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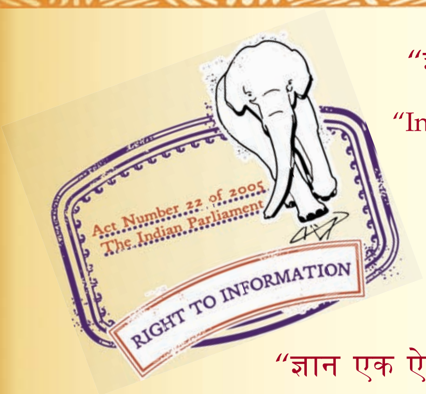

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(Reaffirmed 2001)

Indian Standard

METHODS OF TEST FOR RIGID CELLULAR THERMAL INSULATION MATERIALS

PART 4 WATER VAPOUR TRANSMISSION RATE

UDC 678·077-405·8 : 620·165·29 : 662·998

INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Gr 3

September 1985

Indian Standard

METHODS OF TEST FOR RIGID CELLULAR THERMAL INSULATION MATERIALS

PART 4 WATER VAPOUR TRANSMISSION RATE

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Indian Standard

METHODS OF TEST FOR RIGID CELLULAR THERMAL INSULATION MATERIALS

PART 4 WATER VAPOUR TRANSMISSION RATE

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 12 March 1985, after the draft finalized by the Thermal Insulation Materials Sectional Committee had been approved by the Chemical Division Council.

0.2 In the preparation of this standard, considerable assistance has been drawn from ISO/R 1663-1970 ' Plastics — Determination of water vapour transmission rate of rigid cellular plastics ', issued by the International Organization for Standardization.

0.3 In reporting the result of a test made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2 - 1960*.

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1. SCOPE

1.1 This standard prescribes the method for determination of water vapour transmisssion rate, water vapour permeance and water vapour permeability of rigid cellular thermal insulation materials. Rigid cellular materials with thicknesses from 3 to 80 mm and which may, as integral part of the material, contain natural skins or adhered facings of some different material, may be tested by this method.

2. TERMINOLOGY

2.1 For the purpose of this standard, the definitions given in IS : 3069-1965† and the following shall apply.

2.1.1 *Water Vapour Transmission Rate* — Water vapour transmission rate is the quantity of water vapour transmitted per unit time through unit area of material under specified conditions of temperature, humidity and thickness.

*Rules for rounding off numerical values (*revised*).

†Glossary of terms, symbols and units relating to thermal insulation materials.

2.1.2 *Water Vapour Permeance* — Water vapour permeance is the quotient of the water vapour transmission rate divided by the vapour pressure difference between the two faces of the specimen during the test.

2.1.3 *Water Vapour Permeability* — Water vapour permeability is the quantity of water vapour transmitted per unit time through a given area of the material per unit of vapour pressure difference between its two faces for unit thickness.

3. PRINCIPLE

3.1 A test specimen is hermatically sealed to the open mouth of a test dish containing a desiccant. The assembly is then placed in a temperature and humidity controlled atmosphere. Periodic weighings of the assembly are made to determine the rate of water vapour transmission through the specimen into the desiccant.

3.2 The test is carried out at the following temperature and humidity conditions:

a) 38 ± 1°C and a relative humidity gradient of 0 to 88 ± 2 percent.

b) 23 ± 0·5°C and a relative humidity gradient of 0 to 85 ± 2 percent.

c) 23 ± 0·5°C and a relative humidity gradient of 0 to 50 ± 2 percent.

3.2.1 The test conditions selected should be those most closely approaching the conditions of use.

4. CONDITIONS

4.1 The test specimens shall be conditioned for not less than 16 hours at 27 ± 2°C and 65 ± 5 percent relative humidity.

5. APPARATUS AND REAGENTS

5.1 Beakers or Dishes — Of capacity 250 ml minimum, of non-corroding material and impermeable to water and water vapour.

5.2 Measuring Instruments — As required in accordance with IS : 11239 (Part 1)-1985*.

5.3 Circular Metal Template — Of sufficient diameter to duplicate the area of the specimen being used to the nearest 0·1 cm^2.

5.4 Analytical Balance — Capable of weighing specimen mounted beakers or dishes with an accuracy of 1 mg.

*Methods of test for cellular thermal insulation materials: Part 1 Dimensions.

5.5 Constant Temperature and Constant Humidity Chamber or Room — Capable of being maintained within ± 2 percent of the required relative humidity and within ±1 °C of the required temperature. Alternatively, desiccator in which the required humiditiy can be produced. This desiccator shall be capable of holding at least five beakers with their test specimens and be placed in a constant temperature chamber. The solution for use in the desiccator shall be one of the following:

a) For testing at 38°C and a relative humidity gradient of 0 to 88 percent; potassium nitrate solution, saturated at 38°C which contains a large excess of undissolved potassium nitrate;

b) For testing at 23°C and a relative humidity gradient of 0 to 85 percent; potassium chloride solution, saturated at 23°C, which contains a large excess of undissolved potassium chloride;

c) For testing at 23°C and a relative humidity gradient of 0 to 50 percent; sodium dichromate dehydrate solution, saturated at 23°C, which contains a large excess of undissolved sodium dichromate dehydrate.

An additional desiccator, containing anhydrous calcium chloride and large enough to hold five beakers or dishes for the purpose of sample transfers.

5.6 Sealant — Suitable sealant unaffected by test conditions, for example:

a) A mixture of 90 percent of microcrystalline wax and 10 percent of a plasticizer like low molecular weight poly-iso-butylene;

b) A 60 percent microcrystalline wax with 40 percent refined crystalline paraffin wax.

5.7 Anhydrous Calcium Chloride Desiccant — With particles about 5 mm in diameter, free of fines that will pass a nominal aperture size 600 micrometre sieve.

6. TEST SPECIMENS

6.1 Each test specimen shall be in the form of a cylinder, with a diameter cut to fit exactly (push fit) the beaker or dish. The thickness of the test specimen shall not be less than 3 mm nor greater than 80 mm. The minimum exposure area shall be 32 cm². A groove may be cut in the edge of the test specimen to facilitate the escape of air when mounting in the beaker or dish. The specimens may, as an integral part of the material, contain natural skins or adhered facings of some different material.

6.2 A minimum of five specimens shall be tested.

6.3 When the material to be tested is suspected of being anisotropic, the test specimens shall be cut such that the parallel faces are normal to the direction of vapour flow of the product in its intended use.

6.4 When the materials are faced with natural skins or adhered facings which are different for the two sides, the test specimens shall be tested with the vapour flow in the same direction as in the intended use. If the correction of intended use relative to the facings is not known, a duplicate set of specimens shall be prepared so that test can be made and reported for each direction of vapour flow.

7. PROCEDURE

7.1 Measure the thickness of the test specimens at each quadrant to the nearest 0·1 mm, in accordance with IS : 11239 (Part 1)-1985* and average the results.

7.2 Place a layer of anhydrous calcium chloride, of approximately 20 mm depth, in the bottom of each beaker or dish as shown in Fig. 1. It may be desirable to place a support made of dry material such as closed cell cellular plastic in the bottom of the dish or beaker in order to bring the desiccant closer to the test specimen.

7.3 Insert the test specimen into a beaker or dish. Place the metal template centrally on the top surface and apply the melted sealant along its circumference in order to give a complete seal between the test specimen and the wall of the beaker or dish and provide a well defined exposed area on top of the specimen. After the sealant has set, carefully remove the template.

7.4 Weigh each of the five beakers or dishes with test specimens mounted in position to the nearest 1 mg. Place the beakers or dishes either in a constant temperature or constant humidity chamber maintained at the required test conditions or in the desiccator containing the recommended solution and placed in a constant temperature chamber maintained at the required test temperature.

7.5 At intervals of approximately 24 hours, quickly remove the beakers or dishes from the chamber or room or the desiccator and store them in the transfer desiccator at room temperature for 30 ± 1 *min*: then weigh each specimen mounted beaker or dish to the nearest 1 mg. After weighing, shake each beaker or dish assembly to mix the desiccant, than return the specimens to the chamber or room or the desiccator maintained at constant temperature.

NOTE — It is not necessary to place the beaker in the transfer desiccator if the test weighings are conducted in the same constant temperature and humidity room.

*Methods of test for cellular thermal insulation materials: Part 1 Dimensions.

7.6 Daily plot the observed mass against time and terminate the last when three consecutive points, excluding the initial weighing, lie on a straight line.

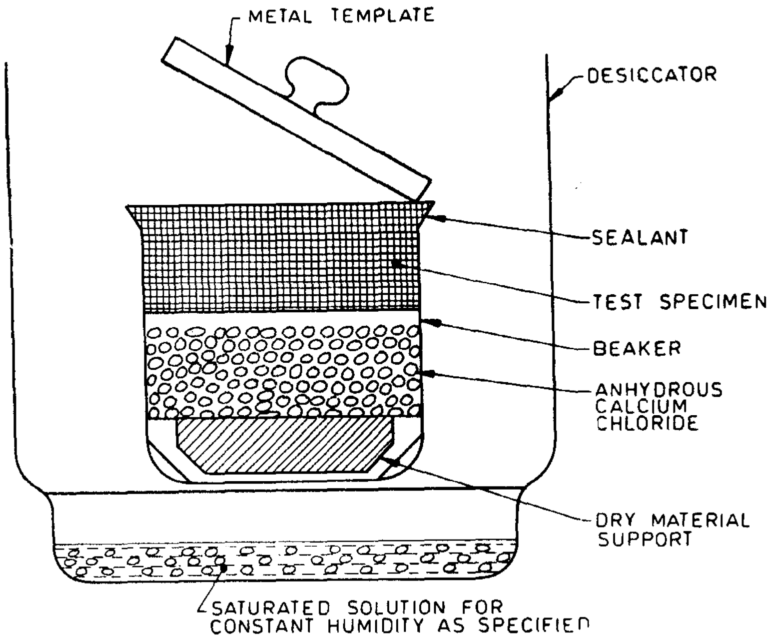

FIG. 1 EXAMPLE OF MOUNTED SPECIMEN IN TEST BEAKER AND CONSTANT HUMIDITY DESICCATOR

8. CALCULATIONS

8.1 Water Vapour Transmission Rate (WVT)— Calculate the water vapour transmission rate by the equation:

$$WVT = 11{\cdot}57 \times \frac{m}{A} \times 10^4$$

where

WVT = water vapour transmission rate, $\mu g/m^2s$;

m = increase in mass of the beaker and contents per 24 hours, determined from the linear part of the graph, g/24 h;

A = exposed, sealant free area of the test specimen, to the nearest 0·1 cm², cm²; and

11·57 = conversion factor from grams per square metre per 24 hours to micrograms per square metre per second [1 g/m². 24 h = 11·57 μg/m².s, 1μg/ (1m².s) = 0·086 4 g/(m².24 h)].

For samples having a water vapour transmission rate higher than 3 000 μg/m².s, the result shall be expressed as greater than 3 000 μg/m².s):

8.2 Permeance — Calculate permeance by the formula:

$$\frac{WVT}{P} = \frac{WVT}{S(R_1 - R_2)} \text{ ng/m}^2\text{s Pa}$$

where

WVT = water vapour transmission rate μg/m²s;

P = vapour pressure difference between the specimen faces, kPa;

S = saturation vapour pressure at test temperature, kPa;

R_1 = relative humidity of the test chamber or room, percent; and

R_2 = relative humidity in the beaker or dish, percent.

NOTE — For condition **3.2**(a), that is 38°C/88 percent relative humidity:
$P = S(R_1 - R_2) = 551$ kPa.

For condition **3.2**(b), that is 23°C/85 percent relative humidity:
$P = S(R_1 - R_2) = 239$ kPa.

For condition **3.2**(c), that is 23°C/50 percent relative humidity:
$P = S(R_1 - R_2) = 140$ kPa.

8.3 Permeability — Calculate permeability by the equation:

permeability = permeance × thickness

where

a) permeance is expressed in nanograms per Pascal of vapour pressure difference per second per square metre (ng/Pa.s.m²);

b) thickness is the specimen thickness, in metres, to the nearest 0·1 mm; and

c) permeability is expressed by the equation in nanograms per Pascal of vapour pressure difference per second per metre (ng/pa.s.m).

9. REPORT

9.1 The report shall include the following:

a) Reference to this test method;

b) Description of the material, including its thickness and presence of any skins or facings;

c) Conditions of test;

d) The water vapour transmission rate, permeance and permeability including the direction of the vapour flow relative to the facings if the two facings are different;

e) Individual test results and arithmetic mean of the test results expressed to two significant figures; and

f) Any deviation from the method specified.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	st

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 $kg.m/s^2$
Energy	joule	J	1 J = 1 N.m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2