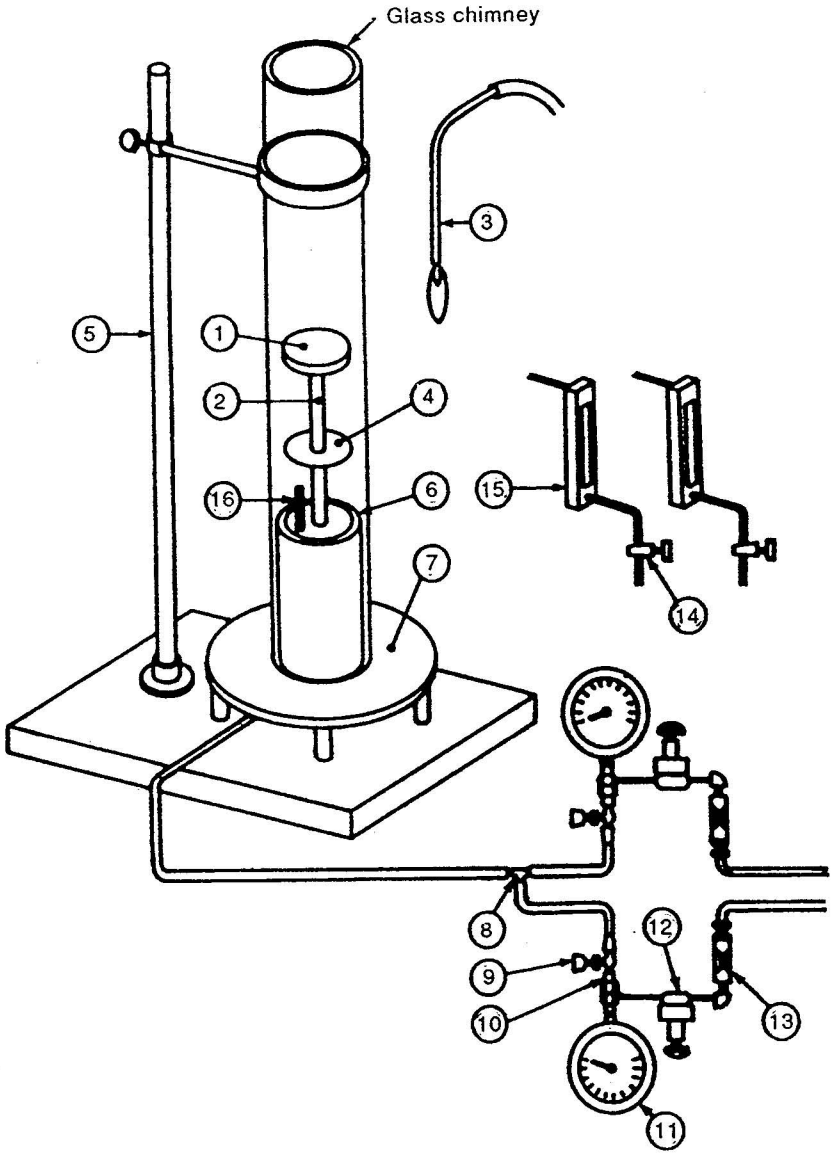
9.1 Identification of the liquid tested including the type, viscosity, density, source, manufacturer's code number, previous history, and conditioning (if any).

9.2 Individual oxygen index value for each of the tests, and average oxygen index value.

9.3 Description of any unusual behaviour such as ash formation, ash glowing, renewed flaming, etc.

10 Precision

Under consideration.



1 Test cup
2 Cup holder
3 Igniter
4 Disk-shaped screen of wire mesh
5 Ring stand
6 Glass beads
7 Base plate
8 Gas premixing joint
9 Cut-off valve
10 Orifice
11 Pressure gauge
12 Precision pressure
13 Filter
14 Gas flow regulator
15 Gas flow meter
16 Temperature sensor

Figure 1 – Schematic arrangement of apparatus for determination of oxygen index

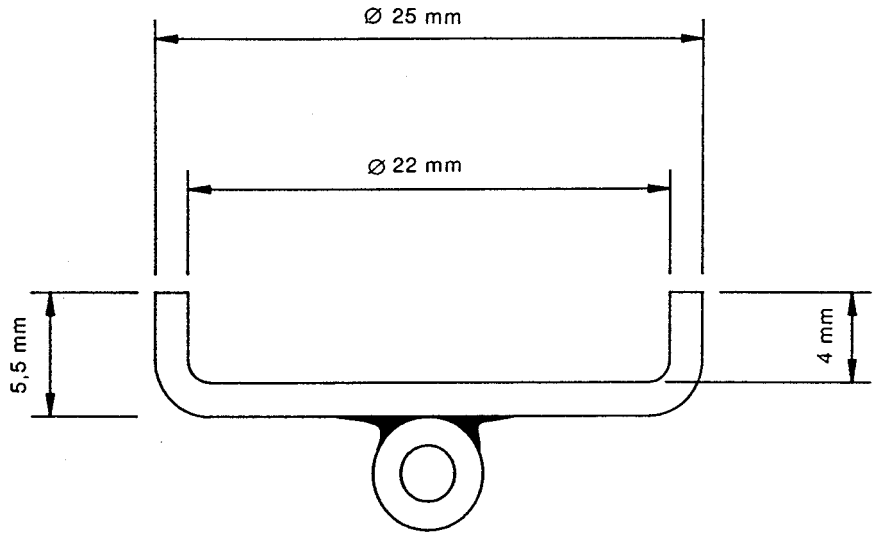
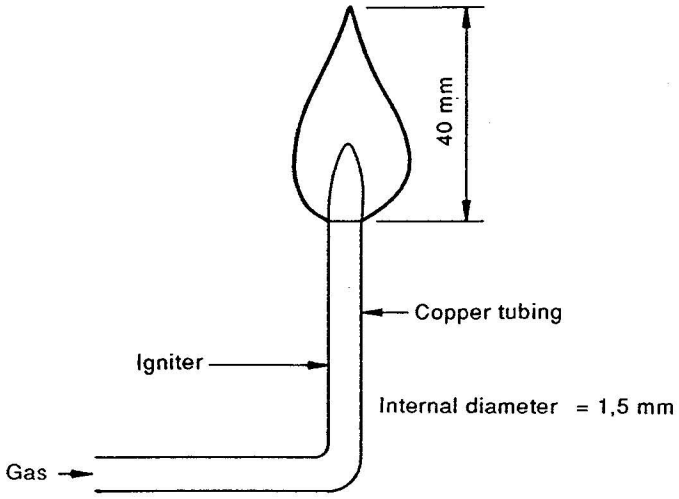
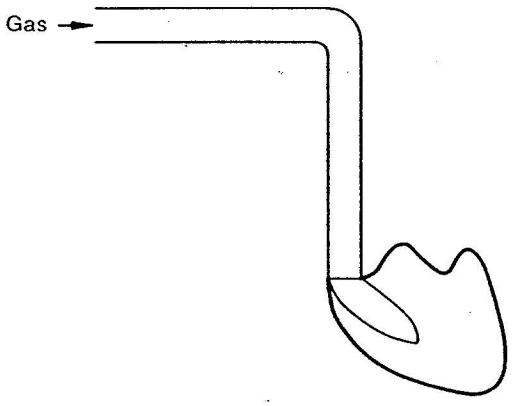


Figure 2 – Borosilicate glass test cup for determination of oxygen index of liquids

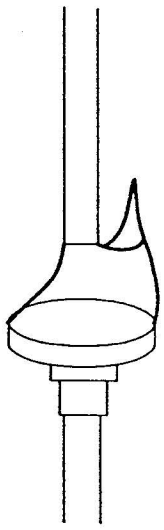
1 Flame size when igniter is upright



2 Flame shape when igniter is inverted



3 Apply flame so that the centre coincides with the centre of the cup and that the flame touches the entire surface area of the liquid



NOTE – Propane gas flame
Flame height: 40 mm
Gas flow rate: 3 ml/s

Figure 3 – Ignition system for determination of oxygen index of liquids

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.

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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 (11072).

Amendments Issued Since Publication

Amendment No.	Date of Issue	Text Affected

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