



Standard Test Method for the Determination of Carbon Dioxide Gas Transmission Rate (CO₂TR) Through Barrier Materials Using An Infrared Detector¹

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1. Scope

1.1 This method covers a procedure for determination of the steady-state rate of transmission of carbon dioxide gas through plastics in the form of film, sheeting, laminates, coextrusions, or plastic-coated papers or fabrics. It provides for the determination of (1) carbon dioxide gas transmission rate (CO₂TR), (2) the permeance of the film to carbon dioxide gas (P'CO₂), and (3) carbon dioxide permeability coefficient (P''CO₂) in the case of homogeneous materials.

1.2 *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.*

2. Referenced Documents

2.1 ASTM Standards:²

D1898 Practice for Sampling of Plastics (Withdrawn 1998)³

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

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

3. Terminology

3.1 Definitions:

3.1.1 *carbon dioxide permeability coefficient* (P''CO₂)—the product of the permeance and the thickness of film. The permeability is meaningful only for homogeneous materials, in which case it is a property characteristic of the bulk material.

¹ This test method is under 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.

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 carbon dioxide permeability is the mol/m²·s·Pa. The test conditions (see 3.1.3) must be stated.

3.1.2 *carbon dioxide permeance* (P'CO₂)—the ratio of the CO₂ TR to the difference between the partial pressure of CO₂ on the two sides of the film. The SI unit of permeance is the mol/(m²·s·Pa). The test conditions (see 3.1.3) must be stated.

3.1.3 *carbon dioxide transmission rate* (CO₂TR)—The quantity of carbon dioxide gas passing through a unit area of the parallel surfaces of a plastic film per unit time under the conditions of the test. The SI unit of transmission rate is the mol/(m²·s). The test conditions, including temperature and carbon dioxide partial pressure on both sides of the film, must be stated.

3.1.3.1 *Discussion*—A commonly used metric unit of CO₂TR is the cc(STP)/(m²·day) at one atmosphere driving force pressure differential where: 1 cc(STP) is 44.62 μmol. 1 atm is 0.1013 MPa. and one day is 86.4 × 10³ s. CO₂ TR in SI units is obtained by multiplying the value in metric units by 5.164 × 10⁻¹⁰ or the value in inch-pound units cm³(STP) / (100 in.² · day) by 8.004 × 10⁻⁹.

4. Summary of Test Method

4.1 The carbon dioxide gas transmission rate is determined after the sample has equilibrated in a dry-test environment. In this context, a “dry” environment is considered to be one in which the relative humidity is less than 1 %.

4.2 The specimen is mounted as a sealed semi-barrier between two chambers at ambient atmospheric pressure. One chamber is slowly purged by a stream of nitrogen and the other chamber with carbon dioxide. As carbon dioxide gas permeates through the film into the nitrogen carrier gas, it is transported to an infrared detector where an electrical output is produced whose magnitude is proportional to the amount of CO₂ flowing into the detector per unit of time.

5. Significance and Use

5.1 Carbon dioxide gas transmission rate (CO₂ TR) is an important determinant of the packaging protection afforded by