Designation: E398 – 03(Reapproved 2009)$^{\varepsilon 1}$

Standard Test Method for Water Vapor Transmission Rate of Sheet Materials Using Dynamic Relative Humidity Measurement[1]

This standard is issued under the fixed designation E398; 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.

ε^1 NOTE—Units information was revised editorially in May 2009.

1. Scope

1.1 This test method covers dynamic evaluation of the rate of transfer of water vapor through a flexible barrier material and allows conversion to the generally recognized units of water vapor transmission (WVT) as obtained by various other test methods including the gravimetric method described in Test Methods E96/E96M.

1.2 *Limitations*—This test method is limited to flexible barrier sheet materials composed of either completely hydrophobic materials, or combinations of hydrophobic and hydrophilic materials having at least one surface that is hydrophobic.

1.3 The minimum test value obtained by this test method is limited by the leakage of water vapor past the clamping seals of the test instrument. A reasonable value may be approximately 0.01 $g/24\ h \cdot m^2$ for any WVTR method including the desiccant procedure of Test Methods E96/E96M at 37.8°C, and 90 % relative humidity. This limit can be checked for each instrument with an impervious specimen such as aluminum foil. Calibration procedures can compensate for the leakage rate if so stated.

1.4 This test method is not suitable for referee testing at this time, but is suitable for control testing and material comparison.

1.5 Several other ASTM test methods are available to test a similar property. This test method is unique in that it closely duplicates typical product storage where a transfer of moisture from a package into the environment is allowed to proceed without constantly sweeping the environmental side with dry gas. Methods with constantly swept dry sides include Test Methods F1249, F372, and F1770.

1.6 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.7 *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]

C168 Terminology Relating to Thermal Insulation
E96/E96M Test Methods for Water Vapor Transmission of Materials
F17 Terminology Relating to Flexible Barrier Packaging
F372 Test Method for Water Vapor Transmission Rate of Flexible Barrier Materials Using an Infrared Detection Technique (Withdrawn 2009)[3]
F1249 Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor
F1770 Test Method for Evaluation of Solubility, Diffusivity, and Permeability of Flexible Barrier Materials to Water Vapor (Withdrawn 2004)[3]

3. Terminology

3.1 *Definitions*—For definitions of terms concerning the transmission of water vapor refer to Terminologies C168 and F17.

4. Summary of Test Method

4.1 The specimen is mounted between two chambers, one of relatively high relative humidity and the other of relatively low relative humidity. After conditioning and isolation of

[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. A previous version was under the jurisdiction of ASTM Committee C16.

Current edition approved May 1, 2009. Published June 2009. Originally approved in 1970. Last previous edition approved in 2003 as E398 – 03. DOI: 10.1520/E0398-03R09E01.

[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.

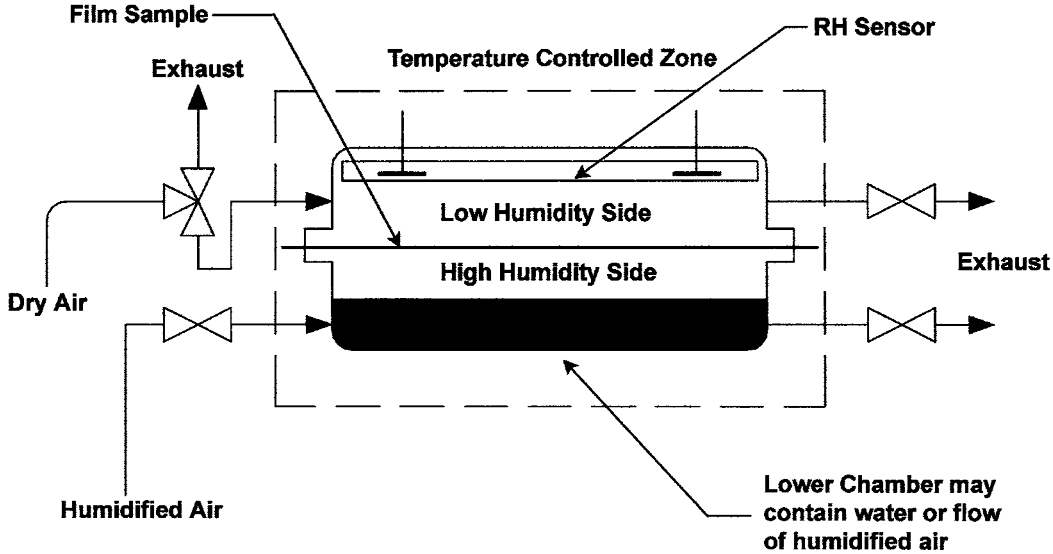

FIG. 1 Sectional Diagram of a Typical Test Chamber Using Relative Humidity Sensing

chambers, the rate at which the moisture increases within the relatively low relative humidity chamber over a predetermined range of interest is measured. This rate is compared to the rate for a calibration sample (calibrated gravimetrically) and the WVTR is determined.

5. Significance and Use

5.1 No single set of test conditions can represent all climatic and use conditions, so this WVTR test method serves more to compare different materials at a stated set of conditions than to predict their actual performance in the field under any conditions.

5.2 The water vapor transmission rate, under known and carefully controlled conditions, may be used to evaluate the vapor barrier qualities of a sheet. Direct correlation of values obtained under different conditions of test temperature and relative humidity will be valid provided the barrier material under test does not undergo changes in solid state (such as a crystalline transition or melting point) at or between the conditions of test.

6. Apparatus

6.1 The apparatus employed should have the following elements:

6.1.1 *Test Cell,* designed to clamp a defined sample area sufficiently large to be representative of the sample (an area of 50 cm^2 has been shown to be satisfactory) between two chambers, one to contain an atmosphere of low relative humidity (sensor-side chamber), and the other an atmosphere of higher relative humidity (humidified chamber) (see Fig. 1).

6.1.2 *Clamping Arrangement,* to allow rapid insertion and removal of the test specimen equipped with gaskets against which the specimen is held to the dry chamber by a clamping force sufficient to resist leakage.

6.1.3 *Humidification Provision,* for maintaining humidity in the wet cell at the desired level. Where an atmosphere close to saturation is required, this may be achieved by means of a reservoir of water or a saturated sponge provided there is a spacing 8 mm or less, between the water source and the specimen and yet no direct contact. Other levels of relative humidity may be obtained with saturated salt solutions or a stream of controlled humidified air.

6.1.4 *Air Source*—Air dried below the operating humidity range of the instrument (5 % relative humidity or less) shall be used as a purge for the sensor-side chamber. Various desiccants have been found satisfactory as drying agents.

6.1.5 *Sensor,* with rapid response and sensitivity capable of detecting changes in the moisture content of the gas within the dry chamber of 0.05 % relative humidity or less. This sensor may take any of a number of forms. For this purpose, the following have been described in the literature: an electrical resistance element,[4] an electrolytic cell,[5] and a beam of infrared radiation.[6]

6.1.6 *Data Collection,* a means to convert the sensor's moisture-change response into a signal that can be used to calculate the passage of moisture through the material under test. This may take the form of registering the time required for the signal to pass between two selected levels of relative humidity, or the change in signal over a given interval of time.

6.1.7 *Temperature Control,* a means of maintaining the test-cell purge air and the test specimen at a constant known temperature within ±0.1°C is provided.

6.1.8 *Standard Films,* which have been calibration by gravimetric means. Various films have been found satisfactory with various thicknesses of PET most commonly used.

7. Test Specimens or Sample

7.1 Test specimens shall be representative of the sample.

7.2 Where the test specimen is completely hydrophobic, no special conditioning procedure is required except that the surface exposed in the dry cell must not have visible free water present.

[4] Ranger, H. O., and Gluckman, M. J., *Modern Packaging* , Vol 37, No. 11, July 1964, p. 153.

[5] Toren, P. E., *Analytical Chemistry*, Vol 37, 1965, p. 922.

[6] Husband, R. M., and Petter, P. J., *Tappi*, Vol 49, 1966, p. 565.