

**BUREAU OF INDIAN STANDARDS**

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भारतीय मानक मसौदा

**कैलोरीमीटर थर्मोमीटर — विशिष्टि**

**भाग 2 संलग्न-स्केल थर्मोमीटर**

(पहला पुनरीक्षण)

*Draft Indian Standard*

**CALORIMETER THERMOMETERS —  
SPECIFICATION  
PART 2 ENCLOSED SCALE THERMOMETERS  
(First Revision)**

ICS 17.200.20

Glass, Glassware & Laboratoryware Sectional Committee, CHD 10

**Last date for Comments: 11 November 2024**

**FOREWORD**

*(Formal clause to be added later)*

The calorimeter thermometers are not provided with auxiliary scales at 0°C and are, therefore, not suited to the absolute measurement of temperature, unless they are checked against a standard thermometer immediately before use. The solid stem thermometers are covered in Part 1 of this standard.

This standard was originally published in 1988. In relation to the Minamata Convention where mercury shall be removed from products by 2025, the committee responsible for formulating this standard decided to revise the standard by providing alternative thermometric liquids in addition to the mercury as liquid-in-glass thermometers are still in use in the country.

In this first revision, a sampling plan for lot testing has also been prescribed and several editorial changes such as the inclusion of the Reference clause, Hindi Title, ICS no, BIS certification marking clause, etc. have also been incorporated.

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 numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Draft Indian Standard*

**CALORIMETER THERMOMETERS — SPECIFICATION  
PART 2 ENCLOSED SCALE THERMOMETERS**

*(First Revision)*

**1 SCOPE**

This standard prescribes the requirements for a series of short-range enclosed-scale calorimeter thermometers, graduated for vertical, total and partial immersion, for use in bomb calorimetry and other purposes where an accurate measurement of change of temperature is required.

**2 REFERENCE**

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

<i>IS No.</i>	<i>Title</i>
IS 2627 : 1979	Glossary of terms relating to liquid - In - Glass thermometers ( <i>first revision</i> )
IS 4610 : 1968	Specification for glass tubes for general purpose and reference thermometers
IS 4905 : 2015	Random sampling and randomization procedures ( <i>first revision</i> )

**3 TERMINOLOGY**

For the purpose of this standard, the definitions given in IS 2627 shall apply.

**4 TYPE**

The thermometers shall be of the liquid-in-glass enclosed-scale type (*see* Fig. 1).

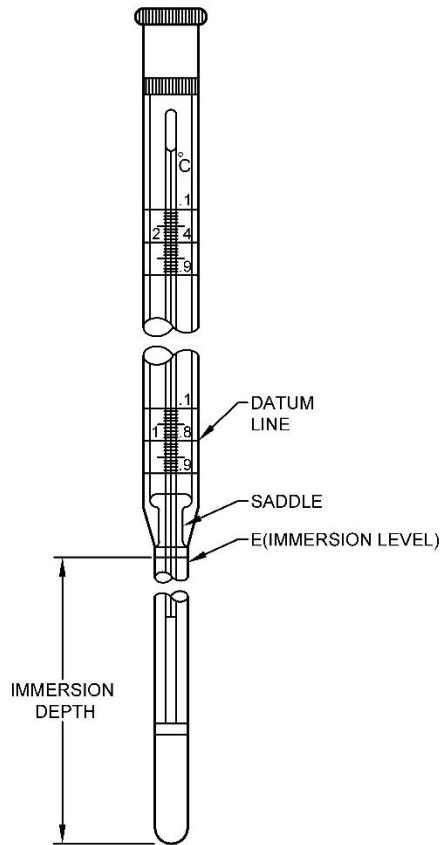


FIG. 1 CALORIMETER THERMOMETER – ENCLOSED-SCALE TYPE

## 5 CALIBRATION AND IMMERSION

5.1 The thermometers shall be calibrated in degrees Celsius.

5.2 The thermometers shall preferably be calibrated for use at total immersion (that is, the reading is taken when the thermometer is vertical and immersed at least to the end of the liquid column in the medium where temperature is required to be measured). The calibration for use at partial immersion is permitted, if agreed to between the purchaser and the supplier. On partial immersion thermometers, a line shall be etched at least half way round the stem of the thermometer at level to which it is intended to be immersed; which would preferably be the junction of the saddle and the sheath (marked, E in Fig. 1).

## 6 REQUIREMENTS

### 6.1 Materials

#### 6.1.1 Glass

The thermometer bulb shall be made of suitable thermometric glass (*see* IS 4610). The glass or glasses comprising the thermometer shall be so selected and processed that the finished thermometer shows the following characteristics:

- Stress in the glass shall be reduced to a level sufficient to minimize the possibility of fracture due to thermal or mechanical shock;
- The correction of the thermometer reading at the lowest temperature of the nominal range shall not change by more than 0.02 °C immediately after the thermometer has been heated for 15 min at a temperature 30 °C higher than the lowest temperature and allowed to cool naturally in air;
- The legibility of the reading shall not be impaired by devitrification or clouding;
- The meniscus shall not be distorted by defects or impurities in the glass.

#### 6.1.2 Thermometric liquid

**6.1.2.1** The thermometric liquid shall be entirely free from contamination particularly of solid particles or of any liquid which produces a variation of volume with time.

**6.1.2.2** Recommended thermometric liquids and the approximate temperature ranges covered by them are given in table 1.

**TABLE 1 TEMPERATURE RANGES FOR VARIOUS THERMOMETRIC LIQUIDS**

(Clause 6.1.2.2)

SI No.	Thermometric Liquid	Approximate Temperature Range, °C
(1)	(2)	(3)
i.	Mercury	– 38 to + 600
ii.	Mercury-thallium alloy [8.5 percent (m/m) of thallium]	– 55 to + 600
iii.	Alcohol	– 80 to + 50
iv.	Toluene (IS 537)	– 90 to + 50
v.	Technical pentane	– 200 to + 30
vi.	Kerosene Oil	– 20 to + 150

**6.1.2.3** The organic liquid used as the liquid filling shall, wherever possible, be coloured by means of light-fast dye which does not stain the glass. Alcohol shall comply in all respects with the provisions of Special Grade of IS 321 subject to the following modifications:

- a) *Aldehydes and ketones* — Alcohol shall not contain more than 0.02 percent (m/m) of aldehydes and ketones, calculated as acetaldehyde (CH<sub>3</sub>CHO); and
- b) *Amines* — Alcohol shall give no indication of the presence of amines when tested by adding to 10 ml of alcohol, 10 ml of distilled water followed by 2 drops of a saturated solution of *p*-nitrophenol in water. Not more than 0.05 ml (1 drop) of 0.1 N sulphuric acid shall be required to discharge any yellow colour produced.

### 6.1.3 Gas filling

Above the thermometric liquid, thermometers may be either vacuum or gas-filled; in the latter case, only a dry, inert gas shall be used. The indication in a gas-filled thermometer, when the meniscus is at the top of the scale, shall not change by more than 0.01°C when the temperature of the gas above the liquid is changed by 30°C.

## 6.2 Construction

### 6.2.1 Shape

The thermometers shall be straight and their external cross-section approximately circular.

### 6.2.2 Top finish

The top of the sheath shall be sealed by fusing and shall be covered by metal cap.

### 6.2.3 Strip bearing the scale

The strip bearing the scale shall be of a material suitable to the temperature to be measured and compatible with the method of fixing the strip. It shall be placed tightly against the capillary tube inside the sheath and shall be firmly and securely fastened at the top of the thermometer. A suitable method of fixing is by fusing a glass tube or rod to the sheath and to the upper end of the strip bearing the scale; the lower end of the strip shall be freely held in a suitable glass saddle. Alternatively, it shall be fixed inside the sheath in any other suitable manner that allows for differential expansion.

### 6.2.4 Capillary tube

The inside of the capillary tube shall be smooth. The cross-sectional area of the bore shall not show variations from the average greater than 5 percent and the bore shall be wide enough to ensure that, without tapping, jumping of the meniscus does not exceed one half of the graduation interval when the temperature is rising at a uniform rate not exceeding 0.05°C per minute. In the case of thermometers calibrated for use at partial immersion, the

volume of mercury contained in the capillary tube between the immersion line and the lowest figured scale line shall not exceed the equivalent of 2°C.

**6.2.5 Expansion chamber (safety chamber)**

The capillary tube shall have an enlargement at the top of sufficient size to allow heating of the thermometer to 70°C. This expansion chamber shall be pear-shaped, with the hemisphere at the top. It shall be so shaped that the meniscus remains in the narrow portion at temperatures up to 40°C.

**6.2.6 Construction Chamber**

A contraction chamber shall be provided so that the mercury does not recede into the bulb at 0°C. It shall be elongated and as narrow as possible.

**6.2.7 Enlargement of the bore**

No enlargement of the bore shall be so located as to produce a variation in the cross-section of the capillary tube in the scale portion greater than that permitted in clause 6.2.4.

**6.2.8 Dimensions**

The dimensions of the thermometers shall be as given in Table 2.

**TABLE 2 DIMENSIONS OF ENCLOSED SCALE CALORIMETER THERMOMETERS**  
(Clause 6.2.8)

SI No. (1)	Requirement (2)	Dimensions in mm (3)
i)	Total length, <i>Max</i>	760
ii)	Distance from bottom of bulb to top of construction chamber, <i>Max</i>	110
iii)	Distance from bottom of bulb to lower nominal limit of scale	280 to 300
iv)	Length of main scale ( nominal limits ), <i>Min</i>	300
v)	Distance from upper nominal limit of scale to top of thermometer, <i>Min</i>	70
vi)	Diameter of sheath, <i>Max</i>	15
vii)	External diameter of bulb and adjoining portion of stem	9 to 11
viii)	Length of bulb to shoulder, <i>Min</i>	40

**7 GRADUATION AND FIGURING**

7.1 The scales and graduation interval of the thermometers shall be as given in Table 3.

**TABLE 3 GRADUATION OF ENCLOSED SCALE CALORIMETER THERMOMETERS**  
(Clause 7.1, 7.4)

SI No. (1)	Schedule No. (2)	Graduation Interval °C (3)	Nominal Scale Range °C (4)
i)	1	0.01	9 to 15
ii)	2	0.01	12 to 18
iii)	3	0.01	15 to 21
iv)	4	0.01	18 to 24
v)	5	0.01	21 to 27
vi)	6	0.01	24 to 30

vii)	7	0.01	27 to 33
viii)	8	0.01	30 to 36
ix)	9	0.01	33 to 39
x)	10	0.01	36 to 42
xi)	11	0.01	39 to 45

**7.2** The scale lines shall be clearly etched/marked and of uniform thickness, which in no case shall exceed 0.05 mm. The lines shall lie in planes at right angles to the axis of the thermometer.

**7.3** The arrangement and figuring of the scale lines shall be according to Fig. 2. Each 0.1 °C scale line shall be a long line, each 0.05 °C line shall have a length of two-thirds of the long lines. The figures shall be placed immediately above the line to which they refer.

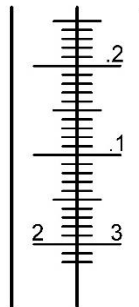


FIG. 2 GRADUATION AND FIGURING

**7.4** The scale of the thermometer shall be extended by ten divisions (that is, 0.1 °C) beyond the nominal limits given in Table 3.

**7.5** The scale shall be figured at each division of 0.1 °C. Full figuring shall be provided at least at each division of 1 °C and more frequently, if required.

**7.6** The pigment filling of the scale lines, figures and inscriptions shall be clearly visible.

#### **7.7 Datum line**

At the right-hand side of the sheath, an indelible datum line shall be placed on a level with the lowest nominal scale line so that any displacement of the scale can easily be noticed.

### **8 ACCURACY**

#### **8.1 Scale Error**

The scale error, when the thermometer is under normal atmospheric pressure and when the emergent liquid column (in the case of a partial immersion thermometer) is at the prescribed temperature, shall not be greater than 0.1 °C.

#### **8.2 Internal Error**

The absolute value of the algebraic difference between the errors at any two points which are not more than 50 divisions apart shall in no case be greater than 0.01 °C.

### **9 MARKING AND PACKING**

#### **9.1 Packing**

Each thermometer shall be suitably packed as agreed to between the purchaser and the supplier.

#### **9.2 Marking**

**9.2.1** Each thermometer shall be marked permanently and legibly with the following:

- a) The letter ‘°C’ near the top of the scale;
- b) Manufacturer’s name or recognized trade-mark, if any;
- c) Serial number of the thermometer;
- d) Schedule No.;
- e) Schedule mark followed by letters ‘TI’ or ‘PI’, as the case may be;
- f) Gas filling, if any; for example, NF for nitrogen filled; and
- g) Immersion line on each thermometer graduated for use at partial immersion, the immersion depth shall be indicated and the emergent stem temperature for which the thermometer was calibrated shall be marked.

### 9.2.2 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.

## 10 SAMPLING

### 10.1 Lot

**10.1.1** All thermometers of the same type in a single consignment and produced under similar conditions of manufacture shall constitute a lot.

**10.1.2** Thermometers constituting the sample shall be drawn from each lot separately for deciding the conformity of the lot to the requirements of the specification.

### 10.2 Scale of Sampling

Number of thermometers to be selected at random from the lot shall depend on the lot size and shall be in accordance with col (3) of table 4. In order to ensure randomness of selection, procedures given in IS 4905 may be followed.

### 10.3 Criteria for Conformity

**10.3.1** For deciding the conformity of the lot to the requirements of this specification, the test results of each characteristic shall meet the corresponding requirements specified in the relevant clauses.

**10.3.2** The lot shall be declared as conforming to the requirements of the specification, if the number of defectives is equal or less than the number given in col (4) of table 4.

**Table 4 Scale of Sampling**  
(Clause 10.2, 10.3.2)

SI No.	Number of thermometers in the lot	Sample size	Acceptance number
(1)	(2)	(3)	(4)
i.	Less than 150	20	1
ii.	151 to 280	32	2
iii.	281 to 500	50	3
iv.	501 to 1200	80	5
v.	1201 and above	125	7