2857

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Methods of testing vulcanized rubber

Part A18. Determination of equilibrium water vapour absorption

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Contents

Foreword

This Part of this British Standard has been published under the authority of the Rubber Industry Standards Committee. The principal changes in the present edition, as compared with the previous (1956) edition, are the adoption of metric units throughout and the more precise description of the constant-humidity vessel.

The results of short-period water absorption tests on massive test pieces, which give indications of the initial rate of absorption only, do not necessarily bear any relationship to those of equilibrium water vapour absorption tests. For such short-period tests on soft vulcanized rubber, the technique described in BS 903 : Part A16, 'Determination of resistance of vulcanized rubbers to liquid', may be used.

Equilibrium water vapour absorption is independent of the dimensions of the test piece and is conveniently determined on finely-divided material because attainment of equilibrium is otherwise too slow. Exposure to vapour of a given relative humidity gives substantially the same equilibrium absorption as immersion in an aqueous solution which would be in equilibrium with the given vapour, apart from effects due to extraction of water-soluble constituents in the latter case.

In the method of test here described the rubber, in finely-divided form, is dried and then exposed to air of known relative humidity, and the amount of moisture absorbed is determined by weighing. The high surface/volume ratio of the finely-divided rubber enables equilibrium absorption to be reached within the period of test, whilst the use of water vapour, instead of immersion in liquid water or aqueous solutions, obviates the difficulty of drying the surface of the rubber.

There is no ISO work corresponding to the method described in this Part of this British Standard.

British Standard

Methods of testing vulcanized rubber

Part A18. Determination of equilibrium water vapour absorption

Method

1. Scope

This part of this British Standard describes a procedure for the determination of the equilibrium water vapour absorption of vulcanized rubber including ebonite.

NOTE. The title of the British Standard referred to in this standard appears on the inside back cover.

2. Definition

For the purposes of this British Standard the following definition applies:

Equilibrium water vapour absorption. The maximum volume of water absorbed by rubber or ebonite when it is exposed to air at a given relative humidity and a given temperature. The volume of absorbed water is expressed as a percentage of the volume of the test material.

3. Test portion

The rubber shall be used in a finely-divided form such as will pass an 850 μm test sieve in the case of soft rubber, or a 250 μm test sieve in the case of ebonite. In each case the test sieve shall comply with the requirements of BS 410.

The method of obtaining such material shall be as follows:

(1) *Soft vulcanized rubber.* The sample shall be comminuted, e.g. by cutting up with scissors, by rasping on a rapidly rotating rasp, or by grinding in a suitable grinder. The type of grinder or mill used is immaterial provided the sample does not become contaminated or unduly heated. Any iron particles present in the comminuted material shall be removed by means of a magnet.

(2) *Ebonite.* The sample shall be rasped to a powder. Any iron particles present in the comminuted material shall be removed by means of a magnet.

4. Apparatus

The apparatus shall consist of:

(1) *Flat-bottomed wide-mouthed weighing bottle,* about 50 mm diameter and 25 mm deep, provided with a stopper.

(2) *Desiccator,* containing an efficient desiccant.

(3) *Constant-humidity vessel,* in which the relative humidity shall be controlled by a suitable means such as a salt mixed with sufficient water to keep it moist, the mixture being spread out in a shallow dish so as to expose as great a surface as possible to the air in the vessel. A suitable vessel is cylindrical, about 100 mm diameter and 150–200 mm high, with a dish of such size as to expose a solution surface area of about 5000 mm^2.

NOTE. The initial rapid absorption of water by the test material can markedly lower the relative humidity; this effect can be reduced by using two dishes of salt solution, one below and one above the test material (see MARTIN, S. 'The control of conditioning atmospheres by saturated salt solution'. *J. Sc. Instrum.* 39, 1962, p. 370).

(4) *Thermostat,* to control the temperature in the vessel described above at 25 ± 0.2 °C.

With relative humidities above about 90 %, temperature control becomes very critical, and it is especially important to avoid even small rapid fluctuations because these greatly alter the relative humidity of the air.

(5) *Balance,* weighing to 0.2 mg.

5. Procedure

Dry the open weighing bottle and stopper in the desiccator for 24 hours and then immediately stopper the weighing bottle and weigh it (mass = B).

Dry about one gram of the finely divided rubber, spread out on the bottom of the weighing bottle, in the desiccator for 24 hours. Remove the weighing bottle from the desiccator, immediately stopper it, and weigh (mass = M_1). Remove the stopper and transfer the bottle to the constant-humidity vessel for a period of 48 hours. At the end of this period remove the bottle, immediately stopper it and re-weigh (mass = M_2).

In all instances, the stoppered weighing bottle shall be allowed to stand in the balance case for 10 minutes prior to weighing.

Determine the mass of water absorbed by the open weighing bottle and stopper under the same conditions, by a separate blank test (mass = A).

6. Temperature of test

During exposure of the test portion, the temperature in the constant-humidity vessel shall be 25 ± 0.2 °C.

7. Expression of results

Calculate the equilibrium water vapour absorption by the formula:

$$V = \frac{D_1(M_2-M_1-A)}{D_2(M_1-B)} \times 100$$

where V is the equilibrium water vapour absorption

D_1 is the density of the sample at 25 °C (Mg/m^3)*

and D_2 is the density of water at 25 °C (Mg/m^3)*

NOTE. The density of water can be taken as 1 Mg/m^3*, within the limits of experimental error.

The test shall be carried out in duplicate and the results averaged.

8. Report

The report shall state:

(1) identification of the sample;

(2) the equilibrium water vapour absorption;

(3) the relative humidity used;

(4) the method used, i.e. BS 903 : Part A18.

*1 Mg/m^3 = 1 g/cm^3

2857