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Paints and varnishes — Determination of resistance to humidity —

Part 2: Condensation (in-cabinet exposure with heated water reservoir)

*Peintures et vernis — Détermination de la résistance à l'humidité —
Partie 2: Condensation (exposition en enceinte avec réservoir à eau
chauffée)*



Reference number
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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 35, *Paints and varnishes*, Subcommittee SC 9, *General test methods for paints and varnishes*.

This second edition cancels and replaces the first edition (ISO 6270-2:2005), which has been technically revised.

The main changes compared to the previous edition are as follows:

- a principle clause has been added;
- the terms and definitions clause has been added;
- a limitations clause concerning the use of other than standard test conditions has been added;
- the recommendation to use distilled or deionized water for filling the trough has been changed;
- a requirement has been added to make sure that condensation forms on all test specimens;
- a method for the determination of the comparison quantity of condensation water has been added;
- information on precision has been added;
- the normative references have been updated.

A list of all parts in the ISO 6270 series can be found on the ISO website.

Introduction

This document is intended to give consistent conditions and procedures for the conditioning of pre-prepared test specimens which are to be evaluated for defects, which may develop when they are subjected to humid ambient atmospheres such as constant condensation-water atmospheres or alternating condensation-water atmospheres.

The tests are designed to clarify the behaviour of the test specimens in humid ambient atmospheres, and to pinpoint any defects in the protection of the test specimens against corrosion. The testing of coatings in these atmospheres does not necessarily give lifetime prediction data.

After conditioning, the test specimens are evaluated either in accordance with agreed documents, such as the appropriate part(s) of ISO 4628^[1] or by procedures agreed between the interested parties.

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Paints and varnishes — Determination of resistance to humidity —

Part 2: Condensation (in-cabinet exposure with heated water reservoir)

1 Scope

This document specifies the general conditions and procedures which need to be observed when testing coated test specimens in constant condensation-water atmospheres or in alternating condensation-water atmospheres, in order to ensure that the results of tests carried out in different laboratories are reproducible.

NOTE The shape and preparation of the test specimens, the duration of the test and the assessment of the test results are not covered in this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 3270, *Paints and varnishes and their raw materials — Temperatures and humidities for conditioning and testing*

ISO 4618, *Paints and varnishes — Terms and definitions*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4618 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

4 Designation

The condensation-water test atmospheres are designated as follows:

Test atmosphere	CH	Condensation atmosphere with constant humidity
	AHT	Condensation atmosphere with alternating humidity and air temperature
	AT	Condensation atmosphere with alternating air temperature

5 Limitations

Temperature and humidity are important parameters affecting test results. Deviations from the requirements specified can lead to results that are not comparable. However, the interested parties may agree upon alternative parameters and these parameters shall be reported.

6 Principle

A coated test specimen is exposed to condensation in a climatic chamber, and the effects of the exposure are evaluated by criteria agreed in advance between the interested parties, these criteria usually being of a subjective nature.

7 Test atmospheres

Condensation-water test atmospheres promote the condensation of atmospheric humidity on the surfaces of test specimens, the temperatures of which are lower than the temperature of the saturated air in the climatic chamber, due to radiation onto the chamber walls or to the cooling of the test specimen.

The atmospheric temperature in the climatic chamber during the condensation process described in this document is $(40 \pm 3) ^\circ\text{C}$.

The condensation-water test atmosphere may be either a constant-humidity (CH) or an alternating (AHT, AT) atmosphere. If, in addition to the action of the condensation water, the change in atmospheric temperature and the change in atmospheric humidity have an important effect on the test specimens, an alternating atmosphere should be chosen.

The quantity of condensation water formed on the surface of the coating may also exercise an important influence on the action of the water; this quantity will be affected by the ambient temperature in the installation room or by the cooling of the test specimen.

The condensate which drips off the test specimens consists of condensation water and also, in some instances, of solid and liquid constituents of the coating dissolved in the condensation water or mixed with it.

Reproducible results can only be expected if the test procedure and test conditions remain constant for a series of tests.

In the case of alternating atmospheres, a cycle time of 24 h shall be used as a general rule. A shorter cycle time (12 h or 16 h) and a correspondingly shortened time for the two test periods may be used for the AT test atmosphere.

A summary of test atmospheres, cycle durations and conditions is given in Table 1. Other cycles may be used by agreement between the interested parties.

Table 1 — Condensation test atmospheres

Test atmosphere		Cycle duration		Conditions in working chamber after reaching equilibrium	
Type	Code	Test period(s)	Total	Air temperature	Relative humidity
Constant-humidity condensation atmosphere		CH	From warm-up to end of exposure	—	(40 ± 3) °C Approx. 100 % with condensation on test specimens
Alternating condensation atmosphere	With alternation of humidity and air temperature	AHT	8 h including warm-up	24 h	(40 ± 3) °C Approx. 100 % with condensation on test specimens
			16 h including cooling down (climatic chamber open or ventilated)		18 °C to 28 °C Approaching ambient
	With alternation of air temperature	AT	8 h including warm-up	24 h	(40 ± 3) °C Approx. 100 % with condensation on test specimens
			16 h including cooling down (climatic chamber closed)		18 °C to 28 °C Approx. 100 % (approximately saturated)

NOTE Set points and operational fluctuations can either be listed independently of each other, or they can be listed in the format “set point ± operational fluctuations”. The set point is the target condition for the sensor used at the operational control point as programmed by the user. Operational fluctuations are deviations from the set point at the control point as indicated by the readout of the calibrated control sensor during equilibrium operation and do not include measurement uncertainty. At the operational control point, the operational fluctuation may not exceed the listed value at equilibrium. When a standard calls for a particular set point, the user programmes that exact number. The operational fluctuations specified for the set point do not imply that the user is allowed to programme a set point higher or lower than the exact set point specified.

8 Apparatus

8.1 Climatic chamber

A vapour-tight climatic chamber is essential for testing in a warm and humid atmosphere. The material of the inner walls shall be corrosion-resistant and shall not affect the test specimens. The climatic chamber is usually equipped with a floor trough which acts as the receptacle for the quantity of water prescribed in 9.1. The climatic chamber shall be controlled by heating the water in the floor trough.

If the quantity of heat introduced via the water is insufficient to raise the air temperature in the climatic chamber to the required level, then additional heating can be employed.

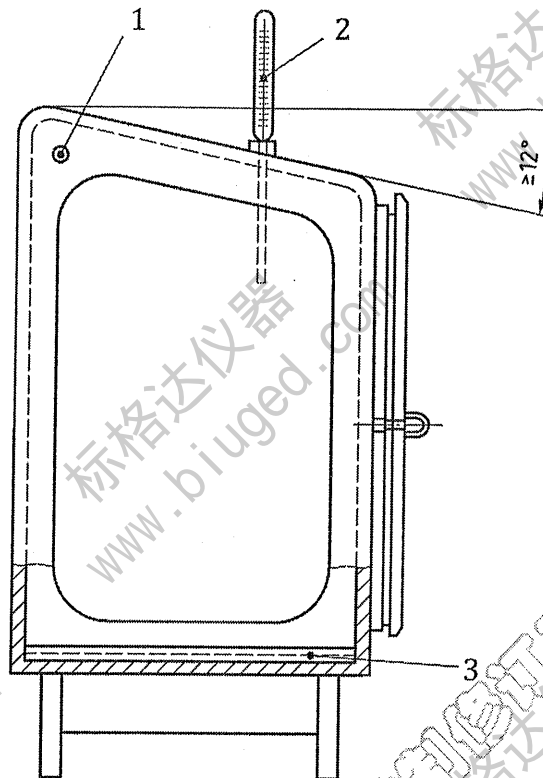
The heating-up time will depend on the nature and quantity of the test specimens, and also on the ratio of the surface of the water in the floor trough to the surface of the walls of the climatic chamber, and on the water temperature. The water temperature should preferably not exceed 60 °C in order to prevent excessive vapour formation.

The dimensions of the climatic chamber and the arrangement of its temperature-measuring and control equipment are optional, provided that the test conditions in accordance with Clause 8 and 9.3 are observed and that the temperature is measured.

The climatic chamber shall be provided with a suitable door or other aperture capable of being closed, which allows the climatic chamber to be charged with test specimens and to be ventilated.

An example of a climatic chamber is shown in Figure 1.

Climatic chambers not equipped with water-filled floor troughs shall be fitted out in such a way that adequate formation of condensation water on the test specimens is achieved.

**Key**

- 1 pressure-relief valve
- 2 temperature-measuring device
- 3 floor trough filled with water

Figure 1 — Example of a climatic chamber

8.2 Installation of the climatic chamber

The climatic chamber shall be installed in a room with an ambient atmosphere containing no corrosive constituents (e.g. it shall not be installed in a chemical laboratory), at a room temperature of $(23 \pm 5) ^\circ\text{C}$ and at a relative atmospheric humidity of 75 % max., in such a way that it is protected against draughts and solar radiation. In the case of comparison tests, the ambient temperature in the installation room shall be the standard temperature of $(23 \pm 2) ^\circ\text{C}$ in accordance with ISO 3270.

NOTE A decrease in the ambient temperature will result in an increase in the quantity of condensation water.

8.3 Device for accommodating the test specimens

The device for accommodating the test specimens shall consist of a corrosion-resistant material and shall not promote the corrosion of the test specimens. It shall allow the test specimens to be arranged in accordance with the requirements of 9.3.

9 Procedure

9.1 Filling the floor trough

The floor trough (if there is one) shall be filled with water in such a way that a depth of water of at least 10 mm is present at all times during operation.

The use of ordinary tap water may cause calcification of the apparatus, so follow the instrument manufacturer's instructions concerning the quality of the water used.

9.2 Test specimens

Only coatings which do not mutually influence one another shall be exposed together at any one time.

If specimens are likely to be affected additionally by the quantity of condensation water formed, then the quantity of condensation water shall be ascertained by way of comparison within one test cycle or within a 24-h period, with the aid of a suitable device, for the purpose of describing the test conditions (see 9.4).

9.3 Arrangement of the test specimens

The test specimens shall be arranged in the chamber at any angle greater than or equal to 60° to the horizontal in such a way that they are not in close contact with each other and that they are able adequately to radiate heat.

The following minimum spacing shall be observed:

Distance from the walls	not less than 100 mm
Distance of the bottom edge of the test specimen from the surface of the water	not less than 200 mm
Spacing between adjoining test specimens	not less than 20 mm

Precautions shall be taken to ensure that no condensation water is allowed to drip onto the test specimens from the walls or ceiling of the climatic chamber, nor from other test specimens.

Make sure that condensation forms on all test specimens.

9.4 Determination of the comparison quantity of condensation water

The device described below is suitable for the determination of the comparison quantity of condensation water:

An 18 mm × 180 mm test tube, filled with water, is used as a standard specimen. The condensation dripping from the test tube shall be collected in a graduated measuring cylinder with a nominal capacity of 10 ml via a glass funnel with a diameter of 55 mm.

The device shall be arranged in the useful space amongst the other specimens in the same way as described in 9.3 for the arrangement of the specimens, and the bottom of the test tube (which shall itself be suspended from a thread of polyamide for example) shall be situated 50 mm above the rim of the funnel placed in the graduated measuring cylinder.

9.5 Test sequence

9.5.1 Start-up

Place the test specimens in position, close the climatic chamber and switch on the heating for the floor trough water or for the climatic chamber. Heat the chamber to the air temperature required for the first test period; this temperature shall be attained within 1,5 h. Condensation water shall be formed on the test specimens.

If possible, check the formation of condensation water on the complete surface of the test specimens by examination through a window (if one exists). In any case, do not open the chamber.

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If no sufficient condensation forms, this can be corrected, e.g. by increasing the spacing between the test specimens, decreasing the total load in the test chamber or changing the ambient conditions in the lab.

9.5.2 Condensation atmosphere with constant humidity (CH)

Maintain the temperature prescribed in [Clause 7](#) in the climatic chamber for the duration of the test as given in [Table 1](#), or as mutually agreed.

In order to make an intermediate assessment, if necessary, remove the test specimens from the climatic chamber without switching off the heating, and replace them within 30 min.

9.5.3 Condensation atmosphere with alternation of humidity and air temperature (AHT)

The test consists of a prescribed or mutually agreed number of climatic cycles, each comprising a first and a second test period.

8 h after commencement of the start-up phase (see [9.5.1](#)), switch off the heating and terminate the condensation process (first test period). Open or ventilate the climatic chamber.

After a further 16 h, check the level of the water in the floor trough, top up if necessary and close the climatic chamber. Switch on the heating again and commence a new cycle.

For the purposes of an intermediate assessment, if required, the test specimens may be removed briefly from the climatic chamber before the start of a new cycle, but shall be replaced within 30 min.

In special cases, intermediate assessments can also be carried out immediately after the heating has been switched off and the climatic chamber has been opened.

9.5.4 Condensation atmosphere with alternation of air temperature (AT)

The test consists of a prescribed or mutually agreed number of climatic cycles, each comprising a first and a second test period.

In the case of a 24 h cycle, switch off the heating 8 h after commencement of the start-up phase (see [9.5.1](#)) and terminate the condensation process (first test period). The climatic chamber remains closed.

After a further 16 h have elapsed, check the level of the water in the floor trough, top up if necessary, and switch the heating on again to commence a new cycle.

In order to make an intermediate assessment, if required, briefly remove the test specimens from the climatic chamber before the start of a new cycle, but replace them within 30 min.

9.6 Interruptions

Any interruption of tests which involve alternating atmospheres shall be compensated for by a prolongation of the second test period, which normally lasts 16 h. The compensation time shall be added to the duration of the interrupted cycle in each case. The compensation time shall be recorded to the nearest minute in the test report.

9.7 End of test

Terminate the test when a specified impairment of the coating has occurred, or when the specified test duration or number of cycles has been attained.

10 Evaluation

10.1 Make a periodic examination of the specimens as quickly as possible, taking care not to damage the surfaces under test. Do not remove the specimens for more than 30 min in any 24 h period. Immediately

replace specimens which have been removed by blanking specimens. Specimens may be blotted with absorbent paper to examine them more clearly, but shall then be immediately returned to the apparatus. They shall not be allowed to dry fully.

10.2 At the end of the specified test period, immediately examine the test surface for signs of deterioration, e.g. in accordance with the appropriate part(s) of ISO 4628[4] or by procedures agreed between the interested parties (see the Introduction).

10.3 If required, keep the specimens in the standard atmosphere in accordance with ISO 3270 for the specified period and examine the test surfaces for deterioration.

10.4 If it is required to examine the substrate for signs of attack, remove the coating by means of a non-corrosive paint remover unless otherwise specified.

11 Precision

Precision is not applicable to this document because this is only the stress test. Precision will result from the subsequent evaluations of the stressed test specimens.

12 Test report

The test report shall contain at least the following information:

- a) all information necessary for identification of the product tested, including a description of the test specimens and their pretreatment if applicable;
- b) a reference to this document, i.e. ISO 6270-2;
- c) the type of test atmosphere used (CH or AHT or AT), the cycle time and the duration of the test, and the reason for terminating the test;
- d) the number and timing of any intermediate assessments performed;
- e) comparison quantity of condensation water, in millilitres per cycle or in millilitres per hour, if required in accordance with 9.2;
- f) details of handling of the test specimens between the end of the test and the beginning of the assessment;
- g) the results of the test, including the results for the individual test specimens and all the other information required by the test standards used, quoting the relevant standard in each case;
- h) any deviations from the procedure specified, including a full description of the climatic chamber if the test was carried out in equipment other than that specified in Clause 8;
- i) any unusual features (anomalies) observed during the test;
- j) the date of the test.

Bibliography

- [1] ISO 4628 (all parts), *Paints and varnishes — Evaluation of degradation of coatings — Designation of quantity and size of defects, and of intensity of uniform changes in appearance*

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