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(JTCCM/JSA)

**Determination of water vapour
adsorption/desorption properties for
building materials — Part 1: Response
to humidity variation**

ICS 91.100.01

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Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry, through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Testing Center for Construction Materials (JTCCM)/ Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently JIS A 1470-1:2008 is replaced with this Standard.

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JIS A 1470 series consists of the following 2 parts under the general title “*Determination of water vapour adsorption/desorption properties for building materials*”:

Part 1 : Response to humidity variation

Part 2 : Response to temperature variation

Determination of water vapour adsorption/desorption properties for building materials — Part 1 : Response to humidity variation

Introduction

This Japanese Industrial Standard has been prepared based on the first edition of ISO 24353 published in 2008 with some modifications of the technical contents in order to reflect the actual situation in Japan.

The portions given sidelines or dotted underlines are the matters in which the contents of the corresponding International Standard have been modified. A list of modifications with the explanations is given in Annex JB. A comparison table between previous and current editions of this Standard on technically significant revisions is given in Annex JC.

1 Scope

This Standard specifies a test method for determining water vapour adsorption/desorption properties at daily cycle (12-hour adsorption, 12-hour desorption) mainly of building materials such as interior materials in response to humidity variation.

NOTE : The International Standard corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 24353 : 2008 *Hygrothermal performance of building materials and products — Determination of moisture adsorption/desorption properties in response to humidity variation* (MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standards and JIS are IDT (identical), MOD (modified), and NEQ (not equivalent) according to ISO/IEC Guide 21-1.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions (including amendments) shall be applied.

JIS A 0202 *Thermal insulation — Vocabulary*

JIS A 1324 *Measuring method of water vapor permeance for building materials*

JIS Z 8704 *Temperature measurement — Electrical methods*

JIS Z 8806 *Humidity — Measurement methods*

3 Terms, symbols and units

3.1 Terms and definitions

For the purpose of this Standard, the terms and definitions given in JIS A 0202 and the following apply.

3.1.1 water vapour adsorption/desorption property

property of a material related to its capacity for and efficiency in water vapour adsorption/desorption

3.1.2 water vapour adsorption process

process by which water vapour is adsorbed into a material from ambient air

3.1.3 water vapour desorption process

process by which water vapour is desorbed into ambient air from a material

3.1.4 water vapour adsorption content

amount of water vapour absorbed into materials in an adsorption process

3.1.5 water vapour desorption content

amount of water vapour desorbed from materials in a desorption process

3.1.6 water vapour surface resistance

resistance against the transfer of water vapour across the boundary layer between the surface of materials and the ambient air

3.1.7 resistance of water vapour transmission

resistance against the transfer of water vapour at the time when the water vapour in the air, which is in contact with both surfaces of materials, moves from one side of high humidity to the other side of low humidity through a component

3.1.8 water vapour adsorption rate

a variation of water vapour adsorption content per hour in an adsorption process

3.1.9 water vapour desorption rate

a variation of water vapour desorption content per hour in a desorption process

3.1.10 residual water vapour content

difference between the water vapour adsorption content at the time of completion of adsorption process and the water vapour desorption content at the time of completion of desorption process

3.2 Symbols and units

The symbols and units shall be as given in Table 1.

Table 1 Symbols and units

Symbol	Description	Unit
w_a	Area specific water vapour adsorption content of specimen at the time of completion of adsorption process	g/m^2
w_d	Area specific water vapour desorption content at the time of completion of desorption process	g/m^2
w_s	Residual water vapour content	g/m^2
m_a	Mass of the specimen at the time of completion of adsorption process ^{a)}	g
m_d	Mass of the specimen at the time of completion of desorption process ^{a)}	g
m_0	Mass of the specimen after precondition ^{a)}	g
G_T	Water vapour adsorption/desorption rate at time T	$\text{g}/(\text{m}^2 \cdot \text{h})$
m_T	Mass of the specimen at time T ^{a)}	g
m_{T-1}	Mass of the specimen at time $T-1$ ^{a)}	g
A	Water vapour adsorption/desorption area of specimen	m^2
t	Time	h
$1/\beta$	Water vapour surface resistance	$\text{m}^2 \cdot \text{h} \cdot \text{Pa}/\mu\text{g}$
R_1	Resistance of water vapour transmission on single-layered specimen	$\text{m}^2 \cdot \text{h} \cdot \text{Pa}/\mu\text{g}$
R_2	Resistance of water vapour transmission on double-layered specimen	$\text{m}^2 \cdot \text{h} \cdot \text{Pa}/\mu\text{g}$
Note ^{a)} The mass of specimen, m , shall be that damp-proofed.		

4 Test specimens

The size, thickness, and number of specimens shall be as follows.

- a) **Size** The size of a specimen shall be $(250 \pm 10) \text{ mm} \times (250 \pm 10) \text{ mm}$ as a rule.

Multiple pieces of specimens shall be combined if the specimen has a small area, e.g. tiles.

- b) **Thickness** The thickness of a specimen shall be the same as the thickness of the product as a rule.

When a specimen is a material whose thickness can be hardly defined, e.g. coating material, the thickness shall be that of non-adsorptive substrate plus the coating applied according to the standard application.

- c) **Number of specimens** The number of specimens shall be, as a rule, one piece for each test condition.

5 Test apparatus

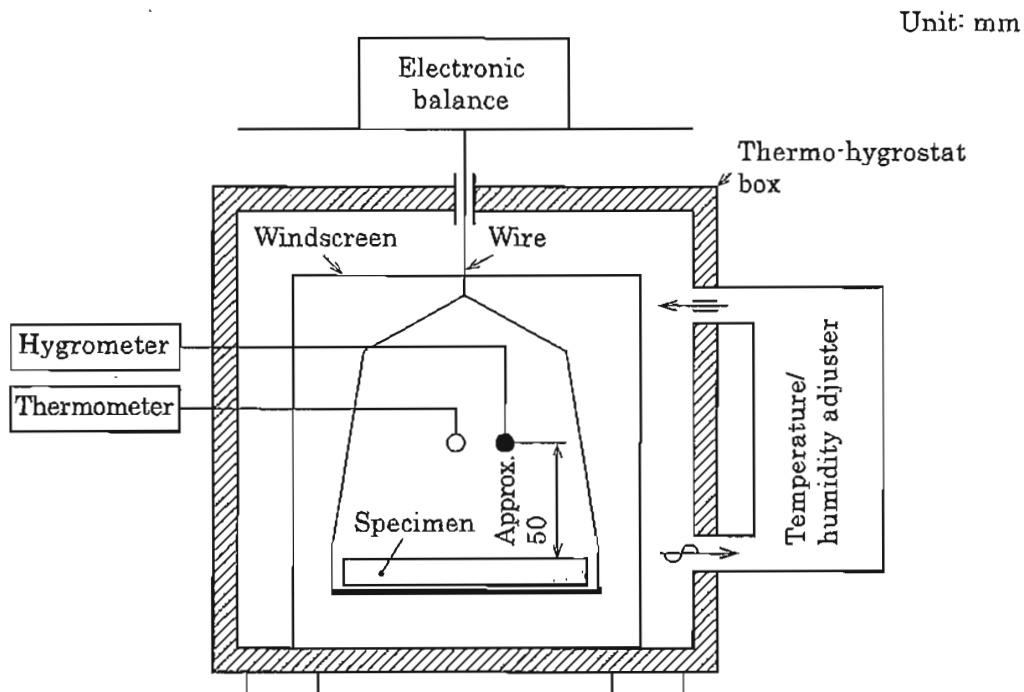
The test apparatus is composed of an electronic balance, thermo-hygrostat box, thermometer, hygrometer and temperature/humidity adjuster, as shown in Figure 1. An apparatus of any structure may be used as long as criteria of measurement preci-

sion described below are satisfied (see Annex B).

- a) **Electronic balance**, capable of weighing to the nearest 0.01 g.
- b) **Thermo-hygrostat box**, equipped with a programmable air conditioner capable of being set at a specific temperature and humidity, and capable of satisfying the following conditions.
 - 1) The box has sufficient capacity to accommodate the specimen.
 - 2) The temperature in the thermo-hygrostat box is measured about 50 mm from the centre of the adsorption/desorption surface of the specimen and maintained to within ± 0.5 °C of a set temperature at any position.
 - 3) The humidity in the thermo-hygrostat box is measured about 50 mm from the centre of the adsorption/desorption surface of the specimen and maintained to within ± 2 % of a set humidity at any position.

NOTE : In humidification, attention shall be paid so that the specimen is free from water spraying.

- 4) When humidity is changed stepwise, the desired humidity shall be reached within 10 min.
- c) **Thermometer**, capable of measuring the temperature to within ± 0.1 °C.
Measurement of temperature shall be in accordance with JIS Z 8704.
- d) **Hygrometer**, capable of measuring the humidity to within ± 2 %, and in accordance with JIS Z 8806.



NOTE : The windscreen should be installed when the air current from a temperature/ humidity adjuster affects a test result.

Figure 1 Typical test apparatus

6 Setting of water vapour surface resistance

- e) Adjust an air flow on the surface of a specimen with a fan to stir inside the box, so as to obtain water vapour surface resistance, as measured in Annex A, equal to $(13 \pm 2) \times 10^{-6} \text{ m}^2 \cdot \text{h} \cdot \text{Pa} / \mu\text{g}$.

7 Water vapour adsorption/desorption test method

Water vapour adsorption/desorption test method shall be as follows.

- a) **Damp proof of specimen** Provide a damp proof consisting of aluminium sheet or other appropriate material as shown in Figure 2, except for a water vapour adsorption/desorption surface.

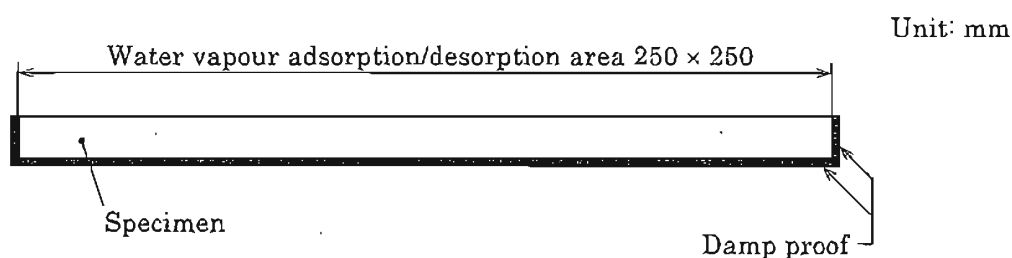


Figure 2 Damp proof of specimen

- b) **Preconditioning of the specimen** The preconditioning of the specimen shall be as follows.

- 1) The ambient temperature at the time of preconditioning shall be $23 \text{ }^{\circ}\text{C} \pm 0.5 \text{ }^{\circ}\text{C}$.
- 2) The ambient relative humidity at the time of preconditioning shall be controlled to within $\pm 2 \%$ of the value of humidity at the time of preconditioning given in Table 2.
- 3) Allow the specimen to adsorb the water vapour in the ambient air of preconditioning, and precondition until the specimen reaches constant mass.

NOTE: A specimen shall be considered as having reached constant mass during the water vapour adsorption process when the rate of increase in mass of adsorbed water vapour is less than 0.1 % in 24 h.

Table 2 Relative humidity levels to be set for water vapour adsorption/desorption test

Unit: %

Humidity condition	During pre-conditioning	Water vapour adsorption process	Water vapour desorption process	Relative humidity difference
		Step 1	Step 2	
Low humidity level	30 ± 2	55	30	25 ± 2
Middle humidity level	50 ± 2	75	50	25 ± 2
High humidity level	70 ± 2	95	70	25 ± 2
Broad humidity level	40 ± 2	80	40	40 ± 2

c) **Test procedure** The test procedure shall be as follows.

In addition, the ambient temperature at the time of a test within the thermo-hygrostat box shall be $23\text{ }^{\circ}\text{C} \pm 0.5\text{ }^{\circ}\text{C}$.

- 1) Select a humidity level from humidity conditions given in Table 2.
- 2) Place the preconditioned specimen into the test apparatus and quickly bring the water vapour surface resistance of the test specimen to the same value as that given in Annex A. Measure the mass (m_0) of the specimen.
- 3) Immediately raise the ambient relative humidity to the Step 1 relative humidity based on the humidity conditions given in Table 2, and maintain it at this value for 12 h. Then lower it to the Step 2 value and maintain it at this value for 12 h.

When the humidity is changed into Step 1 or from Step 1 to Step 2, the difference in relative humidity shall be within $(40 \pm 2)\%$ for broad humidity level, and $(25 \pm 2)\%$ for other humidity levels. The ambient relative humidity in the box at the time of test shall be controlled to within $\pm 2\%$ of the Step 1 and Step 2 values of the relative humidity.

- 4) Measure the mass of specimen continuously from the start of Step 1, at 10 min intervals to the nearest 0.01 g.
- 5) Take the mass of specimen after completion of Step 1 as m_s , and the mass of specimen after completion of Step 2 as m_d .
- 6) For a material whose residual water vapour content at the time of completion of Step 2 exceeds 30 % of that at the time of Step 1, carry out the periodic water vapour adsorption/desorption test as specified in Annex JA. Repeat this process, at least three cycles, until the residual water vapour adsorption at the time of completion of the test becomes equal to or less than 30 % of the water vapour adsorption content at the end of the last cycle.
- 7) In preconditioning of specimens given in b), if four-week preconditioning still does not enable the material to reach the constant mass, the material may be subjected to the periodic water vapour adsorption/desorption test specified in Annex JA before reaching the constant mass. In this case, repeat this process for three cycles, until the residual water vapour adsorption at the time of completion of the test becomes equal to or less than 30 % of the water vapour adsorption content at the end of the last cycle.

8 Calculation of results

Calculation of results shall be as follows. For information, the calculation procedure of water vapour infiltration coefficient is given in Annex C.

- a) **Water vapour adsorption/desorption content and residual water vapour content**
Calculate water vapour adsorption content with Equation (1), water vapour desorption content with Equation (2), and residual water vapour content with Equation (3), each to the first decimal place. The test result shall be indicated in graph

as shown in Figures 3 and 4.

$$w_a = \frac{m_a - m_0}{A} \quad \dots\dots\dots(1)$$

$$w_d = \frac{m_a - m_d}{A} \quad \dots\dots\dots(2)$$

$$w_s = w_0 - w_d \quad \dots\dots\dots(3)$$

- where,
- w_a : water vapour adsorption content at the time of completion of adsorption process (g/m^2)
 - w_d : water vapour desorption content at the time of completion of desorption process (g/m^2)
 - w_s : residual water vapour content (g/m^2)
 - m_a : mass of the specimen at the time of completion of water vapour adsorption process (g)
 - m_d : mass of the specimen at the time of completion of water vapour desorption process (g)
 - m_0 : mass of the specimen after preconditioning (g)
 - A : water vapour adsorption/desorption area (m^2)

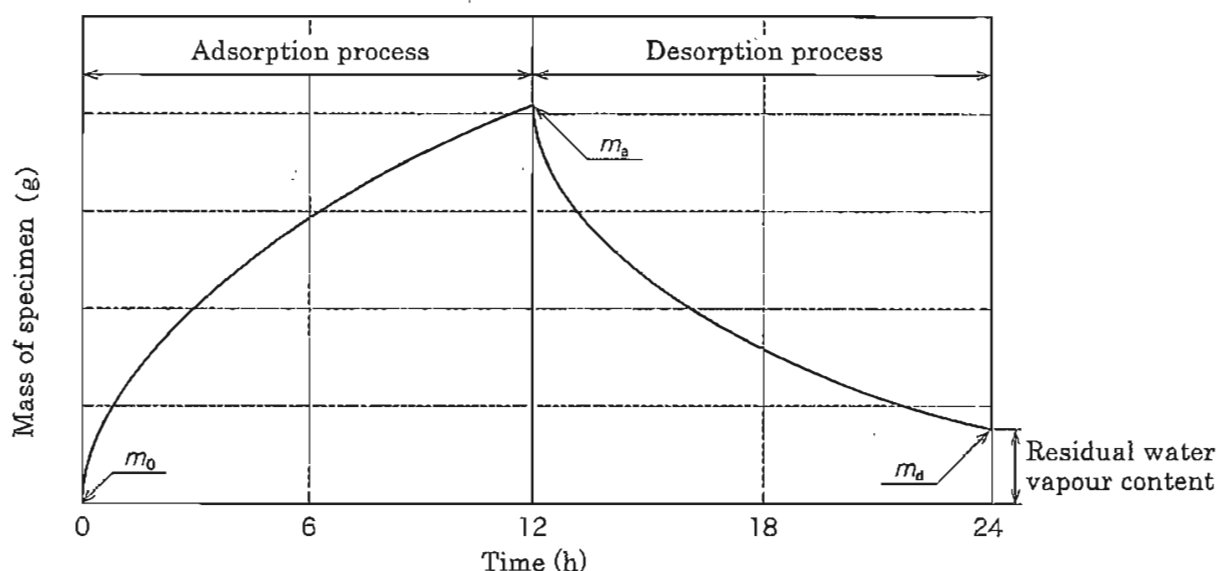
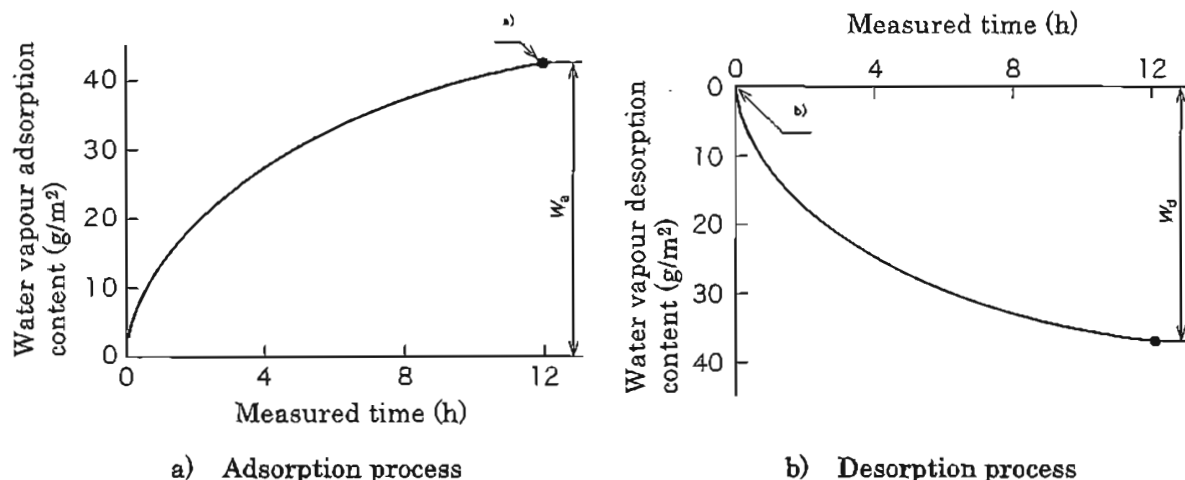


Figure 3 Typical variation of mass of the specimen in water vapour adsorption/desorption process



- a) Adsorption process
- b) Desorption process
- Notes a) Obtain this value by dividing the water vapour adsorption content after 12 h adsorption by the water vapour adsorption/desorption area of the specimen.
- b) Take the value obtained in Note a) to be zero, and plot in graph the relation between the water vapour desorption content and desorption time.

Figure 4 Typical graph showing water vapour adsorption/desorption content

- b) **Water vapour adsorption/desorption rate** Calculate water vapour adsorption/desorption rate per hour to the first decimal place, from the results of measurement of water vapour adsorption/desorption contents in 7 c) by using Equation (4).

$$G_T = \frac{m_T - m_{T-1}}{A} \dots\dots\dots (4)$$

where, G_T : water vapour adsorption rate/desorption rate at time T [$\text{g}/(\text{m}^2 \cdot \text{h})$]

m_T : mass of specimen at time T (g)

m_{T-1} : mass of specimen at time $T-1$ (g)

A : water vapour adsorption/desorption area (m^2)

The variations of water vapour adsorption/desorption rate over time shall be plotted as shown in Figure 5.

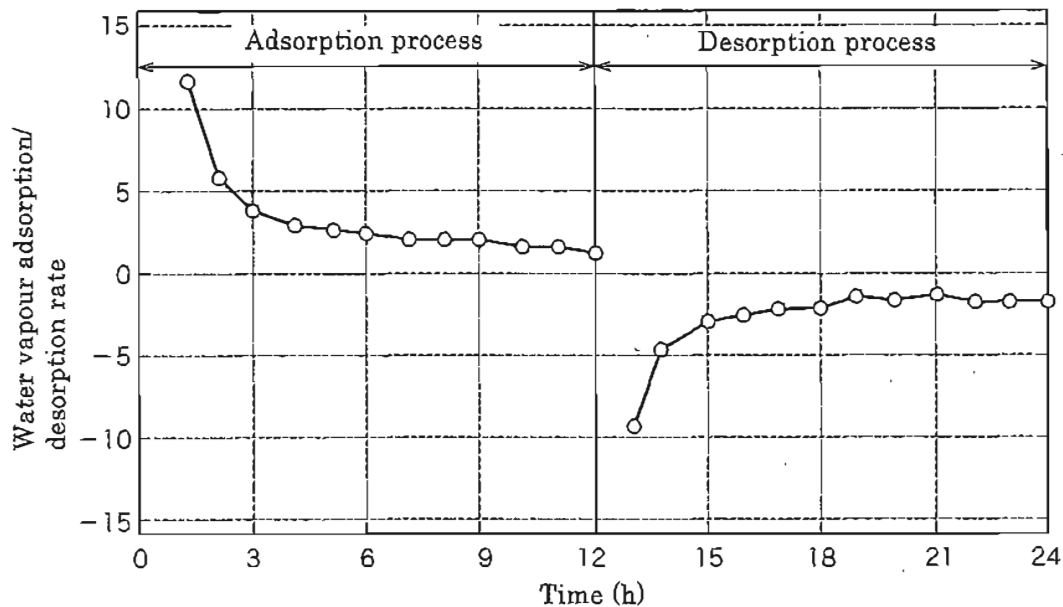


Figure 5 Typical variation of water vapour adsorption/desorption rate over time

9 Test report

The test report shall include the following.

- a) Name, type and brand name of specimen
- b) Size (mm) and thickness (mm) of specimen
- c) Apparent density of specimen (before the start of test)
- d) Test conditions Temperature ($^{\circ}\text{C}$), humidity conditions (distinction of low, middle, high, and broad humidity levels) (%), preconditioning conditions, relative humidity of water vapour adsorption process (%) and relative humidity of water vapour desorption process (%)
- e) Test results
 - 1) Variation of mass of specimen (g), water vapour adsorption/desorption content (g) over time
 - 2) Variation of water vapour adsorption/desorption rates over time [$\text{g}/(\text{m}^2 \cdot \text{h})$]
- f) Test period
- g) Name of test organization

Annex A (normative)

Measurement of water vapour surface resistance

A.1 Measurement

The measurement of water vapour surface resistance shall be as follows.

- a) **Calibration specimen** For a calibration specimen to be used for setting water vapour surface resistance on the specimen surface, prepare two identical specimens which conform to the following conditions.

- 1) Specimen having a moisture permeating resistance of $6.7 \text{ m}^2 \cdot \text{h} \cdot \text{Pa} / \mu\text{g}$ to $26.7 \times 10^{-6} \text{ m}^2 \cdot \text{h} \cdot \text{Pa} / \mu\text{g}$.
- 2) Specimen having a smooth surface.

NOTE : A sheet of similar drawing paper (0.5 ± 0.2) mm in thickness can fit these conditions.

- b) **Cup for fitting calibration specimen** A cup to which a calibration specimen is attached, shall be shaped as shown in Figure A.1. Its materials or other elements ¹⁾ shall be in accordance with JIS A 1324. Place an absorbent specified in JIS A 1324 in the cup as shown in Figure A.1.

Note ¹⁾ Use cups made of polyvinylchloride, acrylic plastics or another material having a sufficiently large moisture permeating resistance to the calibration specimen.

- c) **Fitting of calibration specimen** Fit a calibration specimen specified in a) to the cup specified in b) as shown in Figure A.1. Hermetically seal the surface except for a permeable face with a sealing material specified in JIS A 1324 so that moisture does not seep in from surroundings. A moisture permeable area of calibration specimen is the same as that of water vapour adsorption/desorption specimen.

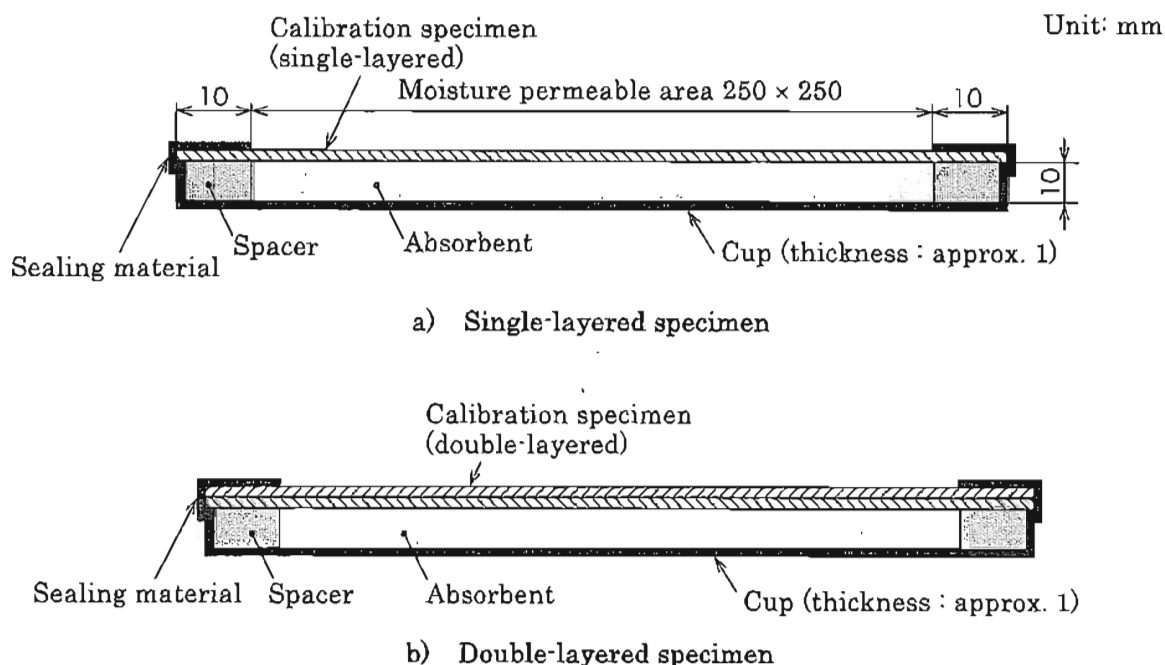


Figure A.1 Calibration specimen for setting water vapour surface resistance

- d) **Measurement of water vapour surface resistance** Measurement of water vapour surface resistance shall be as follows.
- 1) Keep both single-layered specimens and double-layered specimens prepared in c) as horizontal as the specimen placed for water vapour adsorption/desorption test.
 - 2) Carry out measurements in accordance with the cup method specified in JIS A 1324, and measure the resistance of water vapour transmission. After measurement, calculate water vapour surface resistance of the specimen using Equation (A.1). The water vapour surface resistance on the absorbent side shall be regarded sufficiently smaller than that on the opposite side.

$$1/\beta = 2R_1 - R_2 \quad \text{.....(A.1)}$$

where,

- $1/\beta$: water vapour surface resistance ($\text{m}^2 \cdot \text{h} \cdot \text{Pa}/\mu\text{g}$)
- R_1 : resistance of water vapour transmission of single-layered specimen ($\text{m}^2 \cdot \text{h} \cdot \text{Pa}/\mu\text{g}$)
- R_2 : resistance of water vapour transmission of double-layered specimens ($\text{m}^2 \cdot \text{h} \cdot \text{Pa}/\mu\text{g}$)