Designation: F2298 – 03 (Reapproved 2009)ε1

Standard Test Methods for Water Vapor Diffusion Resistance and Air Flow Resistance of Clothing Materials Using the Dynamic Moisture Permeation Cell[1]

This standard is issued under the fixed designation F2298; 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.

ε1 NOTE—Reapproved with editorial changes in February 2009.

1. Scope

1.1 This test method covers the measurement of the moisture vapor transport and gas flow properties of fabrics, membranes, and membrane laminates used for protective materials.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D737 Test Method for Air Permeability of Textile Fabrics

2.2 *Other Standards:*

ISO 11092 Textiles—Physiological Effects—Measurement of Thermal and Water-Vapour Resistance Under Steady-State Conditions (Sweating Guarded-Hotplate Test)[3]

JIS L 1099 Testing Methods for Water Vapour Permeability of Clothes[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *water vapor diffusion, n*—the process by which water vapor molecules move from a region of high concentration to a region of low concentration.

3.1.2 *water vapor transmission rate, n*— the steady water vapor flow in unit time through unit area of a material, under specific conditions of temperature and humidity at each surface.

4. Summary of Test Methods

4.1 The testing outlined in this standard consists of measuring the amount of water vapor transport across a specimen. The water vapor transport properties can be measured in a pure diffusion mode and in a diffusion/convection mode.

4.2 Two test methods are presented in this standard:

4.2.1 *Part A (Diffusion Test)*—The test is done under the maximum difference in relative humidity and zero pressure gradient across the specimen so that only the water vapor diffusion transport through the specimen is measured (Fig. 1).

4.2.2 *Part B (Combined Convection/Diffusion Test)*—A series of pressure gradients is applied in specified increments to force air through the material (Fig. 1). Thus, the test is conducted under a combined air pressure gradient and concentration gradient that allows examination of the interaction of convective and diffusive mass transfer across the specimen. This method is designed for use on relatively air-permeable textile materials because for air-impermeable materials, the results will be the same as the diffusion test alone.

5. Significance and Use

5.1 The water vapor transport properties of textile materials are of considerable importance in determining the comfort properties of clothing systems. Water vapor transport through porous textiles may occur due to both diffusion (driven by vapor concentration differences) and convection (driven by gas pressure differences).

5.2 For air permeable porous materials, a very small pressure gradient can produce large convective flows through the pores in the structure. In many standard water vapor permeability test methods, when used for materials with high air permeability, slight variations in pressure gradient across a specimen will greatly influence the measured water vapor transport properties. Therefore, the water vapor transport

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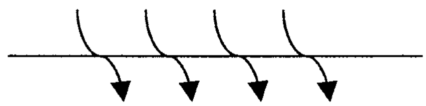
[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

Part A: Diffusion Test – The test is done under zero pressure gradient across specimen so that only water vapor diffusion through the specimen is measured.

Top Cell: 95 % R.H.
water vapor



Higher vapor pressure

0 Air pressure gradient

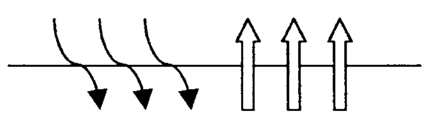
Lower vapor pressure

Bottom Cell: 5 % R.H.

Part B: Diffusion/Convection Test – A series of pressure gradients (negative – positive pressure gradients) are applied to force air through the material.

1. Negative pressure gradient – The flow of the water vapor is in the opposite direction of the air flow through the material.

Top: 95 % R.H.
water vapor



air

Higher vapor pressure, Lower air pressure

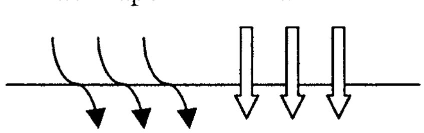
Negative air pressure gradient

Lower vapor pressure, Higher air pressure

Bottom: 5 % R.H.

2. Positive pressure gradient – The flow of the water vapor and the air flow are moving is in the same direction.

Top: 95 % R.H.
water vapor air



Higher vapor pressure, Higher air pressure

Positive air pressure gradient

Lower vapor pressure, Lower air pressure

Bottom: 5 % R.H.

FIG. 1 Overview of the Test Methods

properties of the porous and non-porous textile materials cannot be directly compared when the method has no provision for controlling the pressure gradient. This test method determines the diffusion and convection properties from the same test and generates data that allows direct comparison of the results obtained between materials.

6. Sampling and Preparation of Test Specimens

6.1 *Sampling:*

6.1.1 *Laboratory Sample*—Take test specimens that are believed to be representative of the sample to be tested and free of abnormal distortions. The sample may be a piece of fabric or a garment.

6.1.2 If the material is of nonsymmetrical construction, the two faces shall be designated by distinguishing marks.

6.2 *Sample Preparation:*

6.2.1 Cut three specimens from each laboratory sample.

6.2.2 *Specimen Size*—Use specimens larger than the area of the opening in the clamping plate so that the test area is covered completely.

7. Test Apparatus

7.1 The procedures in these methods require measurement of the pressure gradient across the specimen and the mass flow rate. Fig. 2 is a schematic diagram of the basic system for the dynamic moisture permeation cell (DMPC). This standard is written to allow operation of the DMPC system under manual control of the test operator. However, the preferred method is to automate the data acquisition and control system of the apparatus so the entire test is performed under the control of a computer.

7.2 *Control and Measuring Units:*

7.2.1 *Mass Flow Rate Controller,* measures and controls the gas flows in a wide variety of applications. Either analog or electronic digital type mass flow rate controller can be used. The mass flow rate controllers maintain the correct incoming relative humidity by adjusting the ratio of the relative mass flows of a saturated and a dry nitrogen stream. The test apparatus requires four mass flow controllers. Two controllers adjust the dry and saturated nitrogen gas streams to the top flow cell, and two controllers adjust the dry and wet nitrogen gas streams to the bottom flow cell. The mass flow controllers shall be controlled at an accuracy of ± 1 % of full scale, with a response time of less than 5 s, unless stated otherwise in the data report. Electronic mass flow controllers usually indicate flow rate in terms of volumetric flow rates at standard conditions of 0°C and atmospheric pressure. The actual volumetric flow rate at the actual test temperature can be calculated from the mass flow rate, the temperature, and the pressure of the actual flow.

7.2.2 *Channel Power Supply and Readout,* controls and displays the flow meters and controllers. The display accuracy of the channel readout shall be within ± 0.2 % ± 1 digit, unless stated otherwise in the data report.

7.2.3 *Differential Pressure Transducer,* directly measures the pressure gradient across the specimen. The differential pressure transducer can be either digital or analog type with an accuracy of within ± 0.2 % of the indicated value. The sensor requires power and signal conditioning electronics. The pressure in the flow cells is controlled by means of two automated restrictor valves (7.2.5) at the outlets of the cell.

7.2.4 *Signal Conditioner/Display Unit,* provides power and signal conditioning for the differential pressure transducer sensors.

7.2.5 *Proportioning Valve and Controller,* used to continuously control the gas flows. The restrictor valves at the exits of the cell are used to systematically vary the pressure gradient across the specimen to produce various amounts of convective

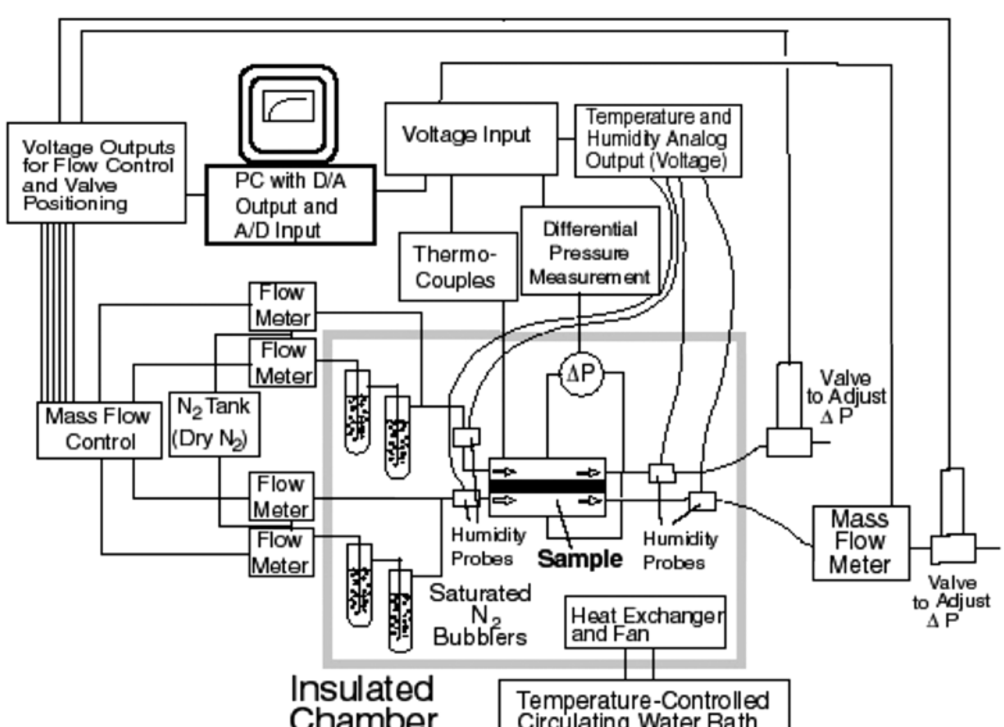


FIG. 2 Schematic of DMPC Test System