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METHODS OF TEST FOR VULCANIZED RUBBERS

PART IX RELATIVE DENSITY AND DENSITY

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0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 8 December 1967, after the draft finalized by the Rubber Products Sectional Committee had been approved by the Chemical Division Council.

0.2 This standard is expected to furnish the rubber industry with standard procedure and terminology in the field of testing rubber products. In this standard, procedures to determine relative density of rubber, which is numerically equal to density, assuming the density of water to be 1·00 at room temperature, are described.

0.3 In the preparation of this standard assistance has been derived from B.S. 903 : Part A 1 : 1956 ' Methods of testing vulcanized rubber : Part A 1 Determination of density and specific gravity ', issued by the British Standards Institution.

0.4 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

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1. SCOPE

1.1 This standard prescribes the methods for determining relative density and density of solid vulcanized rubbers.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions shall apply.

2.1 Density — The mass divided by the volume of rubber at a stated temperature. The units shall be stated.

2.2 Relative Density — The ratio of the mass of a given volume of the rubber at a temperature t_1 to the mass of an equal volume of pure water at a temperature t_2.

*Rules for rounding off numerical values (*revised*).

3. OUTLINE OF THE METHODS

3.1 Relative density of rubber is determined by the density bottle method or by the hydrostatic method with or without the help of a sinker. The density of the material shall be taken to be numerically equal to its relative density. The results are expressed as density in g/ml.

NOTE — The density of water at 27°C is taken as 1·00 g/ml.

4. APPARATUS

4.1 Balance — weighing to 1 mg.

4.2 Balance Straddle — A pan straddle of convenient size to support the beaker and permit determination of the weight of the test piece in water.

4.3 Beaker — 250 ml capacity (or smaller if necessitated by the design of the balance).

4.4 Copper Wire — approximately 0·1 mm in diameter.

4.5 Sinker — for test pieces with relative density less than 1.

5. TEST METHODS

5.1 Preparation of the Test Piece — The test piece shall have a surface, free from crevices as far as possible, weighing at least 5 g. If fabric is attached to or embedded in the rubber product, it shall be removed, before cutting the test piece. The method of removal shall preferably avoid the use of a swelling liquid but benzene, chloroform, carbon tetrachloride may be used to wet the contacting surfaces if necessary. Care shall be taken to avoid stretchening the rubber during the separation from the fabric. The swelling liquid, if used, shall be allowed to evaporate completely from the rubber surfaces after separation. Surfaces shall be buffed, if necessary, to make them smooth and to remove any friction compound.

5.2 Conditioning of Test Piece — The test piece as prepared in **5.1** shall be conditioned at 27° ± 1°C for at least 12 hours. Samples and test pieces shall be protected from light as completely as possible during the interval after vulcanization and before testing.

5.3 Procedure

5.3.0 Two procedures are described in **5.3.1** and **5.3.2**, namely, density bottle method and hydrostatic method.

5.3.1 *Density Bottle Method* — Weigh the clean dry density bottle and stopper. Cut the test piece into suitable small pieces and insert into

the bottle. Weigh the bottle with the sample again. Fill the bottle containing rubber test pieces completely with freshly boiled and cooled distilled water (*see* IS : 1070-1960*) to a temperature of 27° ± 2°C (*see* IS : 196-1966†). Remove air bubbles adhering to the rubber test piece or to the wall of the bottle. Insert the stopper taking care that there shall be no air bubble either in bottle or in capillary. Dry the outside surface of the bottle carefully, and weigh the bottle and contents. Empty the bottle completely and refill with freshly boiled and cooled distilled water. After removal of air bubbles and insertion of stopper and drying, weigh the bottle and water. Weigh throughout to the nearest mg.

NOTE — Air bubbles are the main source of error. Heating the bottle with its contents helps in the removal of air bubbles. Then before weighing, the bottle shall be cooled to 27° ± 1°C. To minimize the adherence of bubbles to the pieces of rubber or the walls of the bottle, it is permissible either to dip the rubber test piece prior to cutting momentarily into a suitable solvent, such as ethyl alcohol or methyl alcohol, miscible with water and having a negligible swelling or leaching action on rubber, or to add trace of detergent to distilled water.

5.3.2 *Hydrostatic Method* — Suspend the test piece from the hook on one side of the balance using a suitable length of wire, so that the bottom of the test piece does not touch the bottom of the beaker. Counter-balance the wire previously by a length of wire on the other pan. Repeat the weighing with the test piece (and sinker when the specific gravity of the test piece is less than 1) completely immerse in the freshly boiled and cooled distilled water to a temperature of 27° ± 2°C, in a beaker. Allow sufficient time for the test piece to attain the temperature of the water. Remove the air bubbles as in **5.3.1** and determine the weight to the nearest mg.

NOTE 1 — If the relative density of the test piece is less than 1, a sinker is necessary. In that case the sinker alone shall also be weighed in water.

NOTE 2 — The main sources of error are: (a) air bubbles adhering to the outer surfaces of the test piece during weighings in water; (b) surface tension effects on the wire; and (c) convection currents in the water in which the test piece is suspended. To minimize these, the temperature of the water and of the air in the balance case should be the same. To minimize the adherence of bubbles to the pieces of rubber or the walls of the bottle, it is permissible either to dip the rubber test piece prior to cutting momentarily into a suitable solvent, such as ethyl alcohol or methyl alcohol, miscible with water and having a negligible swelling or leaching action on rubber, or to add trace of detergent to distilled water.

6. CALCULATION

6.0 Calculate the relative density as in **6.1** for the density bottle method (*see* **5.3.1**) or **6.2** for the hydrostatic method (*see* **5.3.2**).

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*Specification for water, distilled quality (*revised*).

†Atmospheric conditions for testing (*revised*).

6.1 Calculate the relative density of rubber (density bottle method) as follows:

$$\text{Relative density of rubber (27°/27°C)} = \frac{W_2 - W_1}{W_4 - W_3 + (W_2 - W_1)}$$

where

W_2 = weight in g of density bottle and test piece;
W_1 = weight in g of density bottle;
W_4 = weight in g of density bottle filled with water; and
W_3 = weight in g of density bottle, test piece and water.

6.2 Calculate the relative density of rubber (hydrostatic method) as follows:

a) Relative density of rubber (27°/27°C) (when sinker is used) $= \frac{W_1}{W_1 - W_2}$

where

W_1 = weight in g of test piece in air, and
W_2 = weight in g of test piece in water.

b) Relative density of rubber (27°/27°C) (when sinker is used) $= \frac{W_1}{W_1 + W_2 - W_3}$

where

W_1 = weight in g of test piece in air,
W_2 = weight in g of sinker in water, and
W_3 = weight in g of rubber and sinker in water.

7. REPORT

7.1 The report shall state the average of at least two relative density determinations, the method by which determined (*see* **5.3.1** and **5.3.2**) and the temperature at which the test was carried out. The density of rubber shall be taken to be numerically equivalent to its relative density, being expressed as g/ml.