*भारतीय मानक* **IS 13273 : 2024**

***Indian Standard***

# पानी सग्रंहण हीटर के लिए काँचाभ इनैमलकृत भीतरी टंकियाँ — विशिष्टि

*( पहला पुनरीक्षण )*

# Vitreous Enamelled Inner Tanks for Storage Water Heater — Specification

*( First Revision )*

ICS 81.060.20



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**September 2024** **Price Group 7**

Ceramicware Sectional Committee, CHD 09

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Ceramicware Sectional Committee had been approved by the Chemical Division Council.

The requirements of stationary type electric water heaters are covered in IS 2082 : 2018 ‘Stationary storage type electric water heaters — Specification’. The standard was first published in 1962 and is currently in its fifth revision which refers to water heaters having inner tanks made of copper, stainless steel and vitreous enamelled inner tanks.

This standard was first published in 1991. This revision has been taken in order to update the standard with the latest technology advancements and the currently available data.

The major changes in this revision are:

a) The requirement of the base metal has been modified, thickness of the base metal has been removed and minimum thickness for the inner tank has been introduced in its place;

b) The range of thickness of the enamel coating & storage capacity have been modified;

c) The requirement of cathodic protection has been made mandatory and alternate materials have been allowed to be used as sacrificial anode;

d) The low voltage test for verifying continuity of enamel has been deleted; and

e) New test method has been prescribed for Hydrostatic test by superseding the test method prescribed in the earlier version of the standard.

The composition of the Committee, responsible for the formulation of this standard is given in Annex E.

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 value should be the same as that of the specified value in this standard.

*Indian Standard*

# VITREOUS ENAMELLED INNER TANKS FOR STORAGE WATER HEATER — SPECIFICATION

*( First Revision )*

## 1 SCOPE

This standard prescribes requirements, methods of sampling and tests for vitreous enamelled inner tanks for use in stationary storage type electrical water heaters.

## 2 REFERENCES

The standards listed in Annex A 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 agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of these standards.

## 3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 2717 and the following shall apply.

**3.1 Burn Off** — It is a term used to designate a condition caused by saturation of the enamel layer by iron oxide during the firing operation. The condition usually occurs on areas where the enamel has been applied very thin. It can be recognized by:

a) a complete lack of glossiness; and

b) a reddish brown or black appearance of the enamel over the affected area.

## 4 TEST SPECIMEN

The test specimen shall be prepared in accordance with IS 3972 (Part 1).

## 5 REQUIREMENTS

### 5.1 Materials

**5.1.1** *Base Metal*

The base metal and the component used for the fabrication of enamelled inner tank shall be made of steel sheet conforming to IS 513 (Part 1) or IS 513 (Part 2) or IS 1079. The inner tank shall have a minimum thickness of 1.4 mm after deep drawing of the steel sheet. Measure the thickness of the exposed metal by means of a micrometer at three points, each point at a distance of at least 1 cm from the preceding one. The average of the three measurements shall be taken as the thickness of the metal.

**5.1.2** *Fitting Components*

The base plate of all pipes and fittings on the enamel tank shall conform to IS 2082.

### 5.2 Welding

The welding of the steel tank shall be done with low hydrogen type electrode to minimize enamelling defects. In case gas welding is used for welding the steel tank, the filling material shall be of the same composition as the parent metal.

### 5.3 Enamel

**5.3.1** All surfaces of the tank that are exposed to hot water shall have a continuous coating of vitreous enamel.

**5.3.2** The composition of the enamel shall be such as to meet the requirements given in **5.3.2.1** to **5.3.2.5**.

**5.3.2.1** *Release of toxic material*

The enamel shall pass the permissible release limits of 0.5 mg/dm$^2$ for lead (as Pb) and 0.05 mg/dm$^2$ for cadmium (as Cd) when tested by the methods given in IS 12038 (Part 1).

**5.3.2.2** *Resistance to citric acid*

The enamel shall pass the resistance to citric acid test at room temperature for 'AA' or 'A' class when tested by the method prescribed in Annex B.

**5.3.2.3** *Solubility test*

The enamel when tested by the procedure given in Annex C shall not suffer a weight loss of more than 4 mg/cm$^2$.

**5.3.2.4** *Resistance to thermal shock*

The enamel shall pass the resistance to thermal shock test when tested by the procedure given in Annex D.

**5.3.2.5** *Impact resistance test*

The enamel coating shall not show any instantaneous chipping at the impact point when subjected to an impact force of 3.4 kg/cm$^2$. This impact force is achieved by making a steel ball weighing (43 ± 1) g to fall freely from a height of 80 cm at a plain segment of the inner part of the tank

having a flat area larger than the cross sectional area of the ball.

NOTE — For the purpose of this testing, chipping shall be considered as those fractures of enamel coating, which result in spontaneous removal/breaking away of the damaged enamelled flake. Any delayed chipping or chipping on the opposite side of the impact face shall not be taken into account for evaluating the test result of the sample.

**5.3.3** *Thickness*

The thickness of the enamel coating shall be between 0.2 mm to 0.6 mm.

**5.3.4** *Coverage*

In order to be considered a continuous coating, the enamel shall have the minimum defects or discontinuities.

NOTE — Any break in the coating that is sufficient to expose the surface of the steel base shall be a cause of rejection (*see* **5.6**).

**5.3.4.1** *Cathodic protection*

Each enameled tank shall be furnished with a sacrificial anode of magnesium or aluminium or zinc or their alloys having a surface density not less than 275 g/m$^2$ of the inner tank area. The anode shall be electrically grounded to the tank.

**5.3.5** *Edges and Fittings*

All edges and fittings, welded or otherwise, shall be coated with enamel except sharp edges, threadings and small areas immediately adjacent to various fittings. A slight burn-off of enamel, that does not extend more than 6.25 mm back from the sharp edges, shall be permitted.

**5.4 Storage Capacity**

The storage capacity of each tank shall not be less than the rated capacity.

**5.4.1** The tank shall be fixed in its working position. The drain plug and all outlets except the top most outlet shall be plugged. The container is filled with water through its inlet until water starts flowing at the top most outlet. The inlet is closed and when the overflow ceases completely, the water is drained out through the drain plug and the volume of water determined either by measuring or weighing. The capacity so measured is called the storage capacity.

**5.5 Hydrostatic Test**

The enamelled tank shall withstand the water pressure occurring in normal use. Compliance is checked by subjecting the tank to water pressure as given in **22.47** of IS 302-2-21.

**5.6 Enamel Coverage Test**

After completing the hydrostatic test (*see* **5.5**), the tanks shall be cut into four or more segments using a saw. Each segment shall be visually inspected for the presence of exposed metal areas except the cracked areas of the enamel caused by the cutting operation. If any exposed area of the metal shows a diameter of more than 3.5 mm, the tank shall be regarded as failing to meet the requirement of the test.

**5.6.1** If a large number of exposed metal areas of smaller diameter are observed, the average diameter of such exposed metal areas shall be computed and from that the total exposed metal area shall be calculated. If this area exceeds 7 cm$^2$/m$^2$ of the inner tank surface, the sample shall be regarded as failing to meet the requirement of the test.

**6 PACKING AND MARKING**

**6.1 Packing**

Each enamelled tanks shall be packed as agreed to between the manufacturer and the purchaser.

**6.2 Marking**

Each enamelled water tank shall be marked permanently and legibly with the following information:

a) Indication of the source of manufacture;

b) Name of the material, that is, enamelled water tank;

c) Code or serial number to enable the lot to be traced from records;

d) Storage capacity; and

e) Rating pressure.

**6.2.1** *BIS Certification Mark*

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 product(s) may be marked with the Standard Mark.

**7 SAMPLING AND CRITERIA FOR CONFORMITY**

**7.1 Lot**

A lot shall consist of vitreous enamelled tanks manufactured under same conditions and not more than 500 in number.

**7.2** Representative samples of the enamelled tank shall be drawn at inspection Level I of IS 2500 (Part l)/ISO 2859-1 and all the tests shall be conducted on these samples.

**7.3** No defect shall occur at the end of the tests.

## ANNEX A

(*Clause* 2)

## LIST OF REFERRED STANDARDS

| *IS No.* | *Title* |
|---|---|
| IS 302 (Part 2/ Sec 21) : 2018 | Safety of household and similar electrical appliances: Part 2 Particular requirements, Section 21 Stationary storage type electric water heaters (*second revision*) |
| IS 513 | Cold reduced carbon steel sheet and Strip |
| (Part 1) : 2016 | Cold forming and drawing purpose (*sixth revision*) |
| (Part 2) : 2016 | High tensile and multi-phase steel (*sixth revision*) |
| IS 878 : 2008/ ISO 4788 : 2005 | Laboratory glassware — Graduated measuring cylinders (*second revision*) |
| IS 1079 : 2017 | Hot rolled carbon steel sheet, plate and strip — Specification (*seventh revision*) |
| IS 1117 : 2018/ ISO 648 : 2008 | Laboratory glassware — Single-volume pipettes (*second revision*) |
| IS 1375 : 2021 | Black lead pencils — Specification (*second revision*) |
| IS 2082 : 2018 | Stationary storage type electric water heaters — Specification (*fifth revision*) |
| IS 2500 (Part 1) : 2000/ISO 2859 -1 : 1999 | Sampling procedure for inspection by attributes: Part 1 Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection (*third revision*) |
| IS 2717 : 1979 | Glossary of terms relating to vitreous enamelware and ceramic-metal systems (*first revision*) |
| IS 3972 (Part 1) : 2020/ISO 28764 : 2015 | Methods of test for vitreous enamelware: Part 1 Production of specimens for testing (*second revision*) |
| IS 12038 (Part 1) : 2007 | Vitreous and porcelain enamels - Release of lead and cadmium from enamelled ware in contact with food: Part 1 Method of test (*first revision*) |

## ANNEX B

(*Clause* 5.3.2.2)

## TEST FOR RESISTANCE TO CITRIC ACID AT ROOM TEMPERATURE

### B-1 GENERAL

This test method is not suitable for matt enamels, enamels that come in contact with hot and strong acids and enamelled articles that are used in the chemical industry.

#### B-1.1 Outline of Method

A part of the specimen is exposed to attack by a 10 percent (*m/m*) solution of citric acid for 15 min ± 30 s. The results are based on the appearance and cleanability of the enamelled surface.

### B-2 APPARATUS

**B-2.1 Graduated Measuring Cylinder, Capacity 100 ml —** *see* IS 878

**B-2.2 Pipette** — *see* IS 1117

**B-2.3 Filter Paper**

**B-2.4 Towel, White** — cotton or flax

**B-2.5 Pencil** — conventional graphite HB pencils hardness conforming to IS 1375.

**B-2.6 Watch-Glass** — made of polyethylene or glass external diameter approximately 30 mm.

**B-2.7 Balance** — accurate to ± 0.1 g

**B-2.8 Electric Lamp** — 40 W, inside white (for example, siliconized)

### B-3 REAGENTS

#### B-3.1 Citric Acid Solution

Dissolve 10 g pure crystalline citric acid ($C_6H_8O_7.H_2O$) in 100 ml of distilled water. A fresh solution, prepared the same day, is requirement for each test.

#### B-3.2 Grease Solvent

Acetone or trichloroethylene, suitable for cleaning the specimen.

### B-4 PREPARATION OF TEST SPECIMEN

Each specimen shall be prepared in accordance with IS 3972 (Part 1). The specimen shall be cleaned with the grease solvent (**B-3.2**), rinsed with hot water until the water spreads evenly on the surface and then dried with the clean towel (**B-2.4**), it shall be dabbed, not rubbed.

### B-5 PROCEDURE

#### B-5.1 Attack by the Test Solution

Place a filter paper of a small diameter (10 mm to 15 mm) on the test specimen and then place a few drops of the test solution (**B-3.1**) on the filter paper to keep it in moistened condition and cover the etching zone with watch glass. Care should be taken so that the wet filter paper does not dry out. After 15 min ± 30 s remove the watch glass, wash the specimen with either distilled or running water, then dry it with filter paper without piping. Care shall be taken that when using running water, no film of water is allowed to form.

#### B-5.2 Determination

Each test specimen shall be examined within 2 h after the exposure to the test solution. For evaluation, only that part of the surface of the specimen which has been subjected to attack by acid shall be considered as a treated area.

The evaluation is based on the examinations which shall be in accordance with the scheme and results given below. The specimen is to be assigned to one of the five classes designated as AA, A, B, C and D.

**B-5.2.1** *Visual Examination*

View the different areas at varying angles, at a distance of 250 mm from the specimen without a magnifying glass, in order to ascertain whether or not the treated area differs from the non-treated area (for instance, if the brightness or the colour has changed). Carry out the examination in daylight, avoiding direct sunlight. The specimen may also be examined in artificial light provided the latter is uniform and strong enough. If the treated area differs in any respect from the non-treated area, the specimen fails the test,

**B-5.2.2** *Pencil Test* (*Dry*)

Draw some nearly parallel lines on both the treated and non-treated areas with a pencil (**B-2.5**). If, on rubbing the specimen with the dry towel (**B-2.4**), the lines on the treated area are more difficult to remove than those on the non-treated area, the specimen fails the test.

**B-5.2.3** *Reflection Test*

Set the specimen in such a way that the image of the test lamp (**B-2.8**) placed at 35 cm ± 10 cm away from

the specimen reflects on the non-treated area with an angle of incidence of 45 °C. Then watch the image of the lamp on the non-treated area while the specimen is slowly removed, so that the image of the lamp moves into the treated area. If no blurring of the image is observed while it passes from one area to the other, the specimen passes the test. If such is not the case, it is necessary to distinguish, in the passage from one area to the other, if there is a blurring or a complete disappearance of the image.

**B-5.2.4** *Pencil* (*Test Moist*)

Repeat the test specified in (**B-5.2.2**) using the towel (**B-2.4**) which has been moistened with water and thoroughly wrung out, without using any soap or detergent. It the lines on the treated area are more difficult to remove than those on the non-treated area, the specimen fails the test.

## B-6 CLASSIFICATION OF RESULTS

In consequence of the determinations which have been performed in accordance with (**B-5.2**) the enamels are divided into five classes which are shown as Class AA, A, B, C and D, in Fig. 1 and Table 1.

## B-7 TEST REPORT

The test report shall include the following particulars:

a) Description of the specimen;

b) Results of the tests specified in **B-5**; and

c) Classification of the enamel coating according to **B-6**.

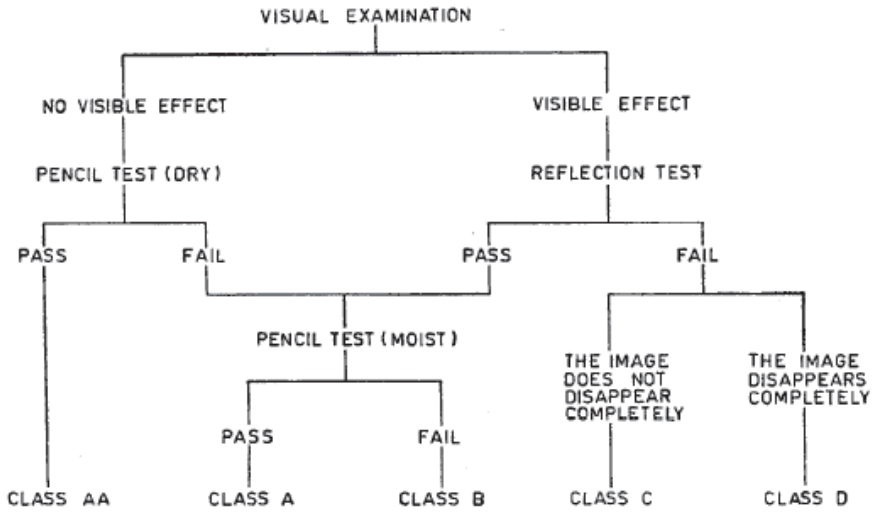



FIG. 1 FLOW SHEET OF TEST PROCEDURE FOR CLASSIFICATION OF TREATED SPECIMEN

**Table 1 Criteria for Respective Classes of Resistance to Citric Acid at Room Temperature**

(*Clause* B-6)

| Sl No. | Class | Visual Examination | Reflection Test | Test with Pencil | |
|---|---|---|---|---|---|
| | | | | Dry | Moist |
| (1) | (2) | (3) | (3) | (4) | (6) |
| i) | AA | Pass | – | Pass | – |
| ii) | A | Pass | – | Fail | Pass |
| | | Fail | Pass | – | Pass |
| iii) | B | Pass | – | Fail | Fail |
| | | Fail | Pass | – | Fail |
| iv) | C | Fail | Partly fail | – | – |
| v) | D | Fail | Totally fail | – | – |

## ANNEX C

(*Clause* 5.3.2.3)

## DETERMINATION OF SOLUBILITY

### C-1 APPARATUS

The apparatus required for determining the solubility of enamel is illustrated in Fig. 2 to Fig. 6. The cylinder assembly shall be constructed of 1.5 mm (16 guage) AISI type 304 stainless steel. The ends shall be ground so as to conform with the curvature of the tank to be tested. The gaskets shall be of neoprene rubber. The apparatus shall be heated with a gas burner of electric heater placed outside the cylinder assembly.

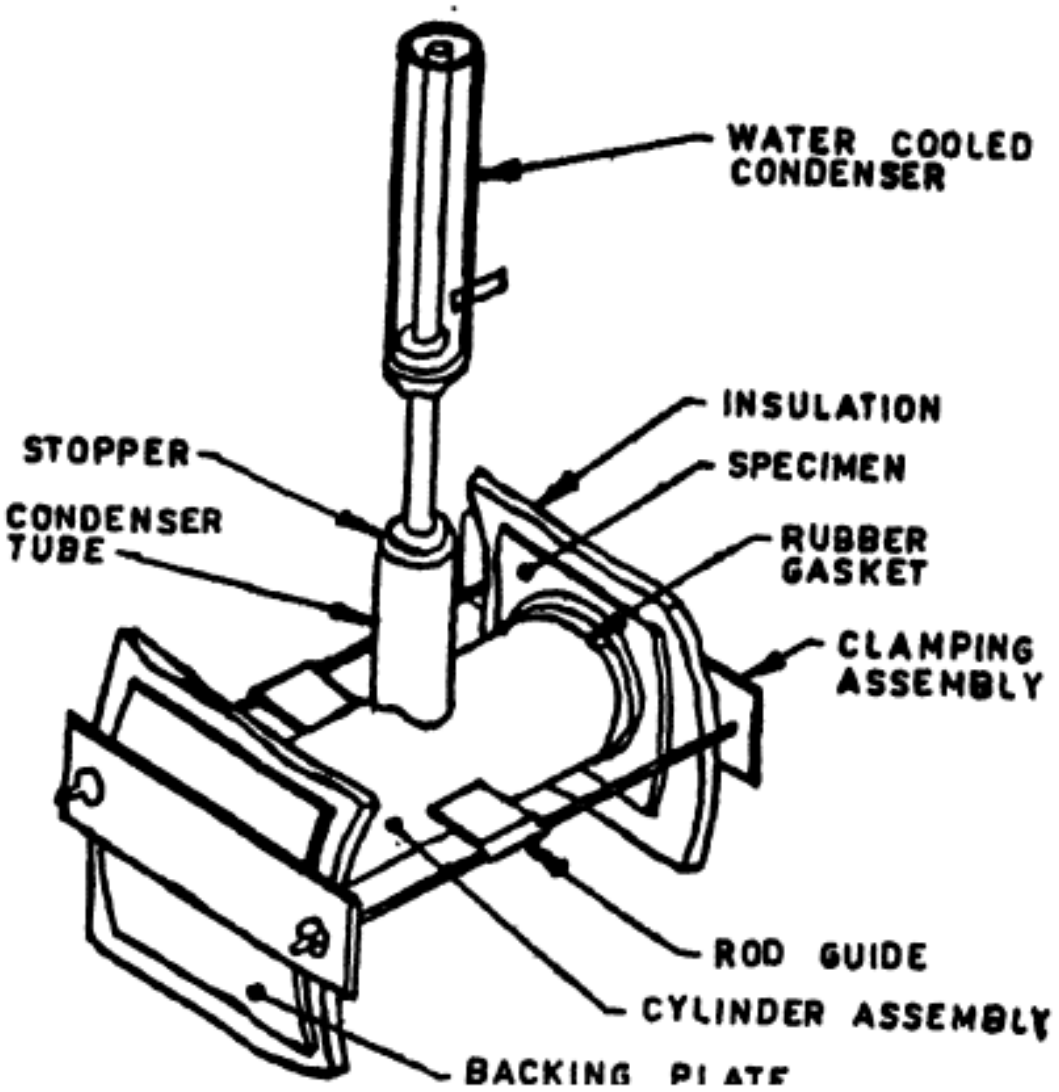
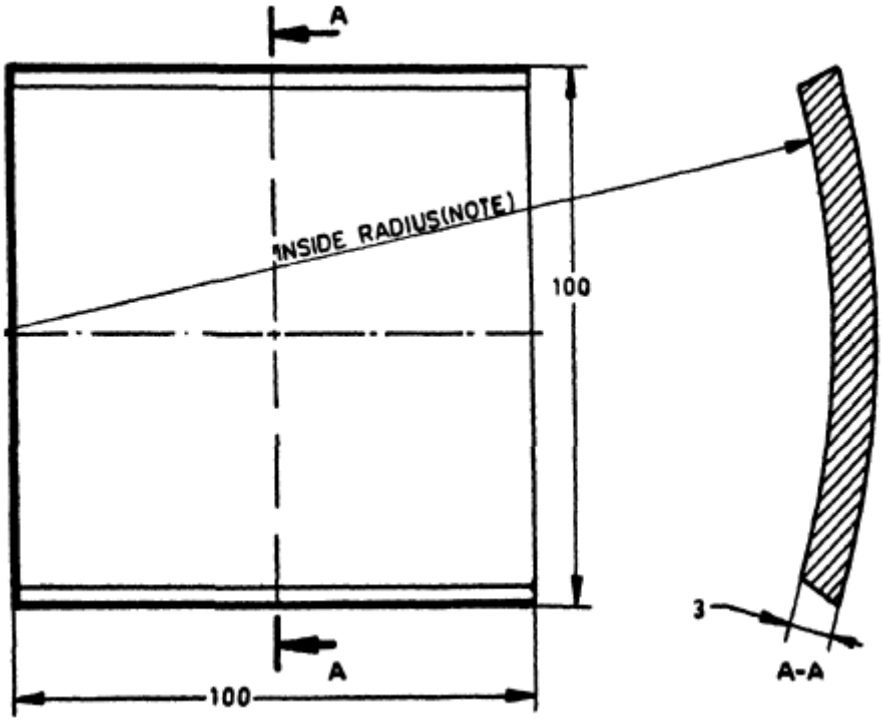
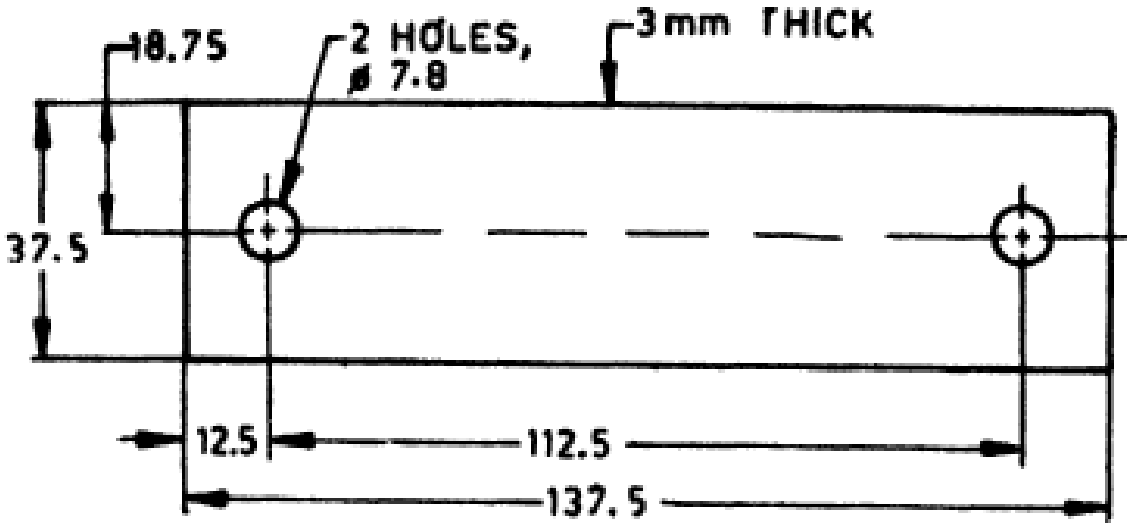


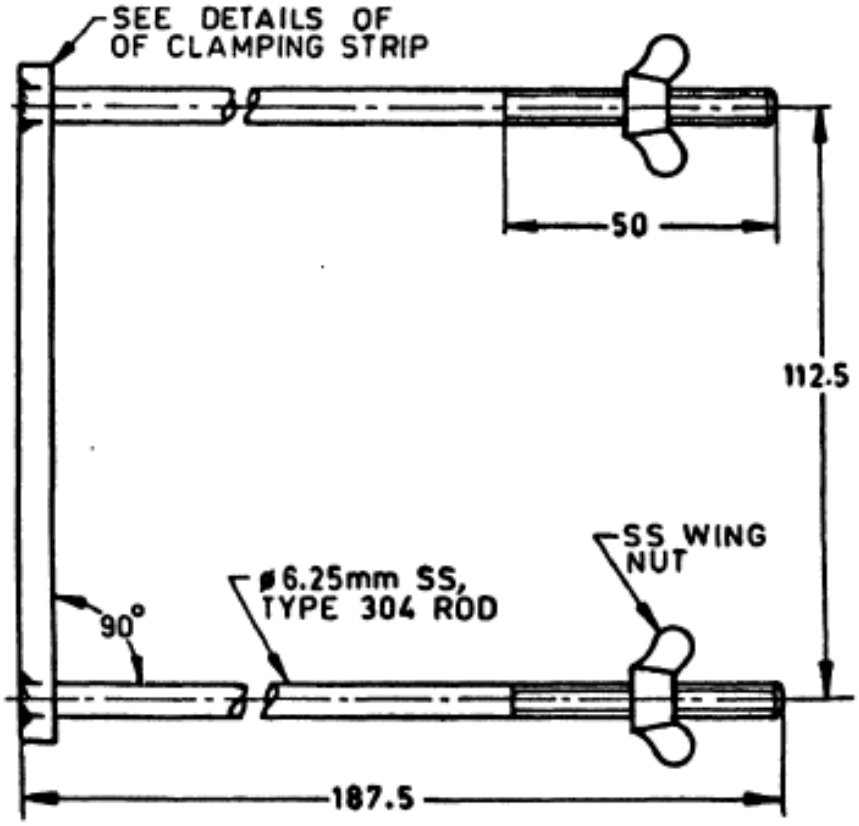

FIG. 2 TEST CELL FOR SOLUBILITY TEST OF ENAMEL




All dimensions in millimetres.
FIG. 3 BACKING PLATE

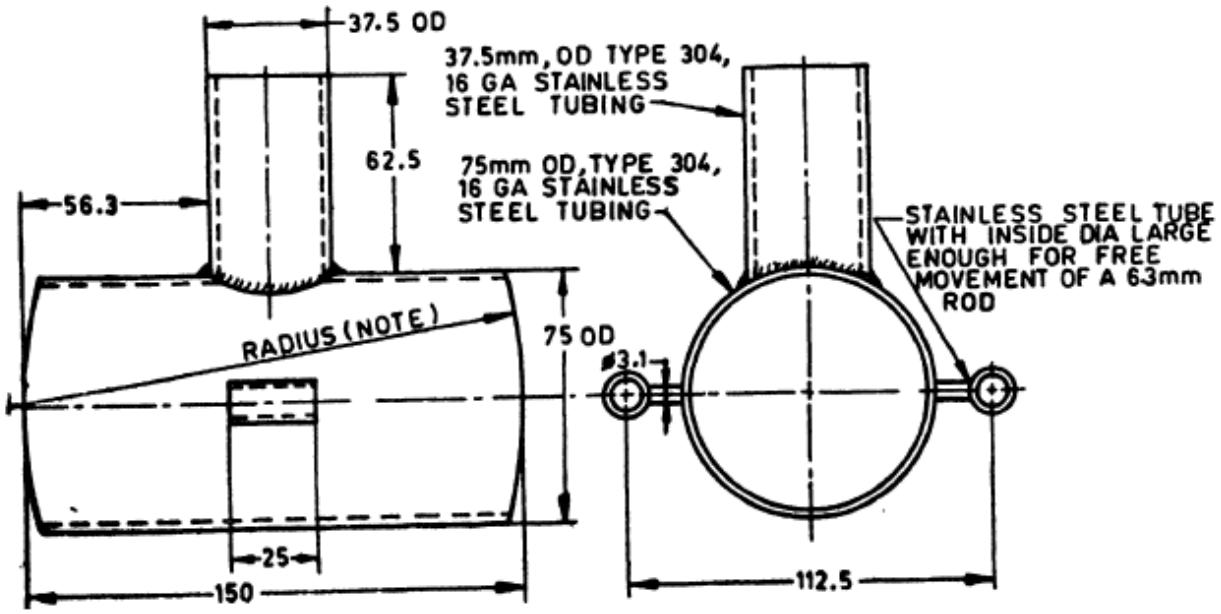



All dimensions in millimetres.
FIG. 4 CLAMPING STRIP




All dimensions in millimetres.

FIG. 5 CLAMPING ASSEMBLY




All dimensions in millimetres.

FIG. 6 CYLINDER ASSEMBLY

**C-2 SPECIMENS**

The specimen for the solubility test shall comprise of four section pieces each of size 100 mm × 100 mm cut from the wall of the enamelled tank approximately midway between the ends.

**C-3 PREPARATION OF SPECIMEN**

The specimen shall be buffed to remove rough edges and enamel fragments. The specimen shall be scrubbed on both sides using nylon brush and a mild abrasive detergent powder, rinsed with distilled water, dried for one hour in a drying oven and cooled in a desiccator.

**C-4 THE INITIAL MASS**

The specimen shall be weighed to an accuracy of 0.1 mg.

**C-5 CALIBRATION OF TEST CELL**

Each test cell shall be calibrated, before it is used, following the procedure given below:

Assemble the cell as it is to be opened. Fill with water to just below where the condenser tube is welded to the tank. Adjust the input to the heat source to give a slow rolling boil. If the water rises in the condenser, remove small amounts of water until the cell operates without surging. Switch off the heat and check it to see if the water level is completely covering the panels. Cool to room temperature, then measure the volume of water contained in the cell. Record this volume in the cell and use this amount of test solution in all subsequent tests.

**C-6 TEST SOLUTION**

The test solution used for each cycle shall consist of 400 mg of sodium bicarbonate dissolved in one litre of distilled water.

**C-7 TEST PROCEDURE**

Assemble the test cell using weighed panels of the same enamel on each end of the test cell. Pour the correct volume of the test solution into the cell. Adjust the input to the heater to give a consistent slow, rolling boil. After boiling for 18 hours, dismantle the cell and discard the used test solution. Clean the specimen using soft cloth and store in a desiccator between solution treatments. After 8 cycles of 18 h each, clean specimen as before rinse with distilled water and dry at 107 °C for 1 h. Place the specimen in a desiccator while hot and after cooling to room temperature weigh to an accuracy of 0.1 mg.

**C-8 CALCULATIONS**

The loss of mass per unit area of the enamelled surface ($M$) after treatment with boiling water is calculated as follows:

$$M = \frac{M_1 - M_2}{A}$$

where

$M_1$ = mass, in g, of the test specimen before the test;

$M_2$ = mass, in g, of the test specimen after the test; and

$A$ = area, in $m^2$, of the exposed surface of the test specimen.

## ANNEX D

(*Clause* 5.3.2.4)

## DETERMINATION OF RESISTANCE TO THERMAL SHOCK

**D-1 OUTLINE OF THE METHOD**

The test for thermal shock resistance consists of heating the specimen to 140 °C ± 3 °C and then chilling with water at room temperature.

**D-2 APPARATUS**

Hot air oven capable of maintaining temperature of at least 150 °C.

**D-3 PROCEDURE**

Heat the specimen in the oven to 140 °C ± 3 °C at the rate of 5 °C to 10 °C per minute. As the required test temperature is attained, maintain the sample at this temperature for 30 min. Switch off the oven and remove the sample and quench it in water at room temperature. At least two samples shall be tested. Examine the samples for any cracking, flaking or blistering. The samples which show occurrence of any chipping of the enamel shall be considered as not being in conformity with the standard.

## ANNEX E

(*Foreword*)

## COMMITTEE COMPOSITION

Ceramicware Sectional Committee, CHD 09

| *Organization* | *Representative(s)* |
|---|---|
| CSIR - Central Glass and Ceramic Research Institute, Kolkata | DR SUMAN KUMARI MISHRA **(*Chairperson*)** |
| Aditya Birla Insulators Company, Halol | SHRI UTTAM SARKAR |
| Ahmedabad Pottery Manufacturers Association, Naroda | SHRI RUPESH C. SHAH |
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| Saint-Gobain India Private Limited, Chennai | SHRI MANISH KUMAR |
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*Member Secretary*
MS PUJA PRIYA
SCIENTIST 'C'/DEPUTY DIRECTOR
(CHEMICAL), BIS

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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 website-www.bis.gov.in or www.standardsbis.in.

This Indian Standard has been developed from Doc No.: CHD 09 (24968).

## Amendments Issued Since Publication

| Amend No. | Date of Issue | Text Affected |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

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