INTERNATIONAL STANDARD

ISO 9932

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Paper and board — Determination of water vapour transmission rate of sheet materials — Dynamic sweep and static gas methods

Papier et carton — Détermination du coefficient de transmission de la vapeur d'eau des matériaux en feuille — Méthode dynamique par balayage de gaz et méthode statique

Reference number
ISO 9932:1990(E)

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 9932 was prepared by Technical Committee ISO/TC 6, *Paper, board and pulps*.

Annexes A and B form an integral part of this International Standard. Annex C is for information only.

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Introduction

The rate of water vapour penetration through a barrier is an important property in many applications, for example, in building and in packaging. ISO 2528 describes a dish method for the determination of the transmission rate and this method has wide acceptance. It does, however, have three disadvantages. Results take several days to obtain, it is not suitable for transmission rates less than 1 g/($m^2 \cdot d$), and it is not recommended for materials thicker than 3 mm.

The methods described in this International Standard can, depending on the material being tested, produce results in a matter of hours and are suitable for materials with transmission rates considerably less than 1 g/($m^2 \cdot d$). Depending on the specific apparatus, they are also suitable for materials up to 38 mm thick.

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Paper and board — Determination of water vapour transmission rate of sheet materials — Dynamic sweep and static gas methods

1 Scope

This International Standard describes general test methods for determining the water vapour transmission rate of sheet materials by means of a dynamic gas method or a static gas method. Depending on the method and specific apparatus employed, materials up to 38 mm thick and with water vapour transmission rates in the range 0,05 g/(m² · d) to 65 g/(m² · d) can be tested. The basis of the function of the instrumental techniques is briefly described. Advice on calibration is given in annex B.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 186:1985, *Paper and board — Sampling to determine average quality.*

ISO 187:1977, *Paper and board — Conditioning of samples.*

ISO 2528:1974, *Sheet materials — Determination of water vapour transmission rate — Dish method.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 water vapour transmission rate: The mass of water vapour transmitted through unit area in unit time under specified conditions of temperature and humidity. It is expressed in grams per square metre per 24 h [g/(m² · d)].

3.2 dry side: That side of the test cell which is exposed to low humidity.

3.3 wet side: That side of the test cell which is exposed to high humidity.

4 Method A: Dynamic sweep gas method

4.1 Principle

The test piece is mounted between two chambers, one at a known relative humidity and the other swept by a dry gas. The amount of water vapour picked up by the dry gas stream is detected by an electrical sensor and converted to a reading which directly, or after calculation, is a measure of the rate of water vapour transmission through the test piece.

4.2 Apparatus[1)]

4.2.1 Test cell, designed to clamp a test piece having a defined area, between two chambers, one swept by a dry gas (the dry side) and the other containing an atmosphere of high relative humidity (the wet side) (see figure 1).

1) The EPS digital WVTR meter and the Permatron W-series are examples of suitable instruments available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of these instruments.

4.2.2 Clamping arrangements, to allow rapid insertion and removal of the test piece, equipped with suitable gaskets against which the test piece is sealed by the clamping force.

4.2.3 Provision for maintaining humidity on the wet side at the desired level. The required level of relative humidity may be obtained with saturated saline solutions containing a solid phase as described in annex A or by distilled water if 100 % relative humidity is required.

4.2.4 Inert dry gas (as required by the specific apparatus to be used), for purging on the dry side.

NOTE 1 The gas is normally desiccated air or dry nitrogen.

4.2.5 Sensor, with rapid response and high sensitivity capable of detecting levels in the moisture content of the sweep gas equivalent to 0,05 % relative humidity or less. The sensor may take a number of forms: an electrical resistance element, an electrolytic cell, or an infra-red detector.

4.2.6 Means to convert the output from the sensor into a signal that can be used to calculate the amount of moisture passing through the test piece being tested in unit time.

4.2.7 Means of maintaining the test chamber and the sweep gas and the sensor at the required temperature..

NOTE 2 The normal test temperature is either 23 °C ± 1 °C or 38 °C ± 1 °C, but other temperatures may be used.

4.2.8 Specimen of stated water vapour transmission rate supplied by the instrument manufacturer for standardization of the test cell.

5 Method B: Static gas method

5.1 Principle

The test piece is mounted in a cell containing an electrolytic element and the cell placed in a humidity cabinet at the required temperature and relative humidity. The water vapour penetrating the cell is electrolyzed and consequently the relative humidity within the cell remains very low (< 1 %). After equilibrium, the electric current is a direct measure of the rate of electrolysis (according to Faraday's law of electrolysis) and the water vapour transmission rate.

5.2 Apparatus[2)]

5.2.1 Control box, containing

a) an electric power supply;

b) a microammeter, graduated directly in grams per square metre per 24 h [g/(m² · d)];

c) selector and range switches;

d) connection points for cells and, if desired, a recorder.

5.2.2 Humidity cabinet, for storing the cells at the required conditions and having a fan for air circulation and small openings for entry of the plugs and cables of the cells. The required level of relative humidity may be obtained as prescribed in 4.2.3.

5.2.3 Stainless steel test cells, designed to clamp a defined area of a test piece and containing an electrolytic element which can be connected to the control box by means of a cable and plug.

5.2.4 Electrolytic element, consisting of two platinum wires wound at constant pitch round an inert former (glass and polytetrafluorethylene are suitable materials). A film of phosphorus pentoxide is deposited over the surface of the wires and former.

5.2.5 Means of drilling holes in test pieces.

5.2.6 Specimen of stated water vapour transmission rate.

6 Sampling

Select samples in accordance with ISO 186.

7 Preparation of test pieces

Test pieces shall be representative of the sample and shall take into account, where appropriate, variations within and between sheets and batches. The test area shall be free from faults likely to affect the determination.

The faces shall be designated one and two respectively. Where the two faces of the material can be distinguished, face one shall denote the face exposed to the wet side in service.

Carefully, in order to avoid damage to the test area, cut 10 test pieces to the required size and drill holes as necessary for the test cell being used.

2) The TNO/Pira WVTR meter is an example of a suitable instrument available commercially. This information is given for the convenience of users of this International Standard and does not constitute an endorsement by ISO of this instrument.

Composite materials may have a core of permeable material which can provide a secondary path for moisture permeation if the edges are left exposed. In this case apply aluminium foil tape to the edges of such test pieces. The foil tape shall cover the edges and overlap the face by at least 10 mm. The foil tape shall be of the self-adhesive type, using dead soft tempered foil at least 40 µm thick.

Thick test pieces of homogenous construction may also allow moisture permeation through the edges and should also be treated as above.

NOTE 3 No definitive statement can be given about the thickness at which sealing the edges becomes necessary, but as a general rule this should not be necessary for thicknesses less than 5 mm.

8 Procedure

The precise method to be used shall be obtained from the manufacturer's operation manual. The general procedure is as follows.

8.1 Method A

Fill the lower part of the test cell with water or the appropriate saturated saline solution containing a solid phase in order to obtain the required humidity and clamp the test piece in the cell with face one towards the wet side of the cell. Set the apparatus to the required temperature. Operate the apparatus in accordance with the manufacturer's instructions to obtain a reading, ensuring that a steady state has been reached. Record this reading and repeat the procedure for the remaining test pieces so that five readings are obtained with face one towards the wet side and five readings with face two towards the wet side.

8.2 Method B

Clamp the test piece in the cell with face one towards the wet side. Place the cell in the humidity cabinet at the required temperature and relative humidity. Record the rate of electrolysis of the water vapour passing into the cell as indicated by the microammeter until a steady state has been reached. Record the reading and repeat the procedure so that five readings are obtained with face one towards the wet side and five readings with face two towards the wet side.

8.3 Barrier material having one face of uncoated paper

Where one face of a barrier material consists of uncoated paper, and this face is towards the dry side, difficulties can be expected. All water must be removed from the paper by the dry gas before a constant water vapour transmission rate is indicated on the meter or recorder.

NOTE 4 The pre-conditioning can last several days and care should be taken to ensure that a true steady state has been reached. It is recommended that the test be carried out only with the paper towards the wet side.

Where a water vapour transmission rate determination yields a value grossly different from comparable samples of the same material, the execution of the particular determination is suspect and shall be investigated and, if necessary, repeated.

8.4 Creased material

For some purposes it may be necessary to determine the transmission rate of creased material; in such cases carry out the creasing procedure described in ISO 2528:1974, annex C, and then follow the procedure of method A or method B, as appropriate.

9 Expression of results

Calculate the mean and standard deviation of the separate determinations carried out with face one and face two facing the wet side respectively.

Express the results in grams per square metre per 24 h [g/(m^2 · d)] for each side, tested to two significant figures.

10 Precision

10.1 Method A

No firm statement about precision can be made at this time, but work in the USA using similar principles gave a repeatability within the range 2 % to 8 % of the test value and a reproducibility within the range 7 % to 13 % of the test value based on samples within the range 2,3 g/(m^2 · d) to 24 g/(m^2 · d) when tested at 38 °C and 90 % relative humidity.

10.2 Method B

There is no precise information for this method at present. According to experience in the Netherlands, a repeatability of about 5 % of the test value and a reproducibility of 10 % to 15 % of the test value can be expected from materials with WVTR in the range 2 g/(m^2 · d) to 5 g/(m^2 · d).

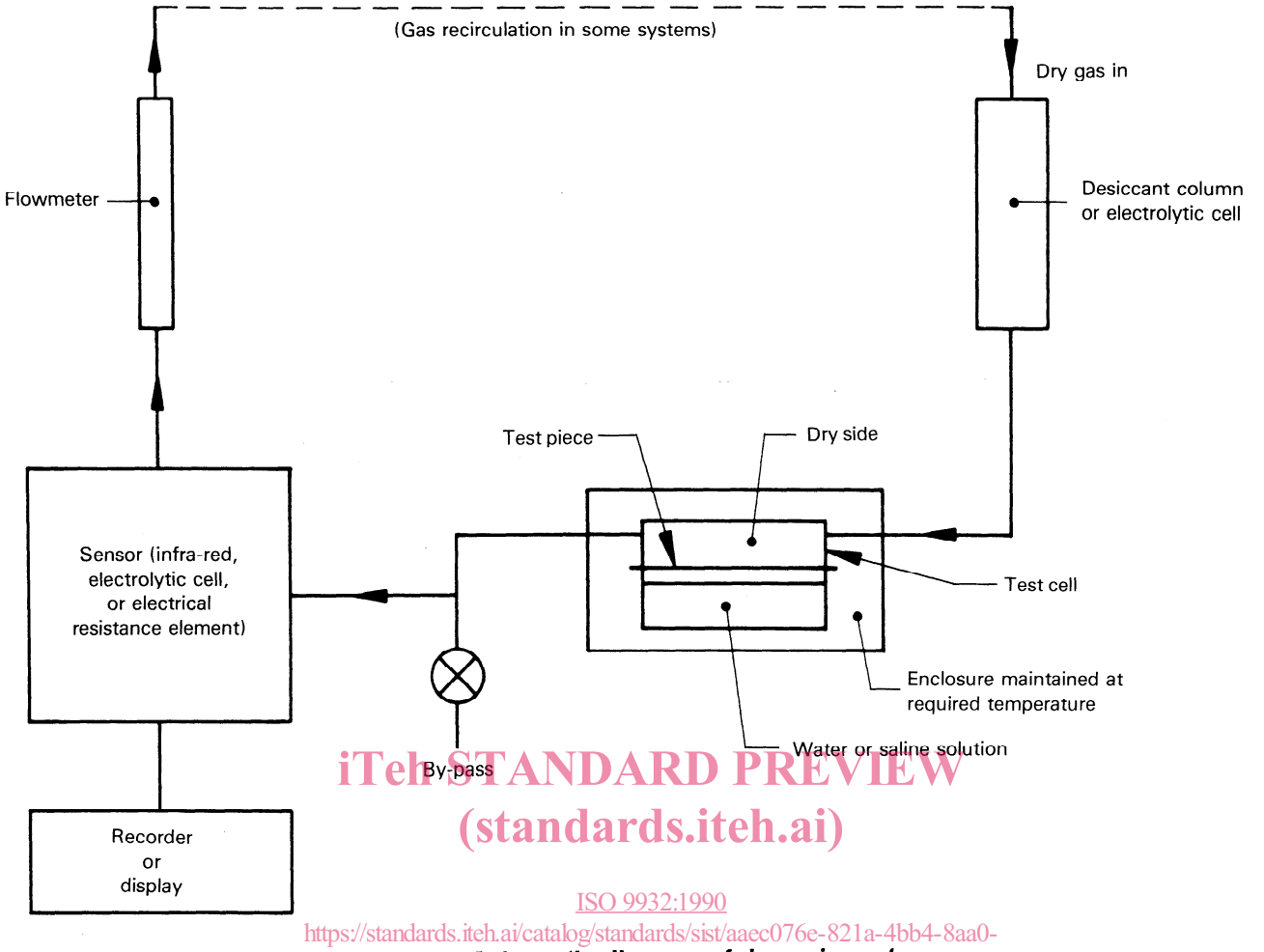

Figure 1 — Schematic diagram of dynamic system

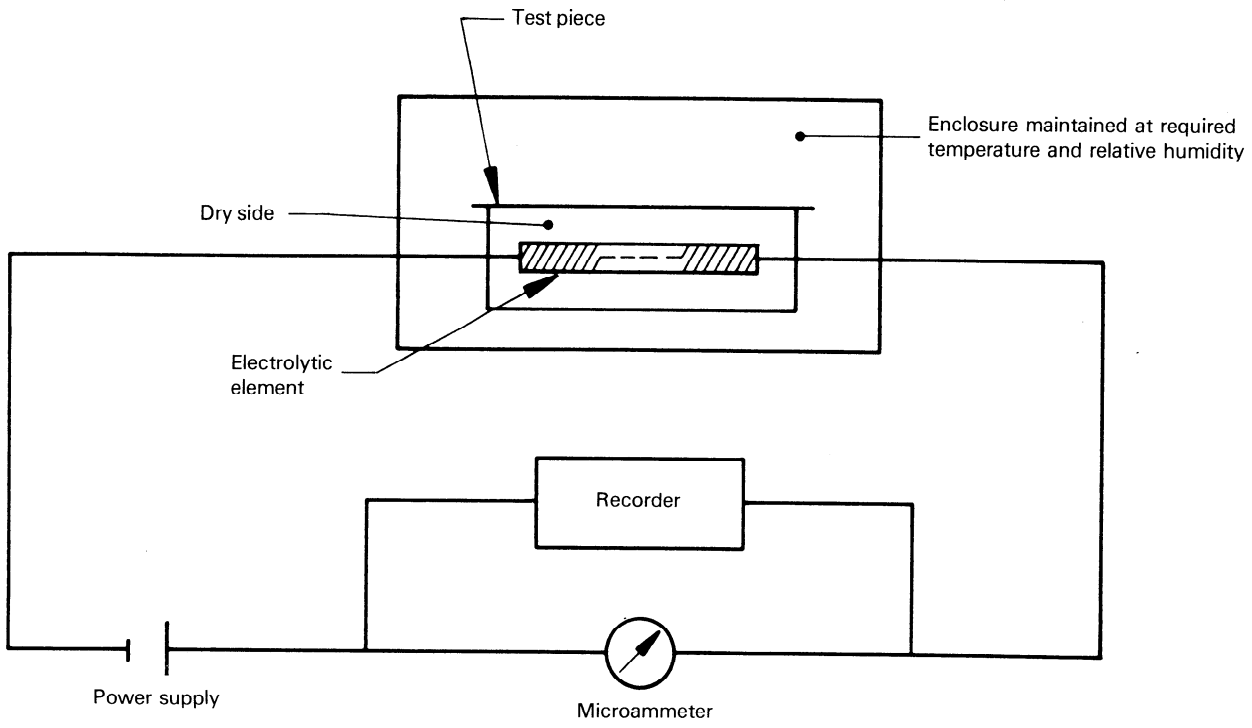

Figure 2 — Schematic diagram of static system

11 Test report

The test report shall include the following:

a) reference to this International Standard;

b) the date and place of testing;

c) all information necessary for the complete identification of the sample;

d) the type of apparatus and the type of dry gas used;

e) the temperature and relative humidity used as the test conditions;

f) the arithmetic mean of the result for each face tested;

g) the standard deviation for each face tested;

h) if necessary, the results after creasing;

i) any deviation from the procedure specified.