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Rubber, vulcanized or thermoplastic — Determination of permeability to gases

Caoutchouc vulcanisé ou thermoplastique — Détermination de la perméabilité aux gaz

Reference number
ISO 2782:1995(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established 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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 2782 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Physical and degradation tests*.

This second edition cancels and replaces the first edition (ISO 2782:1977), as well as ISO 1399:1982, which have been technically revised.

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Introduction

The measurement of the permeability of rubber to gases is important in the evaluation of compounds for products such as inner tubes, tubeless-tyre liners, hoses, balloons and other gas containers, seals and diaphragms. The measurement is also of theoretical importance in the study of the characteristics of gas diffusion and gas solubility in relation to polymer structure.

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Rubber, vulcanized or thermoplastic — Determination of permeability to gases

WARNING — Persons using this International Standard shall be familiar with normal laboratory practice. This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

1 Scope

This International Standard describes two procedures for measuring the permeability of rubber to gases under steady-state conditions. One uses a horizontal measuring device for measurements at constant pressure and the other uses a vertical measuring device for measurements at constant volume or constant pressure. The results obtained by these procedures may be extrapolated to thicknesses of material different from that of the test piece providing the rubber is homogeneous and isotropic.

The procedures apply to solid rubber of hardness not less than 35 IRHD and to gases such as air, nitrogen, oxygen, hydrogen, liquified petroleum gas (in gaseous form) and coal gas. Errors may be introduced if the gas used appreciably swells the rubber under test.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 471:1995, *Rubber — Temperatures, humidities and times for conditioning and testing.*

ISO 3383:1985, *Rubber — General directions for achieving elevated or subnormal temperatures for test purposes.*

3 Definition

For the purposes of this International Standard, the following definition applies.

3.1 permeability coefficient: The rate of volume flow of gas under steady-state conditions, referred to standard temperature and pressure, between opposite faces of a unit cube of solid rubber when subjected to a unit pressure difference and controlled temperature.

4 Principle

The cavity of a test cell, maintained at a constant temperature, is divided by a disc test piece into a high-pressure and a low-pressure side. The high-pressure side is connected to a constant-pressure gas reservoir or is of such a volume that, once filled, it stays at practically constant pressure. The gas permeates into the low-pressure side, which is of a very low volume and connected to a capillary tube which measures the volume change caused by permeation of the gas.

5 Apparatus

5.1 Test cell, having a means of clamping the test piece round its periphery in a gastight manner so as to expose one surface to gas under pressure. The other surface of the test piece shall be supported against the force due to the gas pressure so that no appreciable deformation takes place. For this reason, the low-pressure side of the test cell shall be filled with a rigid, highly permeable packing piece which may consist of a disc of microporous material such as microporous ebonite, discs of microporous sintered stainless steel or discs of fine wire gauze or filter paper which completely fill the cavity. A means of indicating gas pressure with an error of not more than 1 % shall be connected to the high-pressure side of the cell.

The internal volume of the test cell on the high-pressure side of the test piece shall be at least 25×10^{-6} m^3 (25 cm^3) to minimize the pressure loss due to diffusion during a test, which may last several hours.

The internal volume of the test cell on the low-pressure side of the test piece shall be kept to a minimum by the use of permeable packing as described above and by small-diameter passages through a dismountable coupling and tubing to a capillary tube (5.2). The total free volume between the test piece and the datum mark on the capillary tube shall not exceed 2×10^{-6} m^3 (2 cm^3).

Test cells shall be of metal construction with sufficient mass to ensure temperature stability, and shall be provided with a drilled pocket to hold a temperature-measuring device (5.3). It is essential that the assembled test cell is gastight.

5.2 Capillary tube, for the measurement of permeated-gas volumes, the tube being of known and uniform cross-section over the length used for volume measurements.

Suitable cross-sections are $0{,}7 \times 10^{-6}$ m^2 to $2{,}0 \times 10^{-6}$ m^2 (0,7 mm^2 to 2,0 mm^2). The cross-section shall be uniform to within an accuracy of 1 %.

The capillary tube may be either horizontally or vertically mounted. It shall be filled with a non-volatile liquid which does not dissolve the gas [suitable liquids are di-(2-ethylhexyl) sebacate or tritolyl phosphate, coloured with Sudan red]. If the capillary is mounted horizontally, a drop of liquid is used to indicate variations in volume. If the capillary tube is mounted vertically, a vertically adjustable reservoir of liquid is connected by a T-piece to the bottom of the capillary tube. The capillary tube shall be graduated or a graduated scale shall be fixed close to the long straight section. Alternatively, a microscope or cathetometer may be used to observe the position of the liquid. If the capillary tube is mounted vertically, a by-pass valve shall be fitted between the point at which the capillary tube leaves the cell and the datum mark on the scale, to allow gas to be released and the liquid in the capillary brought back to the datum mark after the conditioning period.

NOTE 1 When making measurements at constant volume, an alternative means of measuring pressure, for example a transducer, may be used, provided it is suitably calibrated and enables the procedure to be carried out in essentially the same manner.

Examples of suitable apparatus are shown in figures 1 and 2.

5.3 Temperature-measuring device, readable to within ± 0,2 °C.

5.4 Barometer.

5.5 Device for controlling the test temperature, consisting of a constant-temperature bath or other device capable of maintaining the test cell at the required test temperature to within the specified tolerance (see clause 8). If a bath is used and the capillary tube is mounted vertically, the walls of the bath shall be arranged so that the outlet from the test cell projects through the side, leaving the connection point for the capillary tube accessible. A number of test cells containing different test pieces may then be connected in turn to the same manometer.