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Vitreous and porcelain enamels — Enamelled cooking utensils — Determination of resistance to thermal shock

Émaux vitrifiés — Ustensiles de cuisson émaillés — Détermination de la résistance aux chocs thermiques

Reference number
ISO 2747:1998(E)

Foreword

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International Standard ISO 2747 was prepared by Technical Committee ISO/TC 107, *Metallic and other inorganic coatings,* Subcommittee SC 6, *Vitreous and porcelain enamels*.

This second edition cancels and replaces the first edition (ISO 2747:1973), which has been technically revised.

Annex A of this International Standard is for information only.

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Vitreous and porcelain enamels — Enamelled cooking utensils — Determination of resistance to thermal shock

1 Scope

This International Standard specifies a method of determining, by successive thermal shock tests, the behaviour of vitreous and porcelain enamelled cooking utensils and similar articles under sudden changes of temperature (resistance to thermal shock).

2 Definitions

For the purposes of this International Standard, the following definitions apply.

2.1 thermal shock test: Series of operations commencing with the pouring of cold water into the heated test specimen and ending when the thermal shock temperature for the subsequent thermal shock test has been reached.

2.2 thermal shock temperature: Temperature to which the test specimen is heated before being chilled with cold water.

2.3 thermal shock resistance: Difference between the thermal shock temperature and the water temperature at which the test specimen shows the first damage on chilling or during subsequent heating.

2.4 damage: Chipping or tension cracks in the enamel visible at a distance of 250 mm by normal sight or made visible by using coloured penetrating fluids.

3 Principle

A series of single thermal shock tests is conducted with a temperature increase of 20 °C between each thermal shock obtained by heating the test specimen from the outside and then chilling it inside with water at 20 °C.

For the first test, the thermal shock temperature amounts to 200 °C. The test ends when the first visible damage occurs.

4 Apparatus

4.1 Electric hot-plate, capable of being continously temperature controlled, and of diameter and maximum output as given in table 1.

Table 1 - Hot-plates to be used to heat specimens

Internal diameter of specimen	Hot-plate	
	Diameter	Maximum output
mm	mm	W
Up to 180	145	1 000 ± 100
Over 180 and up to 220	180	1 500 ± 150
Over 220	220	2 000 ± 200

For testing specimens with an uneven base, the hot-plate shall be surmounted by a ring filled with copper grit of grain size 0,100 mm to 0,125 mm.

4.2 Temperature measuring device, quickly indicating, accurate to 2 °C.

4.3 Thermometer for measuring the temperature of the water.

4.4 Chamois leather, paper towel or **laboratory tissue.**

4.5 Water receptacle.

4.6 Stop-watch.

5 Test specimens and sampling

5.1 Use the utensils to be tested as test specimens without any modification.

5.2 The test specimens shall be representative of the entire consignment. The sampling plan shall be agreed upon between the interested parties.

5.3 At least three test specimens shall be tested.

6 Procedure

6.1 General specifications

NOTE — Annex A outlines the reasons underlying the selection of the test conditions specified in this International Standard.

For each thermal shock test, fill the test specimens with water at a temperature of 20 °C ± 1 °C, to a depth of 30 mm if possible. If it is not possible to fill the specimens to a depth of 30 mm, report the actual depth in the test report. Ensure that more water is available at 20 °C ± 1 °C (see 6.2.1).

Heat the test specimens using the preheated electric hot-plate (4.1), operated at its maximum output. Ensure that the maximum output is such that the test temperature is achieved no earlier than 5 min after commencement of heating.

Measure the temperature inside at the base of the test specimen at a distance of a quarter of the internal diameter from the side of the test specimen.

6.2 First thermal shock test

6.2.1 When a temperature of 200 °C ± 5 °C (the thermal shock temperature) is reached, fill the test specimen to a depth of 30 mm with the water at 20 °C ± 1 °C in one pouring. After 5 s ± 1 s remove the test specimen from the hot-plate, fill it completely with water at a temperature of 20 °C ± 1 °C and cool rapidly by placing it in water also at a temperature of 20 °C ± 1 °C. When the test specimen reaches room temperature (23 °C ± 1 °C) pour out the water, dry the test specimen with the chamois leather, the paper towel or the laboratory tissue (4.4) and examine it for damage (2.4).

6.2.2 If there is no damage, heat the test specimen to 220 °C ± 5 °C (the thermal shock temperature of the second thermal shock test).

If damage occurs during heating, the test is finished. In this case, take the temperature of 200 °C as the thermal shock temperature. For testing further test specimens, choose a temperature lower than 200 °C for the first test and state this in the test report.

6.3 Second and further tests

6.3.1 If the test specimen comes through the first test undamaged, repeat the test at a temperature of 220 °C ± 5 °C. Carry out the second test as described in 6.2.1. The temperature shall be now 240 °C ± 5 °C when heating up according to 6.2.2. If any damage occurs, the test is finished and the thermal shock temperature is then taken as being 220 °C.

6.3.2 If no damage occurs, carry out further tests as described with a temperature increase of 20 °C between successive tests until damage occurs.

7 Expression of results

7.1 Average thermal shock temperature

Calculate the arithmetic average thermal shock temperature from the thermal shock temperatures of the individual test specimens at which the first damage is observed.

If one of the individual values of three tests differs by more than 50 °C from the average thermal shock temperature, conduct two further tests. Then calculate the arithmetic average of the five values.

7.2 Average thermal shock resistance

Calculate the average thermal shock resistance by subtracting the water temperature (20 °C) from the average thermal shock temperature calculated in accordance with 7.1.

8 Test report

The test report shall include the following information:

a) reference to this International Standard, i. e. "determined in accordance with ISO 2747 : 1998";

b) a description of the test specimen (shape, internal diameter, thickness of enamel, volume, mass, labelling);

c) the sampling plan used;

d) the number of test specimens tested;

e) the diameter and maximum output of the hot-plate and whether a surmounting ring was used;

f) the thermal shock temperature at which the enamel first showed damage (individual and average values);

g) the average thermal shock resistance;

h) the type of damage to the enamel and, if necessary, a photograph of the damage;

i) the depth of water used for thermal shock if it was not possible to fill the test specimen to a depth of 30 mm.

Annex A
(informative)

Reasons for the test conditions specified

A finished glass coating is generally under a desired compressive stress. The stress is more or less altered under conditions of use; for example, cooking utensils are heated and cooled in such a way that the enamel can be subjected to tensile stress to which it is sensitive. The danger of this happening to a given enamelled article increases with the differences in temperature to which it is subjected during thermal shock. It is for this reason that the test for thermal shock resistance is carried out at increasing thermal shock temperatures. The tendency, however, for the occurrence of tensile stress does not depend solely on thermal shock but also on a number of other factors, especially the coefficient of expansion of the enamel and of the metal, the thickness of the enamel coating, the modulus of elasticity and the thermal conductivity.

The thermal shock test (2.1) was chosen because cracks in the enamel often are so fine that they are not visible. They can be recognized, however, during the subsequent heating because water which has remained in the cracks evaporates quickly (see 6.2.1) and causes the adjacent enamel to chip. The thermal shock temperature just before the damage incurred is therefore critical to the evaluation.

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