International Standard 2781

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Rubber, vulcanized — Determination of density

Caoutchouc vulcanisé — Détermination de la masse volumique

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been set up has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

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.

International Standard ISO 2781 was developed by Technical Committee ISO/TC 45, *Rubber and rubber products*.

This second edition was submitted directly to the ISO Council, in accordance with clause 5.10.1 of part 1 of the Directives for the technical work of ISO. It cancels and replaces the first edition (i.e. ISO 2781-1975), which had been approved by the member bodies of the following countries :

Australia
Austria
Belgium
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Egypt, Arab Rep. of
France
Germany, F. R.
Hungary
India
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Mexico
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New Zealand
Poland
Portugal
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South Africa, Rep. of
Spain
Sri Lanka
Sweden
Switzerland
Thailand
United Kingdom
USA
USSR

No member body had expressed disapproval of the document.

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Rubber, vulcanized — Determination of density

1 Scope and field of application

This International Standard specifies two methods of test for the determination of density of solid vulcanized rubber.

Such determinations are of importance in the control of the quality of a rubber compound and in the calculation of the mass of rubber required to produce a given volume of vulcanizate.

This International Standard does not cover the determination of the relative density of rubber, which is the ratio of the mass of a given volume of the rubber to the mass of an equal volume of pure water at a given temperature.

In this International Standard the determination is made by observation of gravitational forces under different conditions but, for convenience, these forces are expressed in mass units.

2 Principle

Two methods, A and B, are given.

In method A the masses of the test piece in air and in water are determined using a balance equipped with a pan straddle. The mass when immersed in water is less than that in air by the mass of water displaced, the volume of water displaced being equal to that of the test piece.

Method B is intended to be used only when it is necessary to cut up the test piece into small pieces to eliminate air spaces, as in the case of narrow bore tubing and electric cable insulation. Measurements are made using a balance and a density bottle.

3 Definition

density : The mass of unit volume of the rubber at a stated temperature. It is expressed in megagrams per cubic metre (Mg/m^3).

4 Apparatus

4.1 Balance, accurate to 1 mg.

4.2 Balance pan straddle, of convenient size to support the beaker and permit determination of the mass of the test piece in water (for method A).

4.3 Beaker, 250 cm^3* capacity (or smaller if necessitated by the design of the balance) (for method A).

4.4 Density bottle (for method B).

5 Test piece

5.1 The test piece shall consist of a piece of the rubber with smooth surfaces, free from crevices and dust, and having a mass of at least 2,5 g. For method B the shape of the test piece shall be such as to permit cutting into suitable pieces (see 9.3).

5.2 Duplicate tests shall be made.

6 Time-interval between vulcanization and testing

Unless otherwise specified for technical reasons, the following requirements for time-intervals shall be observed.

6.1 For all test purposes, the minimum time between vulcanization and testing shall be 16 h.

6.2 For non-product tests, the maximum time between vulcanization and testing shall be 4 weeks and for evaluations intended to be comparable, the tests, as far as possible, shall be carried out after the same time-interval.

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* The term millilitre (ml) is commonly used as a special name for the cubic centimetre (cm^3), in accordance with a decision of the Twelfth Conférence Générale des Poids et Mesures. The term millilitre is acceptable, in general, for references in International Standards to capacities of volumetric glassware and to liquid volumes.

6.3 For product tests, whenever possible, the time between vulcanization and testing shall not exceed 3 months. In other cases, tests shall be made within 2 months of the date of receipt by the customer of the product.

7 Conditioning of test pieces

7.1 Samples and test pieces shall be protected from direct sunlight during the interval between vulcanization and testing.

7.2 Samples, after such preparation as is necessary, shall be conditioned at a standard laboratory temperature (that is, 23 ± 2 °C or 27 ± 2 °C) for at least 3 h before the test pieces are cut. These test pieces may be tested immediately but, if not, they shall be kept at the standard laboratory temperature until being tested. If the preparation involves buffing, the interval between buffing and testing shall not exceed 72 h.

8 Temperature of test

The test shall normally be carried out at a standard laboratory temperature (23 ± 2 °C or 27 ± 2 °C), the same temperature being used throughout one test or series of tests intended to be *comparable.*

9 Procedure

9.1 Preparation of sample

If fabric is attached to, or embedded in, the samples, it shall be removed before cutting the test pieces. The method of removal shall preferably avoid the use of a swelling liquid, but, if necessary, a suitable non-toxic liquid of low boiling point may be *used to wet the contacting surfaces. Care shall be taken to* avoid stretching the rubber during the separation from the fabric, and the liquid, if used, shall be allowed to evaporate completely from the rubber surfaces after separation. Cloth-marked surfaces shall be made smooth by buffing.

9.2 Method A

Suspend the test piece (clause 5) from the hook on the balance (4.1), using a suitable length of filament so that the bottom of the test piece is about 25 mm above the straddle (4.2). The filament shall be made from a material which is insoluble in water and which does not absorb a significant amount of water. It shall either be counterbalanced or be weighed and, if weighed, its mass shall be deducted from subsequent weighings of the test piece (see note 1).

Weigh the test piece to the nearest milligram in air. Repeat the weighing with the test piece (and sinker, if required, see note 2) immersed in freshly boiled and cooled distilled water at a standard laboratory temperature (23 ± 2 °C or 27 ± 2 °C) contained in the beaker (4.3), placed on the straddle. Remove air bubbles adhering to the test piece (see note 4) and determine the mass to the nearest milligram, watching the pointer for a few seconds to make sure that it does not drift gradually as a result of convection currents.

NOTES

1 Where the filament used has a mass less than 0,010 g, such as is the case with thin nylon filament, the correction to account for its mass is not necessary to ensure the stated accuracy of the final result. If a means of suspension other than a filament is used, the volume and mass of the suspension must be taken into account in making the final calculation.

2 When this procedure is used for rubber having a density less than 1 Mg/m^3, a sinker is necessary; a further weighing of the sinker alone in water is required. Alternatively, a liquid of different density to water may be used in place of the water, in which case the formulae given in 10.1 are modified by the multiplication of the expression by the density of the liquid expressed in megagrams per cubic metre.

3 The main sources of error are

a) air bubbles adhering to the surfaces of the test piece during weighings in water;

b) surface tension effects on the filament;

c) convection currents in the water in which the test piece is suspended, to minimize which the temperature of the water and of the air in the balance case should be the same.

4 In order to minimize the adherence of air bubbles to the test piece, it is permissible either to add a trace (say 1 part in 10 000) of surface active material such as a detergent to the distilled water or to dip the test piece momentarily into a suitable liquid, such as methyl alcohol or industrial methylated spirits, miscible with water and having a negligible swelling or leaching action on rubber. If the latter method is adopted, precautions should be taken to minimize the carry-over of alcohol.

9.3 Method B

Weigh the clean, dry density bottle and stopper (4.4) before and after the insertion of the test piece (clause 5) cut into suitable pieces. The exact size and shape of the pieces will depend on the thickness of the original test piece. They should be such that no two dimensions are greater than 4 mm and the third not greater than 6 mm. Within these limitations the pieces should be as large as possible. All cut edges shall be smooth. Fill the bottle, containing the rubber, completely with freshly boiled and cooled distilled water at a standard laboratory temperature (23 ± 2 °C or 27 ± 2 °C). Remove air bubbles adhering to the rubber or to the walls of the bottle (see note 4 above).

Insert the stopper, taking care that there is no air in the bottle or the capillary. Dry the outside of the bottle carefully. Weigh the bottle and contents. Empty the bottle completely and refill with freshly boiled and cooled distilled water. After removing the air bubbles, inserting the stopper and drying, weigh the bottle and water.

All the above weighings shall be made to the nearest milligram.

NOTE — The main source of error is air bubbles inside the bottle. It may be necessary to heat the bottle and contents to approximately 50 °C to dislodge bubbles, but in this case the bottle and contents must be cooled before weighing. Alternatively, the bottle may be placed in a vacuum desiccator and the vacuum applied and released several times until no more air is extracted.