WI 210808.03

T 448

DRAFT NO. 02 SARG

DATE October 5, 2021

WORKING GROUP CHAIRMAN To Be Determined

SUBJECT CATEGORY Physical Properties

RELATED METHODS See "Additional Information"

CAUTION:
This Test Method may include safety precautions which are believed to be appropriate at the time of publication of the method. The intent of these is to alert the user of the method to safety issues related to such use. The user is responsible for determining that the safety precautions are complete and are appropriate to their use of the method, and for ensuring that suitable safety practices have not changed since publication of the method. This method may require the use, disposal, or both, of chemicals which may present serious health hazards to humans. Procedures for the handling of such substances are set forth on Material Safety Data Sheets which must be developed by all manufacturers and importers of potentially hazardous chemicals and maintained by all distributors of potentially hazardous chemicals. Prior to the use of this method, the user must determine whether any of the chemicals to be used or disposed of are potentially hazardous and, if so, must follow strictly the procedures specified by both the manufacturer, as well as local, state, and federal authorities for safe use and disposal of these chemicals.

Water vapor transmission rate of paper and paperboard at 23°C and 50% RH

(Five-year review of Official Method T 448 om-17)

(No changes from previous draft. Standard reaffirmed)

1. Scope

1.1 This method provides for the gravimetric determination of the water vapor transmission rate (WVTR) of sheet materials at 23°C with an atmosphere of 50% RH on one side and a desiccant on the other.

1.2 It is generally suitable for materials up to 3 mm thick (1/8 inch), although it may be used with caution for thicker materials if the edges of the specimen are completely sealed.

1.3 For testing at other conditions, see TAPPI T 464 "Gravimetric Determination of Water Vapor Transmission Rate of Sheet Materials at High Temperature and Humidity" for 37.8°C (100°F) and 90% RH.

1.4 This test can be used to evaluate water vapor transmission rate for either creased or non-creased specimens. See TAPPI T 465 "Static Creasing of Paper for WVT Tests" and TAPPI UM 590 "Creasing of Paperboard

for Water Vapor Transmission Rate (WVTR) Testing" for the creasing procedure for paper and paperboard respectively.

2. Significance

2.1 This method provides a means for measuring the ability of a material to protect contents that are enclosed within the material from undesirable changes due to the transmission of water vapor to or from the surrounding environment.

2.2 The influence of temperature and humidity on the water vapor transmission rate of sheet materials is seldom linear, so test results obtained at higher or lower temperatures and humidities cannot safely be extrapolated to apply to these conditions.

2.3 If sheet materials are not homogeneous, there may be a considerable difference in the transmission rate depending on which side faces the high humidity. The test is usually made to simulate use conditions; for example, a material for enclosing a dry product would be tested by exposing to the dry atmosphere that surface which would face the product in the package.

3. Definitions

The water vapor transmission rate (WVTR) of a sheet material is the mass of water vapor transmitted per unit time per unit area from one face of the sheet to the other under specified steady conditions. The standard unit is $g/m^2 \cdot$ day and for this method, the specimen has an atmosphere approaching 0% RH on one face and 50% RH on the other at a temperature of 23°C.

NOTE 1: WVTR is a distinctive characteristic, often erroneously termed "permeability" or "moisture-vapor transfer" (MVT).

4. Apparatus[1]

4.1 *Test dish,* a light, shallow, non-permeable dish that can be weighed on an analytical balance, having an opening with an area of at least 50 cm^2 (8 sq. in.) and an inside depth of 10 to 15 mm (0.4 to 0.6 in.). The design of the test dish is such that a wax seal made between the dish and the specimen is impervious to water vapor and clearly defines the test area. A suitable design is shown in Fig. 1. Mechanical seal cups that use screw-down tops and rubber washers to clamp the specimen in place are available. However, these cups may leak in some cases where there is penetration through the edge of the specimen. Additional precautions are noted in section 13.5.

[1] Names of suppliers of testing equipment and materials for this method may be found on the Test Equipment Suppliers list, available as part of the CD or printed set of Standards, or on the TAPPI website general Standards page.

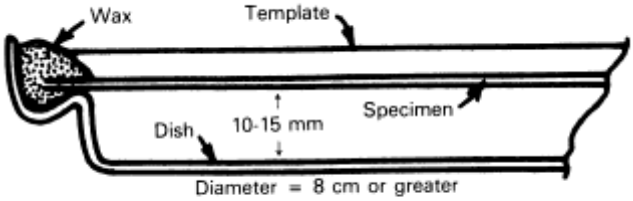

Fig. 1. Test dish.

4.2 *Template*, to define the test area and the location of the wax seal, made of a circular metal disk 3 to 6 mm (1/8 - 1/4 in.) thick with its edge beveled upwards at an angle of approximately 45°. The diameter of its smaller, bottom face defines the test area and must be measured accurately. It is approximately equal to and not greater than the diameter of the effective opening of the dish in contact with the specimen. There is a small hole through the disk to allow air passage, and a handle to facilitate removal of the disk after the wax solidifies. Positioning lugs may help to center the template in the dish.

4.3 *Balance*, of 200 g capacity, sensitive to at least 0.5 mg with a pan large enough to hold the test dishes.

4.4 *Testing room or cabinet*, maintained at 23 ± 1.0°C and 50 ± 2% RH with air continuously circulated over the exposed surface of the test specimens at a speed of at least 30 m/min (about 100 ft/min.).

4.5 *Cutting template*, to cut circular specimens of such a size that they lie flat over the groove on the dish for sealing.

4.6 *Weighing covers*. If the test specimen assemblies must be removed from the conditioned enclosure for weighing, covers are needed to prevent appreciable change in weight of the assemblies during weighing (see 8.7.2). The covers are circular disks of aluminum 1 to 2 mm thick (about 1/32 - 3/32 in.) thick, with a knob in the center for lifting. The circumference of each cover fits the inside beveled surface of the annular wax ring just above the plane of the specimen and is smoothed so as not to remove any wax when lifted. A numbered cover is required for each correspondingly numbered test dish.

5. Materials

5.1 *Desiccant*, anhydrous calcium chloride in the form of small lumps that will pass a No. 8 (2.36 mm) screen, but free from fines that will pass a No. 30 (595 μm) screen, and predried at 200°C (392°F) before use. The permissible moisture gain during the test is limited to 10% of its initial weight. Silica gel may be used if its moisture gain is limited to 4%. **CAUTION: Do not use the highly oxidative (explosive) magnesium perchlorate as a desiccant.**

5.2 *Wax*, for sealing, which adheres tenaciously to both the dish and the specimen and is not brittle, hygroscopic, nor subject to oxidation. The weight of a surface of 50 cm^2 of freshly melted wax when exposed to the test conditions for 24 h should not increase more than 0.001 g. A mixture of 60% of refined laminating-type microcrystalline wax and 40% refined crystalline 57°C (135°F) m. p. paraffin wax is usually satisfactory.

5.3 *Petrolatum* (petroleum jelly), for coating the beveled edges of the templates to facilitate their removal after the wax has been applied and cooled. Silicone lubricants may be used provided the wax is not reclaimed for further use.

6. Sampling and test specimens

6.1 To determine conformance to product specifications, obtain a sample of the sheet material to be tested in accordance with TAPPI T 400 "Sampling and Accepting a Single Lot of Paper, Paperboard, Containerboard, or Related Product."

6.2 With the cutting template, cut three typical specimens from each test unit, and identify the surfaces.

6.3 Conditioning is not necessary unless the material is unusually moist. If so, see TAPPI T 402 "Standard Conditioning and Testing Atmospheres for Paper, Board, Pulp Handsheets, and Related Products."

8. Procedure

8.1 Place sufficient desiccant inside the dish to cover the bottom to a depth of at least 8 mm (about 3/16 in.) and, when leveled, to be within 6 mm (about 1/4 in.) of, but not touching, the under surface of the specimen. Determine the rough weight of the desiccant to stay within the weight gain limitation of 5.1. The exact weight is not essential.

8.2 Center the specimen over the top of the dish with the sides oriented properly (see 2.3).

8.3 Apply a thin film of petrolatum (petroleum jelly) to the beveled edge of the waxing template. Wipe off the excess so as to avoid contaminating the specimen. Center the template over the specimen and dish and apply a firm downward pressure.

8.4 Heat the wax to 80°C (176°F) and flow the molten wax into the annular space around the beveled edge of the template. A special pipet may be used for this, rotating dish if convenient, but add the wax neatly and quickly. Two pours may be used, if desired, to minimize cracks and air bubbles, but in either case, the wax should form a slight meniscus above the upper edge of the template but not flow over that edge.

8.5 When the wax has set and shrunk slightly, a slight twist will release the template. Examine the seal for bubbles and cracks and discard any assembly with a faulty seal.

8.6 Place the assembled dishes, specimen side up, in the testing room or cabinet, and allow the conditioned air to circulate over the specimens for a period of at least 3 hours before starting to weigh the assemblies.

NOTE 2: With specimens having a high rate of transmission it may be necessary to make the first and subsequent weighings at shorter intervals so as to keep the weight gain of the desiccant within limits. A very poor barrier may cause the limit to be passed overnight.

8.7 Two weighing procedures are acceptable, depending on available facilities.

8.7.1 Weigh the test assemblies directly in the test atmosphere.

8.7.2 Weigh the test assemblies with the weighing cover. In this case, first cover the dish in the cabinet with its corresponding cover. Remove each assembly and weigh to the nearest 0.001 g. Replace the assemblies in the cabinet and remove the covers. Between weighings, keep the covers in a dust-free place, preferably resting flat on three-point supports. Always weigh the assemblies in the same order.

8.8 Record the successive weights of each assembly to the nearest 0.001 g. Repeat the weighings at recorded time intervals, usually 24 h, until a constant rate of gain is attained. This can be determined from the data, when the gain in weight becomes constant to within 5% for two successive weighings.

NOTE 3: With barriers having a very low transmission rate, there may be no gain or even a loss in weight in the first several days. Start the test at any time that gain in weight occurs, or report the barrier as "practically impervious" if no gain occurs in seven days.

9. Calculations

Calculate the water vapor transmission rate (WVTR) as follows:

$$\text{WVTR, g/m}^2 \cdot \text{day} = 24x/Ay$$

where

x = gain in grams for the time period y, (during constant rate of gain period)

y = time in hours for the gain of x,

A = exposed area of specimen, m^2.

The quantities x and y can be derived conveniently from a plot of weight gain in grams vs. elapsed time in hours.

10. Report

10.1 For each test unit, report the average, maximum, and minimum water vapor transmission rate as grams per square meter per day, to two significant figures.

10.2 Identify the material tested and the surface exposed to the dry atmosphere.

11. Precision

For the maximum expected difference between two test results, each of which is the average of three (3) test determinations:

Repeatability = 13% (for uncreased samples)
Reproducibility = 16% (for uncreased samples)

in accordance with the definition of these terms in TAPPI T 1200 “Interlaboratory Evaluation of Test Methods to Determine TAPPI Repeatability and Reproducibility.” These values are based on an interlaboratory study (TAPPI archives) conducted in accordance with TAPPI T 1200. Six laboratories participated in the study which included five samples having water vapor transmission rates ranging from 0.5 to 45 $g/m^2 \cdot day$.

12. Keywords

Water vapor transmission rate, Gravimetry, Paper, Paperboard, Paper sheets, Permeability, Sheets, Mass transfer

13. Additional Information

13.1 Effective date of issue: To be assigned.

13.2 To clean the dishes, chill them to 15°C or less until the wax contracts and the waxed specimen can be lifted from the dish. The wax ring may be shaved from the specimen and reused if it is not contaminated with petrolatum.

13.3 Related method: ASTM E-96A, ISO 2528.

13.4 This method was issued in 1940, revised in 1941, 1944, 1971, 1984, 1989, 1997, and 2004. Corrections were issued in 1945, 1946, and 1949. This correction in 2004 was to correct the No. 8 mesh size in 5.1 and this paragraph (13.4). The 2009 review includes a note added to the Apparatus Section 4.1 that excludes the use of mechanical seal cups from this test method. The 2016 review reintroduces the use of mechanical seal cups in this test method in 13.5 (see same wording in TAPPI T464 “Water vapor transmission rate of paper and paperboard at high temperature and humidity”, section 13.7) and allows for conditioning of at least 3 hours instead of overnight in 8.6.

13.5 Some laboratories use gasketed screw down cups for this method instead of the wax seal cups. This should be done with great caution due to the possibility of edge leakage into the cup throughout the thickness direction of the test specimen. Because of this possibility, results may or may not correlate with those obtained using the wax seal dishes. In order to determine if the use of either cup yields statistically comparable results, it is recommended that round robin studies of sufficient statistical strength be performed that compares results obtained using both types of cups and employing various thicknesses of test specimens.

Your comments and suggestions on this procedure are earnestly requested and should be sent to the TAPPI Standards Department. ■