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

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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

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No Member Body expressed disapproval of the document.

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

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies a method for 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 purpose of this International Standard the following definitions apply :

2.1 thermal shock test : The 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.

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

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

2.4 damage : Any chipping or tension cracks in the enamel visible at a distance of 25 cm by normal sight.

NOTE — If an effect of thermal shock exceeding the first damage visible by normal sight is taken as the end of the test, it shall be the subject of agreement in each single case and included in the test report.

3 PRINCIPLE

The test for thermal shock resistance consists of a series of single thermal shock tests with a temperature increase of 20 °C between each thermal shock. The specimen is heated from the outside and then chilled inside with water at 20 °C.

The thermal shock temperature applied for the first test is 200 °C. The test ends when the first visible damage occurs.

4 APPARATUS

4.1 Electric hot-plate with diameter and maximum output in accordance with the following table :

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

For testing specimens with an uneven base, the hot-plate must be surmounted by a ring filled with copper grit of grain size 0,1 to 0,125 mm.

4.2 Temperature measuring device, accurate to ± 2 °C.

4.3 Thermometer for measuring the temperature of the water.

4.4 Chamois leather.

4.5 Water receptacle.

4.6 Stop-watch.

5 SAMPLING AND SPECIMENS

5.1 The utensils to be tested serve as specimens without any modification.

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

5.3 At least three specimens shall be tested.

6 PROCEDURE

Provide sufficient water at a temperature of 20 ± 1 °C for each thermal shock test so that the specimen can be filled to a depth of 30 mm, if possible. More water at this temperature should be available (see 6.1.1).

Heat the specimen by means of the preheated electric hot-plate, operated at its maximum output. The temperature shall be measured inside at the base of the specimen at a distance of a quarter of the internal diameter from the side of the utensil.

6.1 First thermal shock test

6.1.1 When the temperature of 200 ± 3 °C (thermal shock temperature) has been reached, fill the specimen to a depth of 30 mm with the provided water in one pouring. After 5 ± 1 s remove the specimen from the hot-plate, fill it completely with water at a temperature of 20 ± 1 °C and for rapid cooling place it in water also at a temperature of 20 ± 1 °C. When the specimen reaches room temperature (18 to 28 °C) pour out the water, dry the specimen with a chamois leather and examine it for damage (see 2.4).

6.1.2 If there is no damage, heat the specimen to 220 ± 3 °C (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 specimens, choose a temperature lower than 200 °C for the first test and state this in the test report.

6.2 Second and further tests

6.2.1 If the specimen comes through the first test undamaged, repeat the test at a temperature of 220 ± 3 °C. Carry out the second test as described in 6.1.1. The temperature shall be now 240 ± 3 °C when heating up according to 6.1.2. If any damage occurs, the test is finished and the thermal shock temperature is then taken as 220 °C.

6.2.2 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 from the thermal shock temperatures of the individual 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, two further tests shall be run. The arithmetic average is then taken from the five values.

7.2 Average thermal shock resistance

From the average thermal shock temperature calculated according to 7.1, subtract the water temperature of 20 °C.

8 TEST REPORT

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The test report shall include the following particulars :

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

b) the method of sampling;

c) the number of specimens tested;

d) the diameter and maximum output of hot-plate and use, if any, of a surmounting ring;

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

f) the average thermal shock resistance;

g) the kind of damage to the enamel and a photograph, if necessary;

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

ANNEX

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 may be subjected to tensile stress to which it is sensitive. This danger to a given enamelled article increases with the differences in temperature during thermal shock. It is for this reason that the test for thermal shock resistance is carried out with 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 and the modulus of elasticity.

In special cases the first thermal shock temperature may be taken below 200 °C or the test may be broken off after the first thermal shock test. This alteration in the procedure shall be stated in the test report.

A thermal shock test as defined in 2.1 was chosen particularly because often cracks in the enamel 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 6.1.1) and causes the adjacent enamel to chip. Decisive for the evaluation is, therefore, the thermal shock temperature just before the damage.

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