INTERNATIONAL STANDARD

ISO 6452

Third edition
2021-05

Rubber- or plastics-coated fabrics — Determination of fogging characteristics of trim materials in the interior of automobiles

Textiles revêtus de caoutchouc ou de plastique — Détermination des caractéristiques d'embuage des matériaux de garnissage utilisés dans l'habitacle automobile

Reference number
ISO 6452:2021(E)

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Published in Switzerland

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Foreword

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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).

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For an explanation of 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 www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 04, *Products (other than hoses)*.

This third edition cancels and replaces the second edition (ISO 6452:2007), which has been technically revised.

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

— air has been added as a suitable thermal transfer fluid for the test apparatus;

— a new Annex B on comparison between air chamber and oil bath test results has been added;

— precision data in Annex A have been updated with the results of an interlaboratory test program (ITP) carried out in 2019-2020.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Rubber- or plastics-coated fabrics — Determination of fogging characteristics of trim materials in the interior of automobiles

WARNING — Persons using this document should be familiar with normal laboratory practice. This document does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user to establish appropriate safety and health practices and to ensure compliance with any national regulatory conditions.

1 Scope

This document specifies a test method which is intended to determine the fogging characteristics of rubber- or plastics-coated fabrics that are used as trim materials in the interior of motor vehicles.

The method can also apply to fluid, pasty, powdered or solid raw materials which are the basis for such trim materials or from which the materials are manufactured. The method can also apply to other materials and finished products.

The procedure is applicable to the measurement of fog condensate on glass surfaces within the limits of the test conditions. This test cannot measure accurately those cases in which:

— the surface tension of the condensate is low, resulting in early coalescing into a thin transparent film;

— the condensate is present in such a large quantity that the droplets coalesce and form a heavy oily/clear film (this heavy film gives false readings).

In such cases, the gravimetric method is preferred.

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 2813, *Paints and varnishes — Determination of gloss value at 20°, 60° and 85°*

3 Terms and definitions

No terms and definitions are listed in this document.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

4 Principle

A test piece or portion is heated in a glass beaker. Any volatile constituents are condensed on either a cooled glass plate or a disc of cooled aluminium foil.

The fogging value F is calculated as the quotient, in percent, of the gloss value for the glass plate with fogging condensate and the gloss value of the same glass plate without fogging condensate. The gloss values are measured in accordance with ISO 2813.

The mass of the condensable constituents G is given by the difference between the masses of the aluminium foil disc before and after fogging.

5 Materials

5.1 Thermal transfer fluid, liquid or air, for the thermostatically controlled bath or chamber (6.1). The fluid shall be temperature-stable and preferably water-soluble for easier cleaning. A suitable fluid is a modified polyhydric aliphatic alcohol or air.

5.2 Glass-cleaning detergent, of a non-alkaline type.

5.3 Reference liquid, diisodecyl phthalate (DIDP)[1].

6 Apparatus

6.1 Thermostatically controlled bath or **chamber**, designed to operate at up to 130 °C. Safety devices shall be fitted to prevent overheating. The circulation system, the bath or chamber capacity and the heating system shall be such that the temperature can be kept constant to within ± 0,5 °C throughout the bath or chamber. The agitation of the bath or chamber shall be done at a slow and uniform speed.

NOTE 1 It is very important to keep the temperature correct, as tests have shown that only a 0,5 °C difference can be seen in the test results.

NOTE 2 Some heaters/circulators have a centrifugal pump in the bottom, pumping the liquid at high speed around the bath. The beakers (6.3) will then have the liquid passing them at different speeds and this will cause different temperatures in different beakers.

NOTE 3 Comparison between air chamber and oil bath test results is described in Annex B for reference.

The bath or chamber shall be designed so that, after placing the beakers (6.3) in the bath or chamber, the temperature does not drop more than 5 °C, and the test temperature is regained after no more than 20 min. The minimum distance between the beakers and the walls shall be 30 mm and between the bottom of the bath and the beakers 60 mm.

The bath or the chamber shall be equipped with a device indicating the distance between the fluid and the lower surface of the glass plate (6.6). This distance shall be (60 ± 2) mm.

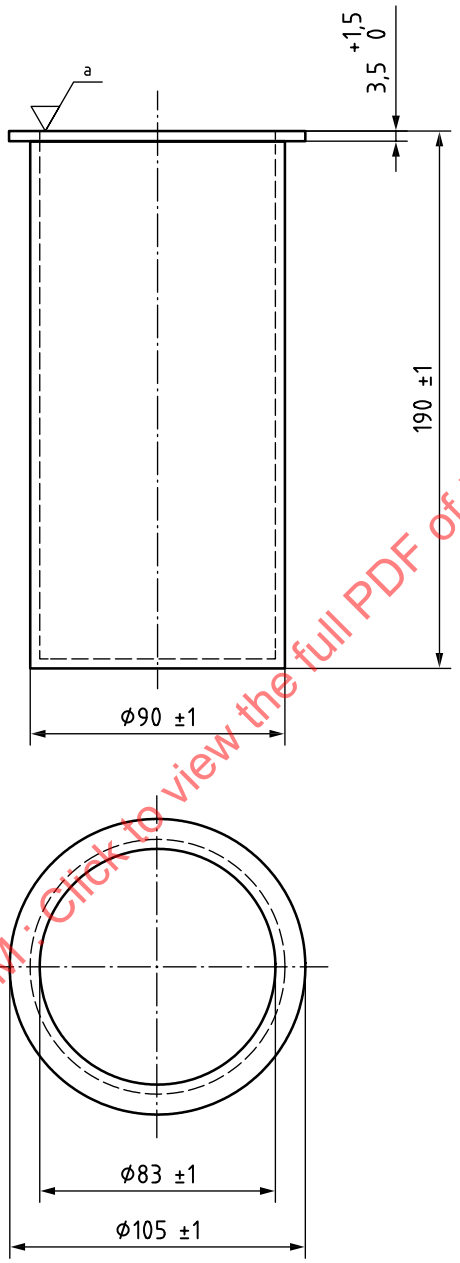
6.2 Cooling plates, designed to be placed on the glass plate (6.6) to keep them cool. The cooling plate shall be hollow and made of corrosion-resistant metal, with the side facing the glass plate made of aluminium. They shall have two cooling-water connections located so that the cooling water flows through the whole of the interior of the plate. The surface in contact with the glass plate shall be flat. When using liquid for thermal transfer fluid, the mass of a cooling plate filled with water shall be at least 1 kg, to overcome the buoyancy of the beaker (6.3) in the bath. The whole of the weight of the cooling plate shall rest on the beaker. A separate cooling plate shall be used for each beaker.

The cooling plate and the associated water thermostat shall be designed so that the mean water temperature is 21 °C and the difference in temperature between the inlet and outlet does not exceed 1 °C.

1) DIDP reference liquid can be obtained from: SP Technical Research Institute of Sweden, Chemistry and Materials Technology, Box 857, SE-501 15 Borås, Sweden, Fax: +46 33 10 33 88, E-mail: info@sp.se. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of the product named.

6.3 Flat-bottomed beakers, of heat-resistant glass, minimum mass 400 g, with the dimensions shown in Figure 1.

Dimensions in millimetres



a Ground.

Figure 1 — Glass beaker

6.4 Metal rings, external diameter 80 mm, internal diameter 74 mm, height 10 mm and mass (55 ± 1) g, made of corrosion-protected steel, to keep the test pieces flat.

6.5 Sealing rings, of silicone- or fluoro-rubber, L-shaped or circular in cross-section, inner diameter 90 mm to 95 mm, thickness 2 mm to 4 mm and hardness 50 IRHD to 70 IRHD.

6.6 Float glass plates, of residential or windshield window quality, for condensation of the fogging, thickness (3 ± 0,2) mm, either square with minimum dimensions of (110 × 110) mm or circular with a diameter of 103 mm. The gloss values of all the plates used shall be the same to within ± 2 % units. The tin and non-tin surfaces of the plate shall be identified and the identification mark shall be placed on the plate.

NOTE The tin and non-tin surfaces of the glass plate can be identified by viewing the surface in a darkened room under a UV light at 254 nm wavelength. The tin surface fluoresces when it is exposed to the UV light.

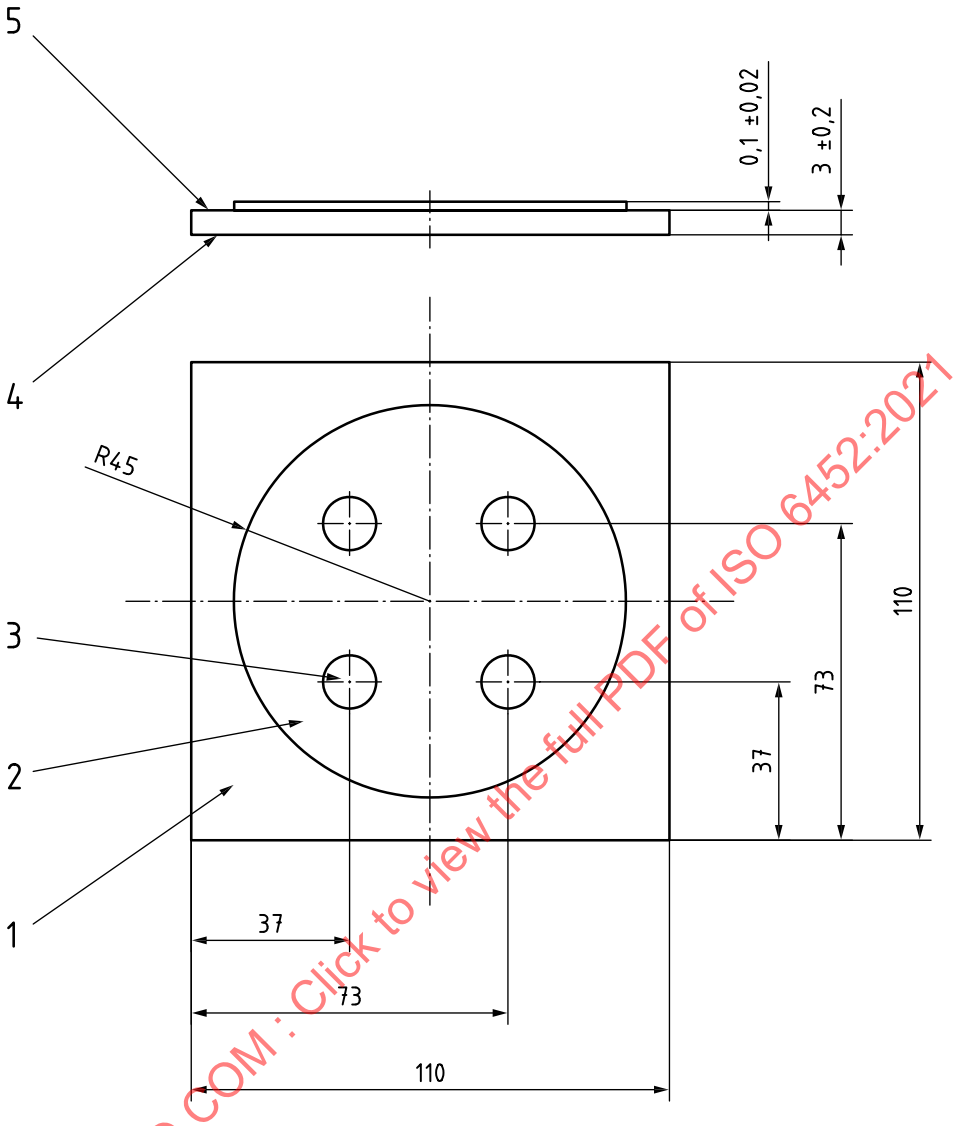
6.7 Filter paper, with a diameter of 110 mm and a mass per unit surface area of 90 g/m^2.

6.8 Aluminium foil discs, thickness 0,03 mm, diameter (103 ± 1) mm. Store the prepared aluminium foil disc in a desiccator (6.15) to avoid condensation and contamination.

6.9 Gloss meter, with a 60° incident beam and 60° measurement beam in accordance with ISO 2813.

6.10 Spacer, designed to prevent contact with the condensate on the glass plate during gloss meter measurements, made of a suitable material such as paper or plastic with a circular hole for the measurements. The thickness of the spacer shall be (0,1 ± 0,02) mm (see Figure 2).

Dimensions in millimetres



Key

1 float glass plate
2 spacer
3 circular holes for the measurements
4 tin surface of glass plate
5 non-tin surface of glass plate

Figure 2 — Example of a spacer on top of glass plate

6.11 Dishwasher, preferably connected to a deionized-water supply and capable of being operated at 80 °C.

6.12 Balance, with scale divisions of 0,01 mg.

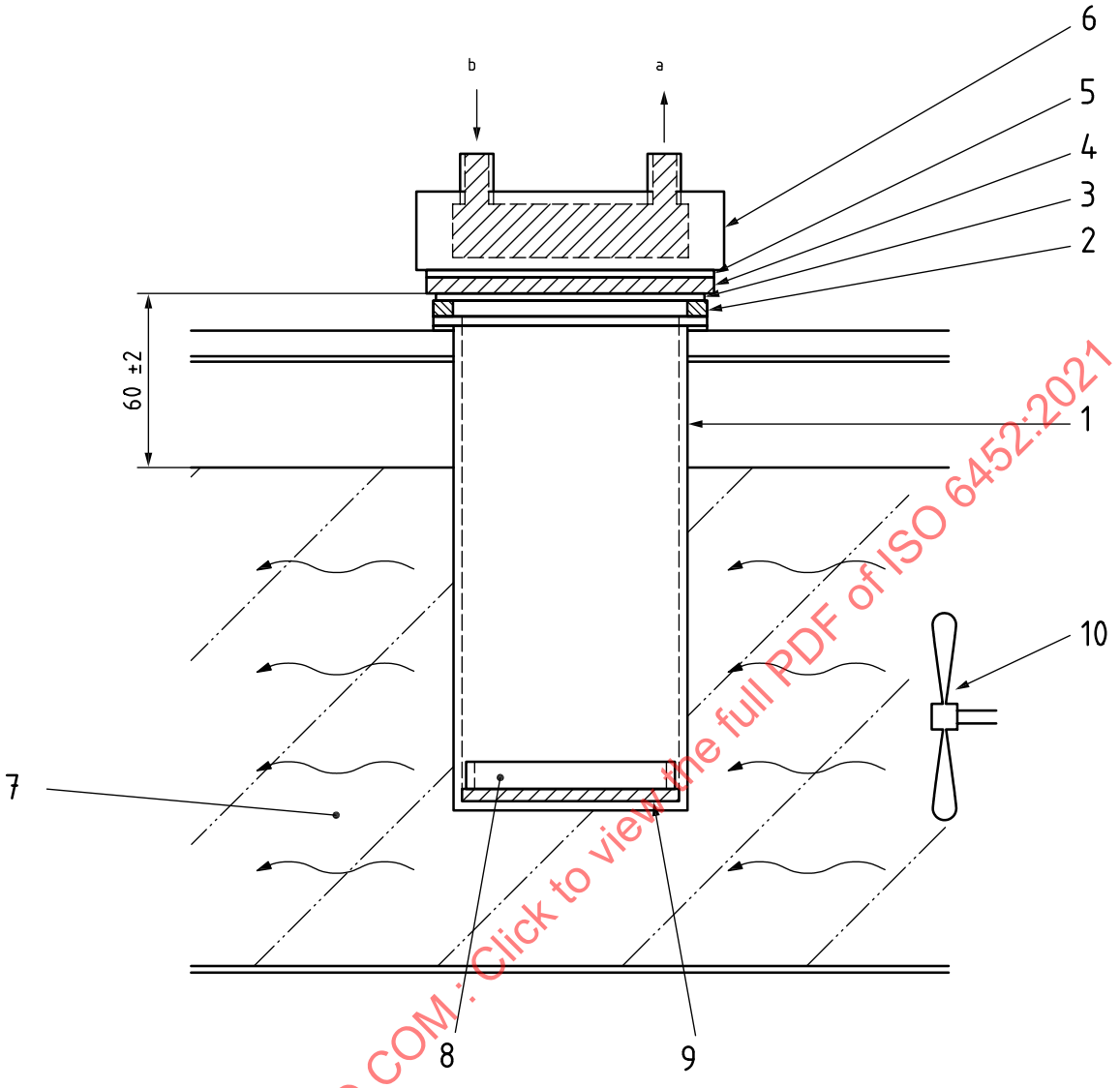
6.13 Polyethylene gloves.

6.14 Tongs.

6.15 Desiccator, with suitable drying material.

An example of a test apparatus is shown in Figure 3.

Dimensions in millimetres



Key

1	beaker	7	thermal transfer fluid (liquid or air)
2	sealing ring	8	metal ring (if necessary)
3	aluminium foil disc (determination of mass of condensable constituents *G* test only)	9	test piece
		10	agitating fan
4	float glass plate	a	Cooling-water outlet.
5	filter paper	b	Cooling-water inlet.
6	cooling plate		

Figure 3 — Example of a test apparatus

7 Test pieces and test samples

In the case of finished products, cut circular test pieces with a diameter of (80 ± 1) mm from the sample. The thickness of the test pieces can be up to 10 mm. Machine thicker materials on the underside to 10 mm (the underside is the side facing away from the side which is visible in the vehicle). If other test piece dimensions are required, these may be as given in the product specification or as agreed between the interested parties.

In the case of powdered, pasty or fluid materials, take a (10 ± 0,1) g test portion of the sample.

Take two test pieces or portions for the determination of the fogging value *F* and another two for the determination of the mass of the condensable constituents *G*.

8 Conditioning

Unless otherwise specified, condition all test pieces or portions at 23 °C and 50 % RH for at least 16 h.

Foamed materials and coated fabrics shall be conditioned by drying in accordance with Table 1 in a desiccator over phosphorus pentoxide (or silica gel) on a carrier, without the use of a vacuum.

Table 1 — Drying times

Material	Drying time days
Foamed materials	1
Coated fabrics	2
Materials with a high water content (e.g. leather)	7

9 Procedure

9.1 Cleaning

9.1.1 General

Only touch the beakers (6.3) on the outer surfaces. Do not touch the glass plates (6.6) or the metal rings (6.4) with bare hands; use gloves (6.13) or tongs (6.14).

After the glass plates have been cleaned and dried, make a visual check that the plates are free of scratches and other defects; if they are not, discard them.

After cleaning, store all items, the beakers upside-down, in a dust-free environment at room temperature until the measurements are made.

9.1.2 Cleaning with a dishwasher

Wash the sealing rings (6.5), beakers and metal rings twice in a dishwasher (6.11) with glass-cleaning detergent (5.2). If the dishwasher is not connected to a deionized-water supply, rinse the cleaned equipment in deionized water.

Prior to each use, clean all glass plates twice in the dishwasher at 80 °C using a glass-cleaning detergent. If the dishwasher is not connected to a deionized-water supply, rinse the cleaned glass plates in deionized water at room temperature and dry them in an upright position.

It is recommended that the glass plates are not reused more than a few times, since microscopic scratches may affect the rate of deposition of any vapours and hence the reproducibility of the method. Discard any glass plates that have surface scratches or abraded spots.

NOTE Tests have shown that it is very important to use a neutral or acid detergent as alkaline detergent affects the glass surface and the fogging value calculated from gloss values increases.

9.2 Reference tests

In parallel with every fogging test, carry out a reference test to determine the fogging value *F* of the reference liquid DIDP (5.3). For this purpose, add (10 ± 0,1) g of DIDP to a beaker, taking care not to moisten the inner wall of the beaker. Place the beaker with the DIDP in the bath or chamber (6.1),

using a different position for each test. After the test period of (180 ± 3) min at the bath or chamber temperature of (100 ± 0,5) °C, the fogging value shall be within 76 to 98. If this is not the case, check the test conditions.

Carry out the same procedure with DIDP when determining the mass of the condensable constituents *G*. After the test period of (16 ± 0,2) h at the bath or chamber temperature of (100 ± 0,5) °C, the mass of the condensable constituents shall be within 0,40 mg to 0,90 mg. If this is not the case, check the test conditions.

NOTE It is very important not to moisten the walls of the beaker with the DIDP when handling the beaker, as this will give a larger area with DIDP and a higher test result.

9.3 Arrangement of test pieces and samples

Insert the test pieces or portions into beakers (one test piece or portion per beaker). Do not touch the test pieces or portions with bare hands.

Place the test pieces so that the visible side, i.e. the side facing the vehicle interior, faces upwards. If necessary to prevent rolling and warping of the test pieces, place a metal ring on each.

When testing powdered, pasty or fluid materials, use a (10 ± 0,1) g test portions of the sample, uniformly distributing it over the bottom of the inside of the beaker.

9.4 Measurements prior to the fogging test

When gloss values are to be determined, calibrate the gloss meter (6.9) in accordance with the manufacturer's operating instructions. For this purpose, place a glass plate, with the non-tin side up, on a matt-white filter paper backing and place a spacer on the glass plate. Make markings on the spacer for the edges of the gloss meter. Place the gloss meter against these markings. The measurement spots shall be at a distance of (25 ± 5) mm from the centre of the glass plate. Take four readings R_{01} to R_{04} with the-gloss meter aligned parallel to the plate edges (or the tangents to the plate edges in the case of circular plates), rotating the gloss meter by 90° between each reading.

Since the measured gloss meter values before and after the fogging test are to be linked in pairs, the measurement geometry shall be the same in each case. The glass plates shall therefore be marked so that they can be positioned in exactly the same way before and after the fogging test.

When the mass of the condensable constituents is to be determined, use aluminium foil discs. Use polyethylene gloves when handling the discs. Take care not to crease the discs. A recommended method of preparing the discs is to cut them out by stamping from several layers of aluminium foil alternating with layers of paper edge-welded to the foil. Take care to avoid contaminating the discs when cutting them out. Use the depression produced in the discs by the stamping procedure to give an improved seal with the sealing ring. Determine the mass G_0 of each disc to ± 0,02 mg.

9.5 Fogging test

9.5.1 Set-up

Place a sealing ring on top of each loaded beaker. For the determination of the fogging value *F*, place a clean glass plate, with its non-tin surface of known R_0 value facing downwards, on top, covering the beaker. For the determination of the mass of the condensable constituents *G*, place a weighed aluminium disc (6.8), bright side downwards, on the sealing ring, followed by a clean glass plate.

Place the beakers prepared in this manner in the thermostatic bath or chamber held at (100 ± 0,5) °C.

NOTE 1 Other temperatures can be agreed upon by the interested parties.

Place a filter paper (6.7) on each glass plate (to prevent scratching of the surface of the glass plate), followed by a cooling plate (6.2).

Set the temperature of the cooling water at (21 ± 1) °C.

NOTE 2 Other temperatures can be agreed upon by the interested parties.

Ensure that the distance between the level of the fluid at the test temperature and the lower surface of each glass plate is (60 ± 2) mm.

In case of using a liquid for thermal transfer fluid, when changing the test temperature, check the level as the volume of the liquid changes with temperature.

9.5.2 Determination of fogging value, *F*

Keep the beakers in the thermostatic bath or chamber for a period of (180 ± 3) min.

NOTE 1 Other periods can be agreed upon by the interested parties.

Then raise the glass plates without touching the fogging condensate and store in a horizontal position, with the fogging condensate upwards, in a dust- and draught-free atmosphere at (23 ± 2) °C and (50 ± 5) % RH. Do not expose the glass plates to direct sunlight.

Carry out the measurement of the gloss meter value after a storage period of (60 ± 6) min.

NOTE 2 Other periods can be agreed upon by the interested parties.

Prior to measuring the fogging condensate with the gloss meter, check visually that the condensate does consist of droplets, and does not consist of a continuous film or contain crystals or other structural features. Do not measure gloss meter values of such condensates since they give misleading results. If such condensates are formed, mention this fact in the test report. If necessary, repeat the test.

Calibrate the gloss meter. Then place the glass plate on the white filter paper backing, and the spacer on the glass plate.

Place the gloss meter over the guide markings and take four readings R_{11}, R_{12}, R_{13} and R_{14}.

Measure the gloss values for two test pieces or portions. If the fogging values obtained deviate by more than 10 % from the mean value, test a further two test pieces or portions and calculate the mean value of only those which are within ± 10 % of the mean.

9.5.3 Determination of mass of condensable constituents, *G*

Allow the beakers to remain in the thermostatic bath or chamber for (16 ± 0,1) h. After this period, carefully remove the aluminium discs, on their sealing rings, and store them with the fogged side up in a desiccator for 3,5 h to 4 h. Do not over-fill the desiccator. Do not expose the discs to direct sunlight in the desiccator. Determine the mass G_1 of each fogged disc to within 0,01 mg.

Carry out measurements on two test pieces or portions. If the masses of the condensable constituents deviate by more than 10 % from the mean value, test a further two test pieces or portions and calculate the mean of the results obtained for all four test pieces or portions.

10 Expression of results

10.1 Fogging value

To calculate the fogging value *F*, first calculate the fogging value F_j for each glass plate using the formula

$$F_j = \left(\frac{R_{11}}{R_{01}} + \frac{R_{12}}{R_{02}} + \frac{R_{13}}{R_{03}} + \frac{R_{14}}{R_{04}} \right) \times \frac{100}{4}$$

where

F_j is the fogging value for the jth plate, in %;

R_{11} to R_{14} are the gloss meter readings for the fogged plate, in GU;

R_{01} to R_{04} are the gloss meter readings for the unfogged plate, in GU.

The fogging value F, in %, is the mean of the F_j values. Report F to the nearest whole number.

10.2 Mass of the condensable constituents

To calculate the mass of the condensable constituents G, first calculate the mass of condensable constituents G_j on each aluminium disc using the formula

$$G_j = G_1 - G_0$$

where

G_j is the mass of the condensable constituents on the jth disc, in mg;

G_0 is the mass of the disc before the test, in mg;

G_1 is the mass of the disc after the test, in mg.

The mass of the condensable constituents G, in mg, is the mean value of the G_j values. Report G to the nearest 0,1 mg.

11 Precision

See Annex A.

12 Test report

The test report shall include the following particulars:

a) a reference to this document including its year of publication i.e. ISO 6452:2021;

b) the parameter measured, i.e. the fogging value F or the mass of the condensable constituents G;

c) all details necessary for complete identification of the test samples;

d) the temperatures and times used for the test;

e) the test results, i.e.

fogging value: individual values F_j

arithmetic mean F

number of test pieces or portions

control value (DIDP);

or

condensable constituents: individual values G_j

arithmetic mean G

number of test pieces or portions

control value (DIDP);

f) any special observations, e.g. details of condensates that could not be measured, large droplets, film formation, crystal formation or running condensates;

g) any deviations from the standard test procedure;

h) the date of the test.

Annex A
(informative)

Precision

A.1 General

A.1.1 An interlaboratory test program (ITP) for the precision evaluation of the two test procedures, fogging value *F* and mass of condensable constituents *G*, was planned and conducted from September 2019 to March 2020. The precision was calculated in accordance with ISO 19983:2017 (Method B). A total of 10 laboratories participated in this ITP.

A.1.2 Three test samples including DIDP (see 5.3) as a reference liquid were chosen for this ITP as shown in Table A.1. They were sent out to each laboratory with instructions to carry out the test on two different days at an interval of one-week.

A.1.3 The precision results as determined by this ITP should not be used for acceptance/rejection testing of any group of materials or products without documentation that the results are applicable to those materials or products and the specific test protocol of this test method.

Table A.1 — Number of laboratories for ITP

Material	Number of laboratories		Total[a]
	Air chamber	Oil bath	
DIDP	7	3	10
Rubber	7	3	10
PVC leather	7	3	10

[a] One laboratory with both air chamber and oil bath is counted two and another laboratory tested only *G* value with both air chamber and oil bath.

A.2 Results

A.2.1 The results of the precision calculations are given in Table A.2, A.3 and A.4. Table A.3 is the precision in oil bath but for reference only because of a few laboratory participants.

The measured values of DIDP as a reference liquid show that all the tests meet the requirement described in 9.2.

A.2.2 The symbols used are as follows:

F fogging value

G mass of condensable constituents

S_D day-to-day repeatability standard deviation

r_D day-to-day in repeatability, in measurement units

(r_D) day-to-day repeatability, in percent of the mean level

S_R reproducibility standard deviation

R reproducibility, in measurement units

(R) reproducibility, in percent of the mean level

Table A.2 — Precision of F and G in air chamber

Property	Material	Mean value	Within laboratory repeatability			Between laboratories reproducibility		
			S_D	r_D	(r_D) %	S_R	R	(R) %
F (%)	DIDP	82,8	0,4	1,1	1,32	4,3	12,2	14,7
	Rubber	65,9	4,2	12,0	18,2	13,8	39,0	59,1
	PVC leather	31,7	1,0	2,7	8,5	3,1	8,7	27,4
G (mg)	DIDP	0,57	0,05	0,13	22,4	0,10	0,27	47,9
	Rubber	2,19	0,17	0,48	21,9	0,14	0,41	18,6
	PVC leather	2,73	0,16	0,45	16,4	0,71	2,01	73,7

Table A.3 — Precision of F and G in oil bath (for reference only)

Property	Material	Mean value	Within laboratory repeatability			Between laboratories reproducibility		
			S_D	r_D	(r_D) %	S_R	R	(R) %
F (%)	DIDP	82,6	2,1	6,0	7,2	3,7	10,6	12,8
	Rubber	77,4	4,3	12,3	15,8	11,9	33,7	43,5
	PVC leather	30,1	1,5	4,1	13,4	4,4	12,4	40,2
G (mg)	DIDP	0,51	0,01	0,01	2,71	0,06	0,17	32,6
	Rubber	2,10	0,10	0,26	12,5	0,35	0,98	47,1
	PVC leather	3,25	0,07	0,20	6,2	0,63	1,77	54,6

Table A.4 — Precision of F and G in both air chamber and oil bath together

Property	Material	Mean value	Within laboratory repeatability			Between laboratories reproducibility		
			S_D	r_D	(r_D) %	S_R	R	(R) %
F (%)	DIDP	82,8	1,17	3,32	4,00	3,87	11,00	13,2
	Rubber	68,8	4,26	12,04	17,5	13,6	38,5	56,0
	PVC leather	31,4	1,12	3,16	10,1	3,13	8,84	28,2
G (mg)	DIDP	0,58	0,03	0,10	16,4	0,09	0,25	43,4
	Rubber	2,16	0,15	0,42	19,7	0,21	0,59	27,5
	PVC leather	2,90	0,14	0,38	13,2	0,69	1,96	67,6

A.3 Repeatability

The repeatability, r_D or (r_D) of the test method was established as the appropriate value tabulated in Table A.2 and A.4 for each material. Two single test results that differ by more than the value should be considered suspect, and it is recommended that some appropriate investigative action be taken.