Designation: F 1249 – 90 (Reapproved 1995)

Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor[1]

This standard is issued under the fixed designation F 1249; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a procedure for determining the rate of water vapor transmission through flexible barrier materials. The method is applicable to sheets and films up to 3 mm (0.1 in.) in thickness, consisting of single or multilayer synthetic or natural polymers and foils, including coated materials. It provides for the determination of (*1*) water vapor transmission rate (WVTR), (*2*) the permeance of the film to water vapor, and (*3*) for homogeneous materials, water vapor permeability coefficient.

NOTE 1—Values for water vapor permeance and water vapor permeability must be used with caution. The inverse relationship of WVTR to thickness and the direct relationship of WVTR to the partial pressure differential of water vapor may not always apply.

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:*

D 374 Test Methods for Thickness of Solid Electrical Insulation[2]

D 1898 Practice for Sampling of Plastics[3]

D 4204 Practice for Preparing Plastic Film Specimens for a Round-Robin Study[4]

E 96 Test Methods for Water Vapor Transmission of Materials[5]

E 104 Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions[6]

3. Terminology

3.1 *Definitions:*

3.1.1 *water vapor permeability coefficient*—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 bulk material.

3.1.1.1 *Discussion*—This quantity should not be used unless the relationship between thickness and permeance has been verified in tests using several thicknesses of the material. An accepted unit of permeability is the metric perm centimeter, or 1 g/m^2 per day per mm Hg·cm of thickness. The SI unit is the mol/m^2·s·Pa·mm. The test conditions (see 3.1) must be stated.

3.1.2 *water vapor permeance*—the ratio of a barrier's WVTR to the vapor pressure difference between the two surfaces.

3.1.2.1 *Discussion*—An accepted unit of permeance is the metric perm, or 1 g/m^2 per day per mm Hg. The SI unit is the mol/m^2·s·Pa. Since the permeance of a specimen is generally a function of relative humidity and temperature, the test conditions must be stated.

3.1.3 *water vapor transmission rate (WVTR)*—the time rate of water vapor flow normal to the surfaces, under steady-state conditions, per unit area.

3.1.3.1 *Discussion*—An accepted unit of WVTR is g/m^2 per day. The test conditions of relative humidity and temperature where the humidity is the difference in relative humidity across the specimens, must be stated.

4. Summary of Test Method

4.1 A dry chamber is separated from a wet chamber of known temperature and humidity by the barrier material to be tested. The dry chamber and the wet chamber make up a diffusion cell in which the test film is sealed. The diffusion cell is placed in a test station where the dry chamber and the top of the film are swept with dry air. Water vapor diffusing through

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[2] *Annual Book of ASTM Standards*, Vol 10.01.

[3] *Annual Book of ASTM Standards*, Vol 08.01.

[4] *Annual Book of ASTM Standards*, Vol 08.02.

[5] *Annual Book of ASTM Standards*, Vol 04.06.

[6] *Annual Book of ASTM Standards*, Vol 11.03.

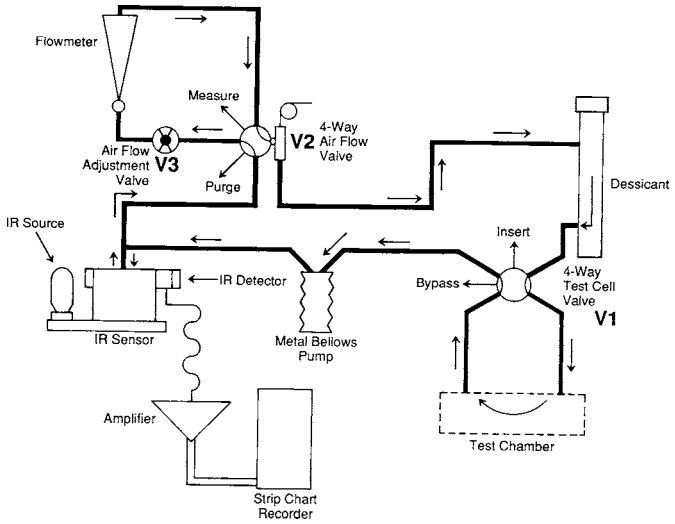

FIG. 1 Measuring System

the film mixes with the air and is carried into a pressure-modulated infrared sensor. This sensor measures the fraction of infrared energy absorbed by the water vapor and produces an electrical signal, the amplitude of which is proportional to water vapor concentration. The amplitude of the electrical signal produced by the test film is then compared to the signal produced by measurement of a calibration film of known transmission rate. This information is then used to calculate the rate at which moisture is transmitted through the material being tested.

5. Significance and Use

5.1 The purpose of this test method is to obtain reliable values for the WVTR of barrier materials.

5.2 WVTR is an important property of packaging materials and can be directly related to shelf life and packaged product stability.

5.3 Data from this test method is suitable as a referee method of testing, provided that the purchaser and seller have agreed on sampling procedures, standardization procedures, test conditions, and acceptance criteria.

6. Apparatus

6.1 This method utilizes water vapor transmission apparatus[7] (Fig. 1) comprised of the following:

6.1.1 *Diffusion Cell*, an assembly consisting of two metal halves which, when closed upon the test specimen, will accurately define a circular area. A typical acceptable diffusion cell area is 50 cm^2. The volume enclosed by each cell half, when clamped, is not critical; it should be small enough to allow for rapid gas exchange, but not so small that an unsupported film which happens to sag or buckle will contact the top or bottom of the cell. A depth of approximately 6 mm (0.250 in.) has been found to be satisfactory for 50-cm^2 cells.

[7] Suitable apparatus can be obtained from Mocon/Modern Controls, Inc., 6820 Shingle Creek Parkway, Minneapolis, MN 55430.

6.1.1.1 *Diffusion Cell O–Ring*—An appropriately-sized groove machined into the humid chamber side of the diffusion cell retains a neoprene O–ring. The test area is considered to be the area established by the inside contact diameter of the compressed O–ring when the diffusion cell is clamped shut against the test specimen.

6.1.1.2 *Diffusion Cell Sealing Surface*, a flat rim around the dry side of the diffusion cell. This is a critical sealing surface against which the test specimen is pressed; it shall be smooth and without radial scratches.

6.1.1.3 *Diffusion Cell Air Passages*, two holes in the dry half of the diffusion cell. These shall incorporate O–rings suitable for sealing the diffusion cell to the test chamber pneumatic fittings for the introduction and exhaust of air without significant loss or leakage.

NOTE 2—*Use of Multiple Diffusion Cells*—Experience has shown that arrangements using multiple diffusion cells are a practical way to increase the number of measurements which can be obtained in a given time. A separate conditioning rack (Fig. 2) contains a manifold which connects the dry-chamber side of each individual diffusion cell to a dry-air source. Dry air is continually purging the dry chamber of those cells that are connected to the conditioning rack while the humid chamber side is held at a specific relative humidity by distilled water or a saturated-salt solution. It is desirable to thermostatically control the temperature of the conditioning rack as described in 6.1.3.

6.1.2 *Test Chamber*, a cavity into which the diffusion cell is inserted. The test chamber shall incorporate means for clamping the diffusion cell in accurate registration with pneumatic system openings to the dry-air source and the infrared detector. The chamber shall also provide a thermometer well for the measurement of temperature.

6.1.3 *Test Station Temperature Control*—It is desirable to thermostatically control the temperature of the test station. A simple resistive heater attached to the station in such a manner as to ensure good thermal contact is adequate for this purpose. A thermistor sensor and an appropriate control circuit will serve to regulate the temperature unless measurements are being made close to ambient temperature. In that case it may be necessary to provide cooling coils to remove some of the heat.

6.1.4 *Flowmeter*—A means for regulating the flow of dry air within an operating range of 5 to 100 cc/min is required.

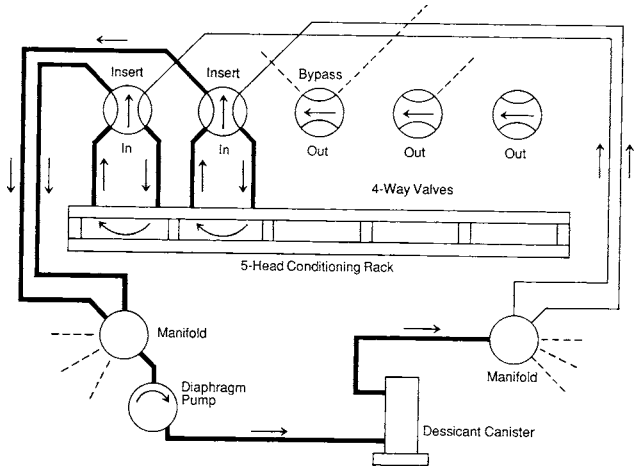

FIG. 2 Conditioning System