
**Vitreous and porcelain enamels —
Determination of resistance to boiling water
and water vapour**

Émaux vitrifiés — Détermination de la résistance à l'eau bouillante et à sa vapeur



Foreword

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International Standard ISO 2744 was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings*, Subcommittee SC 6, *Vitreous and porcelain enamels*.

This third edition cancels and replaces the second edition (ISO 2744:1983), which has been technically revised.

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International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet central@iso.ch
X.400 c=ch; a=400net; p=iso; o=isocs; s=central

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Vitreous and porcelain enamels — Determination of resistance to boiling water and water vapour

1 Scope

This International Standard specifies a method of test for determining the resistance of flat surfaces of vitreous and porcelain enamels to pure boiling water and/or water vapour (see note 1).

This International Standard is also suitable for determining the resistance of vitreous and porcelain enamels to any other water for example to drinking water and river water.

The method is also applicable to determination of the resistance of enamels to the liquid and vapour phases of the corrosive medium.

NOTES

1 If temperatures below the boiling point of water are used this should be stated in the test report.

2 The resistance of vitreous and porcelain enamel to water generally depends on the pH value and of the substances in the water. In addition, the test results obtained in the liquid phase are influenced by the corrosion products of the vitreous and porcelain enamel and also of the borosilicate glass of the testing apparatus. Therefore, the test results obtained for different exposure times can differ (see also note in 8.1).

2 Normative references

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

ISO 2723 : 1995,	<i>Vitreous and porcelain enamels for sheet steel - Production of specimens for testing.</i>
ISO 2724 : 1973,	<i>Vitreous and porcelain enamels for cast iron - Production of specimens for testing.</i>
ISO 2733 : 1983,	<i>Vitreous and porcelain enamels - Apparatus for testing with acid and neutral liquids and their vapours.</i>
ISO 3585 : 1991,	<i>Borosilicate glass 3.3 - Properties.</i>
ISO 4788 : 1980,	<i>Laboratory glassware - Graduated measuring cylinders.</i>

3 Principle

A set of similarly enamelled test specimens are exposed to boiling distilled or demineralized water for 48 h (2 d) or 336 h (14 d), the test specimens being placed in the liquid zone and in the vapour zone of the test apparatus as required.

The loss in mass is determined from which the loss in mass rate per unit is calculated.

NOTE — The lower the loss in mass rate per unit area, the higher the resistance of the vitreous and porcelain enamel to boiling water or water vapour.

4 Reagents

During the determination, use only reagents of recognized analytical grade.

4.1 Distilled or demineralized water

A fresh supply of distilled or demineralized water is required for each test.

4.2 Acetic acid solution, concentration 5 % (V/V), for cleaning the test apparatus and test specimens.

4.3 Cleaning medium, for example ethanol (C_2H_5OH) or water containing a few drops of liquid detergent, for cleaning and degreasing the test specimen.

5 Apparatus

5.1 Test apparatus and packing B or C, both complying with ISO 2733.

5.2 Drying oven, capable of maintaining temperatures of at least 130 °C.

5.3 Desiccator, with an internal diameter of at least 200 mm.

5.4 Graduated measuring cylinder, capacity 500 ml, complying with ISO 4788.

5.5 Beakers.

5.6 Balance, accurate to 0,2 mg.

5.7 Sponge, soft.

6 Test specimens

6.1 Prepare at least four test specimens in accordance with the International Standards for the appropriate base metal. Specimens not enamelled on both sides shall be used only for the short test period (48 h).

The test specimens for testing vitreous and porcelain enamels for sheet steel and for cast iron shall be prepared in accordance with ISO 2723 and ISO 2724, respectively.

6.2 Rinse each test specimen with the water (4.1). If necessary, a suitable cleaning and degreasing medium (4.3) shall be used. Then dry the test specimen for 2 h in the drying oven (5.2) maintained at $(110 \pm 5) ^\circ\text{C}$. Allow the test specimen to stand for at least 2 h in the desiccator (5.3) and finally weigh it to the nearest 0,2 mg (starting mass).

7 Procedure

7.1 Carry out one determination for each test specimen.

7.2 Fix the test specimens in the test apparatus (5.1) so that the cover coat sides of the test specimens are facing the interior of the cylinder.

Screw down the three wing-nuts evenly to ensure that the test apparatus is watertight.

7.3 Run 450 ml of the water (4.1) into the test apparatus through the socket for the reflux condenser, replace the latter and switch on the heater.

To ensure that the distilled or demineralized water (4.1) begins to simmer, a simmering aid as shown in figure 1, made of borosilicate glass 3.3, complying with ISO 3585, may be introduced into the cylinder of the test apparatus such that it is immersed into the distilled or demineralized water (4.1).

As soon as the solution is boiling vigorously, adjust its rate of boiling by means of the heat-control device so that the condensate discharges from the condenser at the rate of 30 drops per minute to 50 drops per minute.

7.4 The duration of boiling shall be 48 h (2 d). If the loss in mass of a test specimen after this time is less than 5 mg, repeat the test using new test specimens and a duration of boiling of 336 h (14 d).

If the test is confined exclusively or mainly to attack by one phase only (liquid or vapour) this determines the test time (2 d or 14 d, respectively).

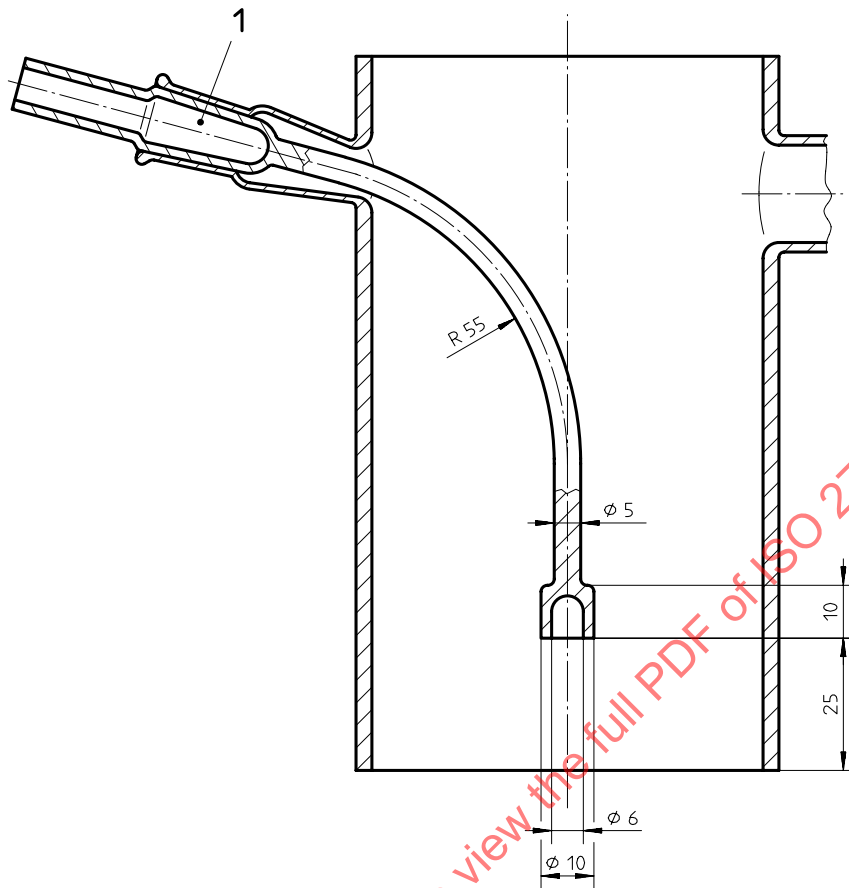
7.5 After boiling for 48 h (or 336 h) empty the cylinder, cool it and rinse it with the water (4.1).

Take the test specimens from the test apparatus and wipe them at least three times with the sponge (5.7), previously soaked in the acetic acid (4.2) at room temperature, then rinse the test specimens with water.

Carefully remove any packing residues from the edges of the specimens and dry them for 2 h in the drying oven (5.2) maintained at $(110 \pm 5) ^\circ\text{C}$. Allow the test specimens to cool for 2 h in the desiccator (5.3) and weigh them to the nearest 0,2 mg (final mass).

7.6 Disregard test specimens which show defects such as pinholes down to the metal, chipped edges or edge corrosion and test a corresponding number of new specimens.

Dimensions in millimetres



1 Ground glass orifice

Figure 1 — Cylinder of test apparatus with a simmering aid

8 Expression of results

8.1 The rate of loss in mass per unit area, v_{48} , for a test time of 48 h (2 d), expressed in grams per square metre per hour, or the loss in mass per unit area, $\Delta\rho_{A48}$, for a test time of 48 h, expressed in grams per square metre, is given by the equations (1) and (2), respectively:

$$v_{48} = \frac{\Delta m \times 10^4}{50 \times 48} = 4,167 \Delta m \quad \dots (1)$$

$$\Delta\rho_{A48} = \frac{\Delta m \times 10^4}{50} = 200 \Delta m \quad \dots (2)$$

where

Δm is the loss in mass of the test specimen (starting mass minus final mass), in grams;

50 is the exposed area of the test specimen, in square centimetres;

48 is the exposure time of the test specimen to the water or the water vapour, in hours.

Similarly, for a duration of boiling of 336 h (14 d), the rate of loss in mass per unit area, V_{336} , expressed in grams per square metre per hour, is given by the equation

$$V_{336} = 0,595 \Delta m \quad \dots (3)$$

NOTE — When vitreous and porcelain enamel is exposed to contact with water, the loss in mass is often proportional to the square root of the exposure time. Therefore, the loss in mass rates per unit area V_{48} and V_{336} can differ.

8.2 The results obtained for the test specimens placed in the liquid zone and in the vapour zone of the test apparatus are calculated separately. Since the determination consists of two parallel tests, two values are obtained for the liquid phase and two values for the vapour phase; these values shall be separately averaged.

The difference between the individual values of the loss in mass rate per unit area (V_{48} or V_{336}) shall not exceed 30 % of the arithmetic mean. Otherwise, a further test shall be carried out. The four values shall be used to calculate a new arithmetic mean.

9 Test report

The test report shall include the following information:

- a) reference to this International Standard, i. e. "determined in accordance with ISO 2744 : 1998";
- b) identification of the enamel tested;
- c) the test temperature if it is below the boiling point of water, in degrees Celsius;
- d) the duration of test, in days;
- e) the rate of loss in mass per unit area, V_{48} or V_{336} , expressed in grams per square metre per hour, rounded to the nearest $1 \times 10^{-3} \text{ g} \cdot \text{m}^{-2} \cdot \text{h}^{-1}$, or the loss in mass per unit area in grams per square metre, rounded to the nearest $1 \times 10^{-2} \text{ g} \cdot \text{m}^{-2}$, separated according to liquid and vapour phases, giving the arithmetic means and the number of individual values;
- f) the kind of water.

Annex A
(informative)

Bibliography

- [1] LORENTZ, R., Korrosion von Chemieemail durch wäßrig-neutrale Medien [Corrosion of chemical service glass-enamel in neutral aqueous media]. Werkstoffe und Korrosion, 1986 (vol. 37), pp. 613-621.

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