U. S. Department of Commerce
Malcolm Baldrige
Secretary

National Bureau of Standards
Ernest Ambler, Director

National Bureau of Standards

Certificate

Standard Reference Material 1470

Polyester Plastic Film for Gas Transmission

John D. Barnes

This Standard Reference Material (SRM) is intended for use in standardizing methods for measuring gas transmission rates of thin polymeric films. The certified values of permeance for N_2, O_2, CO_2, and He can be compared with results obtained using any of the commonly available techniques, including the manometric[1], volumetric[1], and coulometric[2] methods. The permeance, P_g, of nine samples of the plastic film selected randomly from the entire lot of material, was measured as a function of temperature, pressure, and gas using a complete factorial experimental design[3]. Measurements were made at four pressures between 67.5 and 135.0 kPa (one standard atmosphere is 101.33 kPa) and five temperatures between 292.15 and 304.15 K. The NBS computer-controlled manometric permeation measuring facility[4] was employed for the collection of the data.

From these determinations the permeance of this plastic film for each of the four different gases can be expressed as

$$P_g\,(T) = P_g\,(296.15)\; e^{B_g\,(T-296.15)} \qquad (1)$$

where values for P_g (296.15) and B_g are given in Table 1. The permeance was found to be independent of pressure within the error of these measurements. The material is not certified for conditions of pressure and temperature outside the ranges given above.

The uncertainty (one standard deviation of the measured values) of a value calculated from equation (1) is expressed by

$$s = C_g\,P_g\,(T)$$

where values of C_g for each of the four gases are given in Table I. This uncertainty includes both the differences between samples and the measurement errors.

If measurements are made using a single sample from the lot of SRM material, the standard deviation, d, of the differences between these measurements (assuming that there is no measurement error) and the value given by equation(1) is given by

$$d = K_g\,P_g\,(T)$$

where values of K_g are also given for each of the four gases in Table I.

Experimental determinations most frequently involve the gas transmission rate, G, which is the product of the permeance, P, and Δp, the difference in partial pressure of the permeating species from one side of the film to the other:

$$G_g\,(\Delta p, T) = \Delta p \cdot P_g\,(T).$$

The statistical evaluation of the data for this SRM was performed by Robert Paule of the National Measurement Laboratory. The work leading to the certification of this SRM was performed by J.D. Barnes of the Polymer Science and Standards Division.

The technical and support aspects involved in the preparation, certification, and issuance of this Standard Reference Material were coordinated through the Office of Standard Reference Materials by R.K. Kirby.

Washington, D.C. 20234
February 23, 1982
(Revision of Certificate
dated January, 1978)

George A. Uriano, Chief
Office of Standard Reference Materials

(over)

This Standard Reference Material has been carefully packaged to avoid damage, however, occasional pinholes or other defects may be encountered. If, during the measurement process, values outside the stated uncertainties are encountered, a new portion of the SRM should be used.

Differences between the oxygen permeance of SRM 1470 as measured for this revised certificate and those measured for the earlier (1978) certificate indicate that the permeance of the material may have increased slightly during the intervening time due to aging effects. These changes are, however, near the limit of detectability. If further monitoring reveals that there are significant aging effects, NBS will notify users of this material.

References:

[1] ASTM D-1434-Standard Method of Test for Gas Transmission Rate of Plastic Films and Sheeting. Part 35 of the Annual Book of ASTM Standards, American Society for Testing and Materials, Philadelphia, Pa.

[2] ASTM D-3985-Standard Method of Test for Oxygen Gas Transmission Rate of Plastic Films and Sheeting Using a Coulometric Sensor, Part 35 of the Annual Book of ASTM Standards, American Society for Testing and Materials, Philadelphia, Pa.

[3] Experimental Statistics, NBS Handbook 91, by Mary G. Natrella, U.S. Govt. Printing Office, Washington, D.C. 1966.

[4] A Computer-Controlled Gas Transmission Measuring Apparatus, J.D. Barnes, Proceedings of the 1982 ANTEC meeting of the Society of Plastics Engineers.

Table I

Quantity	Unit	Nitrogen	Oxygen	Carbon Dioxide	Helium
Permeance at 296.15K (P_g)	$\frac{pmol}{m^2 \cdot s \cdot Pa}$	0.0421	0.352	1.722	13.79
Temperature Coefficient (B_g)	$\frac{1}{K}$	0.05211	0.03762	0.03089	0.02872
Error Coefficient for Mean (C_g)	None	0.023	0.014	0.018	0.012
Error Coefficient for Difference Between Mean and Single Specimen (K_g)	None	0.057	0.045	0.056	0.037

The units of G in the SI system are $pmol \cdot m^{-2} \cdot s^{-1}$. Factors for converting these SI units to various customary units are given in Table II.

Table II Conversion of Units

Units of G Given	Units of G Desired: $\frac{pmol}{m^2 \cdot s}$	$\frac{cm^3}{m^2 \cdot day}$	$\frac{cm^3}{100\,in^2 \cdot day}$
	Multiply G by		
$\frac{pmol}{m^2 \cdot s}$	1	$1.938 \cdot 10^{-3}$	$1.2503 \cdot 10^{-4}$
$\frac{cm^3}{m^2 \cdot day}$	516	1	$6.452 \cdot 10^{-2}$
$\frac{cm^3}{100in^2 \cdot day}$	7998	15.5	1