



Standard Test Method for Determination of Oxygen Gas Transmission Rate, Permeability and Permeance at Controlled Relative Humidity Through Barrier Materials Using a Coulometric Detector¹

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1. Scope

1.1 This test method covers a procedure for determination of the rate of transmission of oxygen gas, at steady-state, at a given temperature and %RH level, through film, sheeting, laminates, co-extrusions, or plastic-coated papers or fabrics. This test method extends the common practice dealing with zero humidity or, at best, an assumed humidity. Humidity plays an important role in the oxygen gas transmission rate (O_2GTR) of many materials. This test method provides for the determination of oxygen gas transmission rate (O_2GTR), the permeance of the film to oxygen gas (PO_2), the permeation coefficient of the film to its thickness ($P'O_2$), and oxygen permeability coefficient ($P'O_2$) in the case of homogeneous materials at given temperature and %RH level(s).

1.2 The values stated in SI units are to be regarded as the standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Specific precautionary statements are given in Section 9.*

2. Referenced Documents

2.1 ASTM Standards:²

D1898 Practice for Sampling of Plastics (Withdrawn 1998)³

D3985 Test Method for Oxygen Gas Transmission Rate Through Plastic Film and Sheet Using a Coulometric Sensor

¹ This test method is under the jurisdiction of ASTM Committee F02 on Flexible Barrier Packaging and is the direct responsibility of Subcommittee F02.10 on Permeation.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

E104 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions

E691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

3. Terminology

3.1 Definitions:

3.1.1 *oxygen permeability coefficient* ($P'O_2$)—the product of the permeance and the thickness of the film. The permeability is meaningful only for homogeneous materials, in which case it is a property characteristic of the bulk material. This quantity should not be used unless the relationship between thickness and permeance has been verified on tests using several different thicknesses of the material. The SI unit of oxygen permeability is the $\text{mol}/(\text{m} \cdot \text{s} \cdot \text{Pa})$. The test conditions (see 3.1.4) must be stated.

3.1.2 *oxygen permeance* (PO_2)—the ratio of O_2GTR to the difference between the partial pressure of O_2 on the two sides of the film. The SI unit of permeance is the $\text{mol}/(\text{m}^2 \cdot \text{s} \cdot \text{Pa})$. The test conditions (see 3.1.4) must be stated.

3.1.3 *oxygen permeation coefficient* ($P'O_2$)—the ratio of O_2GTR to the thickness of the film. The SI unit of permeance is the $\text{mol}/(\text{m}^2 \cdot \text{s} \cdot \text{cm})$. The permeation coefficient is meaningful only for homogeneous materials, in which case it is a property characteristic of the bulk material. This quantity should not be used unless the relationship between thickness and transmission rate is known.

3.1.4 *oxygen transmission rate*—at a given temperature and %RH (O_2GTR), the quantity of oxygen gas passing through a unit area of the parallel surfaces of a plastic film per unit time under the conditions of test. The SI unit of transmission rate is the $\text{mol}/(\text{m}^2 \cdot \text{s})$. The test conditions, including temperature, %RH and oxygen partial pressure on both sides of the film must be stated.

3.1.5 *transmission rate* (O_2GTR)—a commonly used metric unit of O_2GTR is the cm^3 (STP)/($\text{m}^2 \cdot \text{d}$) at one atmosphere pressure differential where: 1 cm^3 at Standard Temperature and Pressure (STP = 273.15K; 1.013×10^5 Pa) is 44.62 μmol and one day is 86.4×10^3 s. O_2GTR in SI units is obtained by