

BUREAU OF INDIAN STANDARDS

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<p>भारतीय मानक मसौदा औद्योगिक पत्थर के बर्तन — विशिष्टि (पहला पुनरीक्षण)</p> <p><i>Draft Indian Standard</i> INDUSTRIAL STONEWARE — SPECIFICATION (<i>First Revision</i>)</p> <p>(ICS 81.060.20; 97.040.60)</p>	
Ceramicware Sectional Committee, CHD 09	Last Date for Comments: 29 April 2024

FOREWORD

(formal clauses to be added later)

This standard covers glazed or unglazed stoneware articles for general industrial as well as chemical uses. Such stoneware articles are relatively strong and it is possible to make these into almost any shape and in sizes up to 2 250 litres. Such articles are suitably salt or slip glazed to give a surface suitable for easy cleaning.

This standard does not cover such stoneware items as tiles, drain pipes, ducts, gulleys, cesspool linings, pipes, bricks, etc.

Corrosion resistance to practically all chemicals and gases, except hydrofluoric acid, and its derivatives, and hot caustic alkalis have led to widespread use of stoneware storing vessels for acids and other chemicals. But stoneware reaction vessels, agitators, condensers, crystallizers, evaporators, digesters are also used. White glazed stoneware is used widely in food preservative industry because it shows up easily any dirt or impurities and its smooth glaze prevents absorption of traces of food material in pores which may decompose and taint later batches. No foreign taste is imparted to the contents stored in a stoneware vessel.

This standard is essentially based on the results of thorough investigation carried out by the Central Glass and Ceramic Research Institute, Calcutta, on the samples of industrial stoneware articles currently being produced in the country. However, in the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries. This has been met by deriving assistance from B.S. 784:1953 'Methods of test for chemical stoneware' issued by the British Standards Institution.

The specific properties of industrial stoneware may form part of a contract between the manufacturer and the purchaser for which complete details of the working conditions, under which the stoneware article is to be used, may have to be specified by the purchaser and in that case this specification may be applicable only in so far as the particular requirements as have been specified.

This standard was first published in 1964. In this revision the committee felt a need to revise the standard with a view to update the standard based on the experience of last six decades and on the currently available data.

This standard contains clauses which call for agreement between the purchaser and the supplier and which permit the purchaser to ask for values for those requirements. The relevant clauses are **4.9** and **6.1**.

This standard is one of a series of Indian Standards on stoneware articles. Other standard so far published in the series is IS: 2838 - 1964 'Stoneware containers for general purpose'.

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 these specified value in this standard.

1 SCOPE

This standard lays down the requirements and the methods of sampling and test for industrial and chemical stoneware articles.

2 REFERENCES

The standards listed 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 revisions, and parties to agreements based on this Indian Standard are encouraged to investigate the possibility of applying the most recent editions of these standards indicated below;

<i>IS No.</i>	<i>Title</i>
IS 264 : 2005	Nitric acid - Specification (<i>third revision</i>)
IS 266 : 1993	Sulphuric acid - Specification (<i>third revision</i>)
IS 2781 : 2020	Glossary of Terms Relating to Ceramicware (<i>third revision</i>)
IS 460 (Part 1) : 2020	Test Sieves — Specification Part 1 Wire Cloth Test Sieves (<i>fourth revision</i>)

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 2781 shall apply.

4 REQUIREMENTS

4.1 Description — Industrial stoneware shall be fired ceramicware with or without glaze having a visually opaque and an off-white or coloured body.

4.2 Material and Workmanship — The articles shall be of good workmanship and of satisfactory appearance and finish.

4.3 Glazing — All visible surfaces in case of glazed articles, shall be evenly glazed except the stopcocks or threaded neck portions where glaze is not required and the surfaces or points on which the articles are supported in kiln during firing; but in all such cases the unglazed surfaces shall be well finished. The glazed surface shall be free from glazing defects.

4.4 Craze Resistance — The glaze shall be free from craze or other glaze defects, when tested in accordance with the method prescribed in **Annex A**.

4.5 Water Absorption — The water absorption of the material when tested in accordance with the method prescribed in **Annex B** shall be not more than 3 percent unless otherwise agreed to between the purchaser and the supplier.

4.6 Modulus of Rupture — The average modulus of rupture shall be not less than 350 kg/cm² when tested in accordance with the method prescribed in **Annex C**.

4.7 Resistance of Body to Acids — The resistance to acid shall be not less than 99.5 when tested in accordance with the method prescribed in **Annex D**.

4.8 Resistance of Glaze to Acids — The loss in weight shall be not more than 10 mg/dm² when tested in accordance with the method prescribed in **Annex E**.

4.9 Resistance to Thermal Disruption and Abrasion — Subject to agreement between the purchaser and the supplier, the industrial stoneware articles may be tested for their resistance to thermal disruption and to abrasion in accordance with **Annex F** and **Annex G** respectively. If such tests are required by the user, the manufacturer shall declare the values obtained for the material supplied.

5 MARKING

5.1 Each article shall be permanently and legibly marked on its lower surface with the maker's name or his trade-mark, if any. The marking shall generally be under glaze in case of glazed articles and shall be embossed in the case of unglazed articles.

5.2 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.

6 PACKING

6.1 The packing of the stoneware shall be as agreed to between the purchaser and the supplier.

7 SAMPLING

7.1 Representative samples of the material shall be drawn and their criteria for conformity shall be determined as prescribed in **Annex H**.

ANNEX A

(Clause 4.4)

TEST FOR CRAZE RESISTANCE

A-1 PRINCIPLE

The articles are subjected to an autoclave test of alternate heating and cooling for three cycles.

A-2 TEST PIECES

A-2.1 Break six test pieces each having a surface area of about 50 cm² from widely separated parts of three articles. The two major surfaces shall be glazed surfaces and any other surface unglazed and freshly broken. Care should be taken not to produce cracks in the body or in the glaze; any such pieces should be discarded. Alternatively, test pieces may be separately made using the same body and glaze materials as used in the making of the wares of the batch and put through the kiln along with the wares.

A-3 PROCEDURE

A-3.1 Place the test pieces in suitable pressure vessel and subject to constant pressure of 5 ± 0.2 kg/cm² in saturated steam for one hour after which time release the pressure by the opening of blow valve. Allow the test pieces to cool to room temperature in the autoclave. Examine them for cracking or crazing by applying a dye solution to the surface. Subject the test pieces to three cycles of the above test and observe them for crazing or cracking.

A-3.1.1 None of the test pieces shall show cracking or crazing.

ANNEX B

(Clause 4.5)

TEST FOR POROSITY

B-1 PRINCIPLE

Porosity of the material is determined by the amount of water absorbed.

B-2 TEST PIECES

Break six test pieces each having a surface area of about 50 cm² from widely separated parts of three articles. The two major surfaces shall be glazed surfaces and any other surface unglazed and freshly broken. Care should be taken not to produce cracks in the body or in the glaze; any such pieces should be discarded. Alternatively, test pieces may be separately made using the same body and glaze materials as used in the making of the wares of the batch and put through the kiln along with the wares

B-3 PROCEDURE

Dry the test pieces to a constant weight at a temperature between 110°C and 115°C and then cool to room temperature in a desiccator. Weigh the pieces to an accuracy of not less than 0.01 g and place in a vessel from which the air can be removed maintaining the pressure at less than 3 cm of mercury for one hour. Add cold freshly-boiled distilled water to the vessel without reducing the vacuum until the pieces are covered. Then admit air to the vessel and remove and boil the pieces in distilled water for not less than 20 minutes. Wipe the pieces with a damp smooth cloth in such a manner as to remove the surface water only and then weigh quickly.

B-4 CALCULATION

B-4.1 Water absorption of the test piece shall be calculated as follows

$$\text{Percentage, water absorption} = \frac{W_2 \times W_1}{W_1} \times 100$$

Where

W_1 = weight of the dry test piece, and

W_2 = weight of test piece after treatment.

B-4.1.1 All the six test pieces shall show a water absorption not more than 3 percent.

ANNEX C

(Clause 4.6)

DETERMINATION OF MODULUS OF RUPTURE

C-1 PREPARATION OF TEST SAMPLE

Break or cut test pieces from the ware and ground to 100 × 25 mm having the same thickness as that of the ware. In case it is not possible to break or cut suitable test pieces they shall be separately prepared using the same body and glaze materials as used in the making of the stone wares of the batch and put through the kiln along with the wares.

C-2 PROCEDURE

Determine the modulus of rupture by using 10 such test pieces (*see* C-1.1) mounted on supports 76 mm apart, loading rapidly (approximately 5 kg/sec) at the midpoint.

C-3 CALCULATION

C-3.1 The modulus of rupture shall be calculated from the following:

$$S = \frac{1.5 PL}{bd^2}$$

Where

S = modulus of rupture,

P = total load in kg.

L = span of bar in mm,

b = width of the test bar to the nearest 0.1 mm, and

d = depth of the test bar to the nearest 0.1 mm.

C-4 REPORTING OF TEST RESULTS

C-4.1 Calculate the average (\bar{X}) of the test results. Treat as suspect those observations which are either less than ($0.8\bar{X}$) or more than ($1.2\bar{X}$).

C-4.2 Finally report the average of the test results after rejecting the suspect value, if any.

ANNEX D

(Clause 4.7)

DETERMINATION OF RESISTANCE OF BODY TO ACIDS

D-1 PRINCIPLE

The material is ground and digested in concentrated acid and the loss in the weight is calculated.

D-2 REAGENTS

D-2.1 Concentrated Nitric Acid — conforming to IS 264.

D-1.2 Concentrated Sulphuric Acid — conforming to IS 266.

D-3 PREPARATION OF THE TEST SAMPLE

D-3.1 Take the test sample from the body of the ware; it shall be free from glaze. Crush the sample in a stoneware mortar. Use the fraction which passes 850-micron IS Sieve and is retained by 600-micron IS Sieve [see IS 460 (Part 1)] for testing. The portion so collected shall be not less than 30 g and shall be washed free from dust as follows:

Place the material in a porcelain basin and add about 150 ml of distilled water for each 30 g of sample. Place the basin on a sand bath and heat until the water is at boiling point. Continue heating for one hour taking care to avoid loss by spurting. Decant the water immediately and rinse the particles for times with cold distilled water. Dry the material remaining at 110°C, to constant weight (about 4 hours will be normally sufficient).

D-4 PROCEDURE

D-4.1 Weigh 25 g of the prepared sample accurately within ± 1 mg and place in a 11-cm diameter porcelain basin. Then add a mixture of 7 ml of nitric acid, 13 ml of sulphuric acid and 65 ml of distilled water. Place the basin and its contents on a sand-bath and heat carefully, avoiding spurting, till all nitric acid has evaporated and sulphuric acid starts fuming profusely. Cool the basin and contents. Add 90 ml of distilled water and 10 ml of nitric acid (sp gr 1.42). Repeat the heating process, until the sulphuric acid again fumes strongly. Cool the basin and contents and decant the acid carefully. Then add about 150 ml of cold distilled water and heat up to boiling point and decant. The cycle of addition of fresh water, boiling and decantation shall continue until the decanted liquor is found to be free from sulphuric acid when tested with barium chloride solution. No particle shall be lost in the process. After the final decantation, dry the sample at 110°C to constant weight.

D-4 CALCULATION

$$\text{Resistance to acid} = \frac{\text{Final weight in grams}}{\text{Initial weight in grams}} \times 100$$

ANNEX E

(Clause 4.8)

DETERMINATION OF RESISTANCE OF GLAZE TO ACID

E-1 PRINCIPLE

The resistance of the glaze to acid is determined by reacting it with hydrochloric acid.

E-2 PREPARATION OF TEST SAMPLES

Test sample having a capacity of 250 ml shall be separately prepared using the same body and glaze materials as used in the making of the stoneware of the batch and put through the kiln along with wares.

E-3 PROCEDURE

E-3.1 Wash the vessel in cold dilute hydrochloric acid followed by distilled water, dry to constant weight at 120°C and when cold, tare against a similar vessel. Fill the vessel to three quarters of its total capacity with 5 percent hydrochloric acid solution, cover with a clock-glass and heat on steam for four hours. Wash with distilled water and dry to constant weight at 120°C taring against the same vessel as before. Calculate the loss in weight.

E-3.1.1 There shall not be any noticeable pitting of the glaze.

E-4 REPORTING OF RESULT

E-4.1 Report the loss in weight of the article as mg/dm².

ANNEX F

(Clause 4.9)

DETERMINATION OF RESISTANCE TO THERMAL DISRUPTION

F-1 PRINCIPLE

The material is heated in a certain ascending order for one hour and then quenched in water. After each quenching the modulus of rupture is measured.

F-2 PROCEDURE

F-2.1 Take 80 pieces of unglazed round bars each 100 mm long having a diameter of 16 mm ± 1 mm, of the same body composition and fired under the similar conditions as the batch of stoneware articles. Starting from room temperature, heat the test bars consecutively at temperatures 50°, 100°, 150°, 200° and 230°C ± 5°C in a suitable tubular furnace for one hour and quench in water kept in a bucket below. After each quenching for a duration of 15 minutes take out 10 bars, wipe dry and test for modulus of rupture (*see C-2.1*) and subject the balance test bars to heating again at next higher temperature and determine the modulus of rupture. Repeat the process till the last batch of test bars is heated at 25° ± 5°C.

F-2.2 The loss in the transverse strength of each batch shall be expressed as percentage of the values obtained for unquenched test pieces.

ANNEX G

(Clause 4.9)

DETERMINATION OF RESISTANCE TO ABRASION

G-1 PRINCIPLE

The stonewares are rubbed with an abrasive material and the loss in weight after the time period is determined.

G-2 TEST PIECES

Test pieces shall be specially made unglazed straight tile pieces of dimension 150 × 100 × 25 mm.

G-3 APPARATUS

The apparatus consists of a frame into which the sample can be fitted. Means are provided to give a reciprocating motion to the frame by means of suitable gearing driven by an electric motor of not less than 0.18 kw (or ¼ hp). The frequency of oscillation shall be 30 minutes and the amplitude 37 mm. Held in a separate frame but resting on the test piece is a cast iron pan having a slot in the bottom. The weight of the pan shall be 4.5 kg ± 0.5 kg.

G-4 PROCEDURE

G-4.1 Weigh the sample accurately to within 0.01 g and secure firmly in the frame. Place the cast iron pan on the sample and fill with silicon carbide powder (passing 850-micron IS Sieve and retained on 500-micron IS Sieve). The weight of silicon carbide in the pan shall be kept between 0.70 kg and 0.90 kg throughout the test (that is approximately half-full). Set the sample frame in motion and record the time. After one hour stop the machine, and remove the sample and weigh to the nearest 0.01 g. Repeat the procedure for eight one-hourly periods.

G-4.2 Make a separate determination of bulk density. The abrasion loss during the first hour shall be disregarded because the original surface of the test piece is unlikely to be plane, with the result that losses during this period do not relate to the whole surface, the subsequent weight lost in grams shall be divided by the bulk density and the abrasion loss expressed in terms of milliliters per hour.

ANNEX H

(Clause 7.1)

SAMPLING AND CRITERIA FOR CONFORMITY

H-1 SCALE OF SAMPLING

H-1.1 Lot — All the stoneware articles of the same type, produced under essentially similar conditions of manufacture and offered for inspection at the same time, shall be grouped together to constitute a lot.

H-1.2 The conformity of the lot to the requirements of this specification shall be ascertained separately for each individual lot. For this purpose samples shall be taken in accordance with col 1 and 2 of Table 1.

TABLE 1 NUMBER OF SAMPLES AND TEST

(Clause H-1.2 H-2.1 and H-2.2)

NO. OF ARTICLES IN THE LOT	NO. OF ARTICLES IN THE SAMPL	PERMISSIBLE NO. OF DEFECTIVE ARTICLES	NO. OF COMPLETE SERIES OF TESTS FOR CLAUSES 4.4 to 4.9
<i>N</i>	<i>n</i>		
(1)	(2)	(3)	(4)
UP to 100	13	1	1
101 to 500	20	2	1
591 to 3 000	32	3	1
Over 3 000	50	5	2

H-1.3 The samples shall be selected at random from the lot. To ensure randomness of selection, use shall be made of random number tables. If such a table is not available, the following procedure shall be adopted.

Starting from any article in the lot count them as 1, 2 up to *r* and so on where *r* is the integral part of N/n (*N* being the number of articles in the lot and *n* being the number of articles in the sample). Every *r*th article thus counted shall be withdrawn to constitute the sample.

H-2 NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

H-2.1 Each of the articles in the sample as selected in H-1.3 shall be inspected for requirements **4.1** to **4.3**. An article failing to meet any one or more of these requirements shall be termed as a defective article. The number of defective

articles in the sample shall not exceed the number given in col 3 of Table 1, otherwise the lot shall be considered as not conforming to the requirements.

H-2.2 The number of tests for requirements **4.4** to **4.9** shall be as indicated in col 4 of Table 1. The lot shall be considered as conforming to the requirements of these clauses, if all the tests so conducted are found satisfactory. If one or more of the tests fail, the lot shall be declared as not conforming to the requirements of this specification.