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Textiles — Test methods for nonwovens —

Part 12: Demand absorbency

Textiles — Méthodes d'essai pour nontissés —

Partie 12: Absorption par contact unifacial

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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this part of ISO 9073 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 9073-12 was prepared by Technical Committee ISO/TC 38, *Textiles*.

ISO 9073 consists of the following parts, under the general title *Textiles — Test methods for nonwovens*:

— *Part 1: Determination of mass per unit area*

— *Part 2: Determination of thickness*

— *Part 3: Determination of tensile strength and elongation*

— *Part 4: Determination of tear resistance*

— *Part 6: Absorption*

— *Part 7: Determination of bending length*

— *Part 8: Determination of liquid strike-through time (simulated urine)*

— *Part 9: Determination of drape coefficient*

— *Part 10: Generation of lint and other particles in the dry state*

— *Part 11: Run-off*

— *Part 12: Demand absorbency*

Annex A forms a normative part of this part of ISO 9073. Annexes B and C are for information only.

Textiles — Test methods for nonwovens —

Part 12: Demand absorbency

1 Scope

This part of ISO 9073 describes a method for the evaluation of the absorbency of fabrics when one side is in contact with a liquid and the fabric is under mechanical pressure.

This test is designed to allow comparison of absorbent materials such as nonwovens and is not intended to simulate in-use conditions of finished products.

NOTE Demand absorbency is also called demand wettability.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 9073. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 9073 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 139:1973, *Textiles — Standard atmospheres for conditioning and testing*

ISO 3696:1987, *Water for analytical laboratory use — Specification and test methods*

3 Terms and definitions

For the purposes of this part of ISO 9073 the following terms and definitions apply.

3.1
maximum absorbed mass
A_f
mass of liquid absorbed, in grams, at time T_f, when the absorbed mass variation in the previous 5 s time period is lower than 1 % of the absorbed mass corresponding to T_f

3.2
demand absorbency capacity
DAC
maximum absorbed mass of liquid, A_f, divided by the mass of the test piece, m, expressed in grams per gram

3.3
maximum absorption rate
MAR
maximum change in liquid absorbed mass per time interval, expressed in grams per second

NOTE The MAR is calculated over a 1 s time period from data recorded with sampling intervals of 0,25 s or less. The maximum absorption rate is observed at the point of inflexion of the curve absorbed mass of liquid versus time.

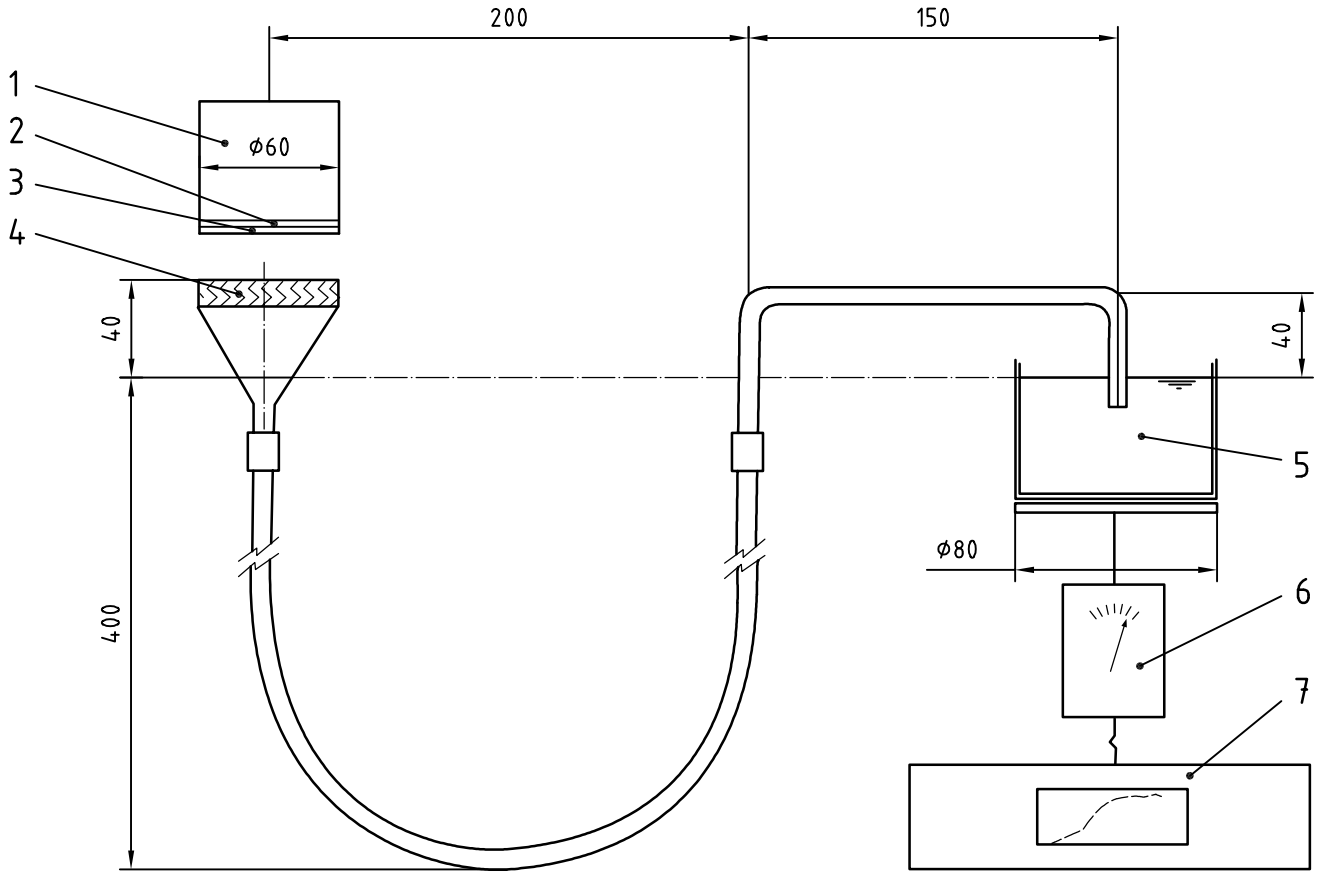
4 Principle

The method measures the demand absorbency of a fabric under constant mechanical pressure. The test piece is placed on a specified porous plate, which is connected by a siphon to a liquid reservoir. The level in the reservoir is set below the upper surface of the porous plate. The demand absorbency is measured in terms of the change in mass of the reservoir with time.

5 Apparatus

See Figure 1.

Dimensions in millimetres



Key

1 Cylindrical weight
2 Foam piece
3 Sample
4 Porous glass plate
5 Reservoir
6 Electronic balance
7 Data system

Figure 1 — Siphon assembly

5.1 Plain porous glass plate, diameter (60 ± 1) mm set into the top of a funnel which has a minimum outlet diameter of (7,0 ± 0,2) mm. The plate (4 ± 1) mm thick has a porosity rating of 2 (4 μm to 90 μm) and a flow rate of 2,5 g/s to 3,5 g/s under the conditions specified in the calibration procedure (see annex A).

5.2 Glass reservoir, cylindrical, with a diameter ⩾ 80 mm.

5.3 Siphon assembly, consisting of a glass U-tube and a flexible silicone rubber tube each with an internal diameter of (8,0 ± 0,2) mm (see Figure 1).

5.4 Electronic balance, to weigh the reservoir and its content, capable of determining the mass to an accuracy of 0,01 g.

5.5 Data acquisition system, that allows the change of mass of the reservoir to be recorded against time (e.g. microprocessing device, data analysis and printing device). If this is a digital system it shall be able to take readings at least four times per second.

NOTE High absorbent rate materials may need readings taken eight times per second. (See 9.4, note 1.)

5.6 Hydrophobic polyether-polyurethane foam piece, (55 ± 1) mm in diameter and (2,0 ± 0,5) mm thick, with 20 regular open cells per centimetre and a density of (28 ± 3) kg/m^3.

5.7 Cylindrical weight, (60 ± 1) mm in diameter. The total mass of the weight and the foam piece shall be (605 ± 5) g, which corresponds to an imposed pressure on the test piece of (2,50 ± 0,05) kPa.

5.8 Test liquid, normally demineralized water (in accordance with ISO 3696), but other appropriate liquids can be used. The liquid used shall be specified and identified in the test report and used at temperature of (20 ± 2) ºC.

5.9 Cleaning product, e.g. sulfochromic acid (1/3 $K_2Cr_2O_7$ at 50 g/l and 2/3 H_2SO_4 at 95 %) or equivalent.

5.10 Spirit level.

6 Assembly of the apparatus

6.1 The layout of the apparatus is shown in Figure 1. The components shall be assembled according to the dimensions given.

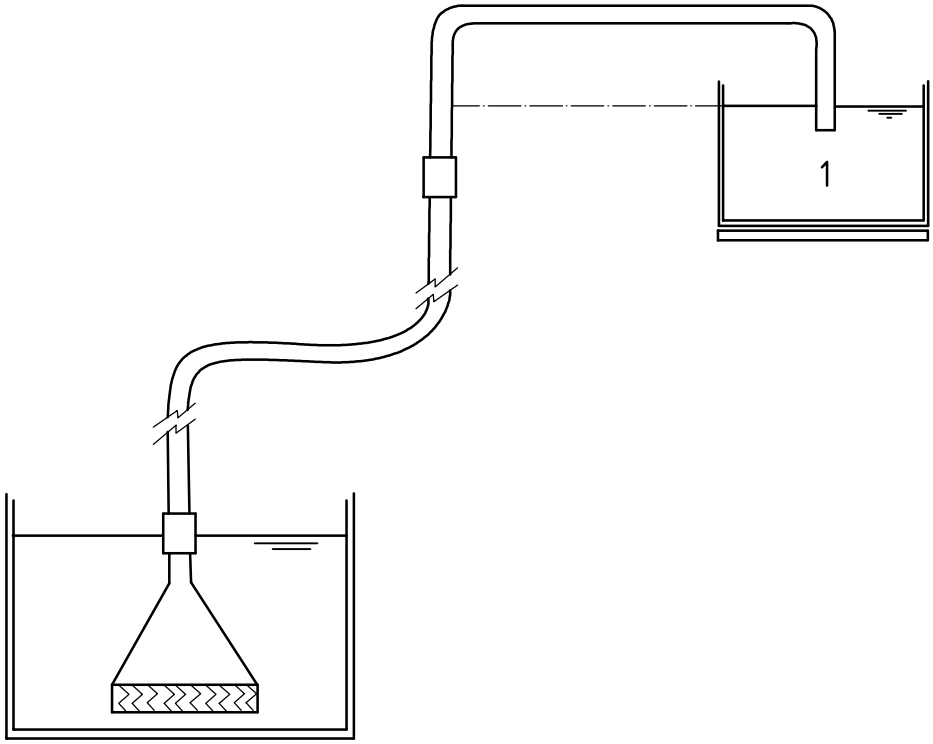
6.2 The hydrophobic foam (5.6) is attached to the bottom of the cylindrical weight (5.7) using hydrophobic double-sided tapes so that the foam can be changed from time to time.

6.3 In order that the apparatus be filled with liquid without the entrainment of air bubbles, ensure that all the tubes are filled and then connect them to the funnel containing the porous medium under water as shown in Figure 2.

6.4 Using a spirit level (5.10), align the top surface of the porous medium and the horizontal part of the top external surface of the glass U-tube (5.3) ensuring both are (40,0 ± 0,5) mm above the liquid level in the reservoir.

6.5 Set up the data acquisition system (5.5) and check it for effectiveness.

NOTE The flow resistance of the apparatus itself will affect the results and this is governed by the dimensions and shapes of the tubes, the water level and the porosity of the porous medium. Consequently it is essential to adhere to the specifications of the apparatus and the defined procedure if good reproductibility is to be obtained.



Key

1 Reservoir

Figure 2 — Method of tube and funnel connection

7 Preparation and conditioning of test pieces

7.1 Mark the nonwoven samples so that the face to be in contact with the porous plate is readily identifiable.

7.2 Cut out 5 test pieces from each sample (55 ± 1) mm in diameter.

7.3 Condition the test pieces as specified in ISO 139.

8 Procedure

8.1 Weigh the test piece and record the mass, m, in grams.

8.2 If necessary, dry the foam attached to the weight with a hair drier.

8.3 Attach the test piece to the foam face of the weight (5.7) using 3 pieces of 1 cm^2 hydrophobic double-sided tape.

8.4 Ensure that the height of the porous plate (5.1) and the horizontal part of the top external surface of the U-tube (5.3) are (40,0 ± 0,5) mm above the liquid's surface.

8.5 Weigh the reservoir of liquid and record the mass m_0, in grams.

8.6 Start the data acquisition system (5.5).

8.7 Place the weight with the foam (5.6) and test piece attached on the porous medium. As far as possible, ensure that the face of the test piece is parallel to the face of the porous medium and also that the test piece is concentric to the medium at the time the test piece and the porous medium come into contact.

8.8 Record the decreasing mass of the reservoir and liquid, m_t, using the data acquisition system.

8.9 Run the test and record the mass until the mass variation within the previous 5 s is lower than 1 % of the maximum absorbed liquid. Stop the data acquisition system.

8.10 Remove the weight from the porous medium and remove the test piece from it.

8.11 Repeat steps 8.1 to 8.10 with the other four test pieces.

8.12 Use fresh conditioned test liquid (5.8) for each set of five test pieces.

8.13 After each set of five tests, clean the porous medium with sulfochromic acid or equivalent cleaning product (5.9) and then rinse with distilled water.

9 Expression of the results

9.1 Mass versus time curve

Several characteristics can be determined for each test piece on the basis of absorbed mass, A, against time, t.

Calculate and draw the curve of A against t (see Figure 3 for an example)

$$A_t = m_o - m_t$$

9.2 Maximum absorbed mass (A_f)

Calculate for each test piece:

The maximum absorbed mass (A_f) is recorded at the time T_f at which the mass variation within the previous 5 s time period is lower than 1 % of the maximum absorbed mass.

In practice the calculation is made on a time period ΔT close to 5 s and equal to a full number n of time steps Δt, i.e.:

$$\Delta T = n\Delta t > 5 \text{ s}$$

with

$$(n-1)\Delta t < 5 \text{ s}$$

and

$$A_f - A_{(T_f - \Delta T)} < \frac{1}{100} A_f$$

NOTE 1 The sampling time interval is defined by $\Delta t \leqslant 0{,}25$ s.

Generally the 5 s are a multiple of Δt and ΔT = 5 s, but if it is not the case, the maximum difference between ΔT and 5 s could be $\pm$ 1 % ΔT, in which case the resulting error on T_f and more conclusively on A_f is completely negligible.

NOTE 2 Independently of the method of calculation, the final time T_f usually presents a large coefficient of variation (contrary to the maximum absorbed mass A_f). For this reason, T_f is mentioned in the test report only if requested.

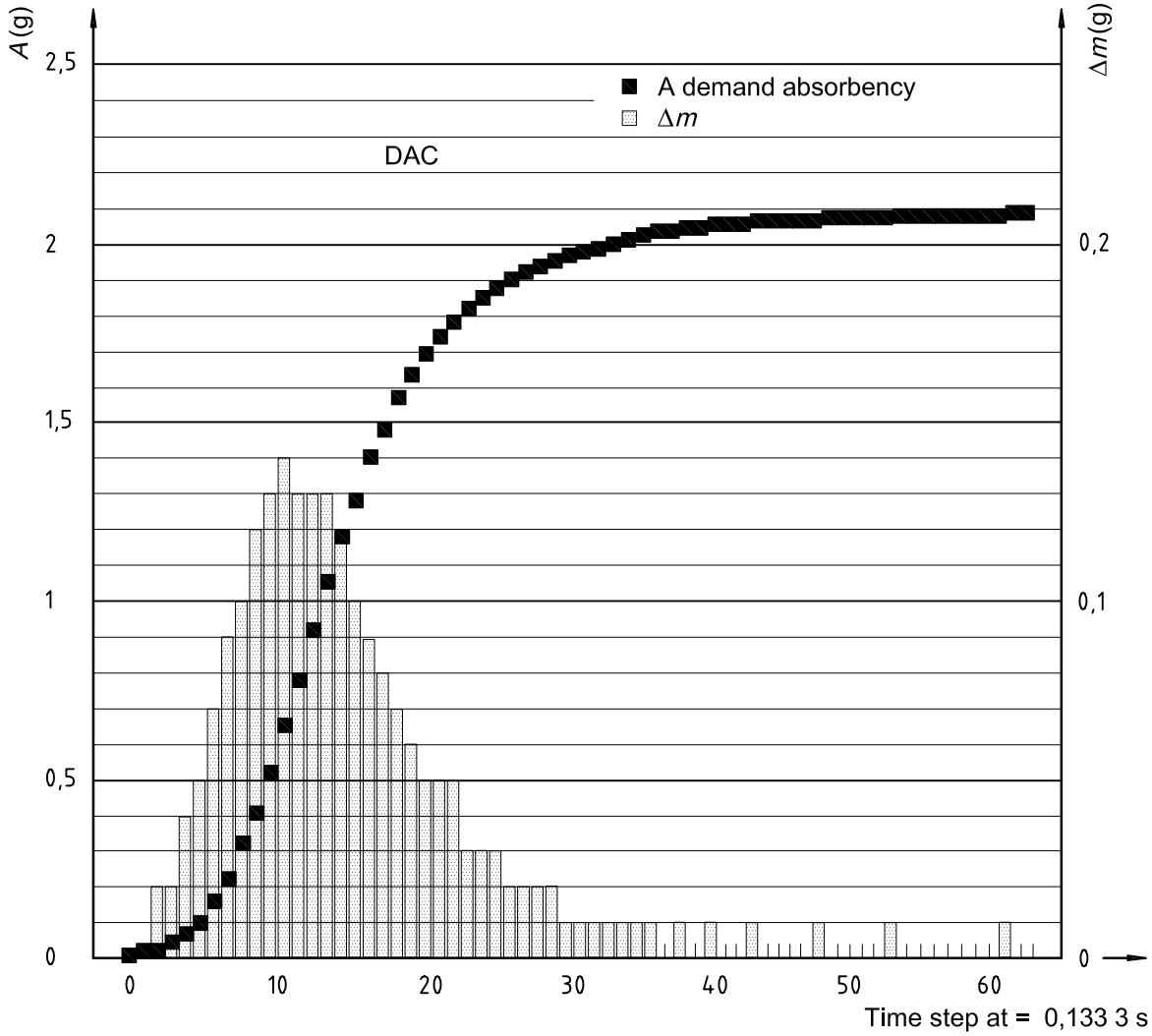


Figure 3 — Plot of A against t

9.3 Demand absorbency capacity (DAC)

Calculate for each test piece:

$$DAC = A_f/m$$

9.4 Maximum absorption rate (MAR)

In general:

$$AR_x = |(m_x - m_{x-1})/(t_x - t_{x-1})|$$

Where AR_x is the absorption rate corresponding to the time interval t_{x-1} to t_x

If $\Delta m_x = |m_x - m_{x-1}|$

and $\Delta t_x = (t_x - t_{x-1})$

Then, with a constant sampling interval Δt

$AR_x = \Delta m_x/\Delta t$

It is thus necessary to calculate the mass change Δm for each sampling interval, and to identify the maximum change. The mass changes for other sampling intervals are then ranked in order of decreasing magnitude until the sum of the sampling intervals is greater than 1 s.

The MAR for the 1 s period is based on the individual, highest-ranked changes whose total sampling intervals are equal to or less than 1 s. In this case the highest-ranked mass changes are completed with the due proportion of the next ranked change. That proportion is related to the time required to be added to the already summed sampling intervals in order to total 1 s.

The calculations are best laid out as a table. See data table example in annex B.

For each sampling interval after absorption has started calculate the mass absorbed, Δm until the recorded mass stabilizes. Rank the n highest values of Δm in descending order such that $n\ \Delta t > 1$ s and $(n - 1)\ \Delta t \leqslant 1$ s. Let these be Δm_{max}, Δm_{max-1}, Δm_{max-2},....Δm_n.

If $(n - 1)\ \Delta t < 1$ s:

calculate a factor $k = [1 - (n - 1)\Delta t]/\Delta t$ then:

$$MAR = \Delta m_{max} + \Delta m_{max-1} + \Delta m_{max-2} + \ldots + \Delta m_{n-1} + k\left[\Delta m_{n-1} - k\left(\Delta m_{n-1} - \Delta m_n\right)\right]$$

If $(n - 1)\ \Delta t = 1$ s, $k = 0$

NOTE 1 For material having an exceptionally high absorbent rate the following rule is applicable.

If 60 % of the DAC is reached in less than 1 s, the maximum time step for measurement will be reduced from 0,25 s to 0,125 s and the time for calculating the MAR will be reduced from 1 s to 0,5 s.

NOTE 2 If the sampling interval Δt_x is not constant the calculation is obviously more complex and needs to be based on AR, rather than Δm.

The n highest values of AR_x are easily ranked in descending order in a table mentioning, in parallel, the corresponding Δt_x, i.e.

From AR_{max}, AR_{max-1} to AR_n, to which correspond

Δt_{max}, Δt_{max-1} to Δt_n, such that

$$\sum_{x=max}^{x=n} \Delta t_x > 1 \text{ s}$$

and

$$\sum_{x=max}^{x=n-1} \Delta t_x \leqslant 1 \text{ s}$$

calculate the factor

$$k' = \left[1 - \sum_{x=max}^{x=n-1} \Delta t_x\right] / \Delta t_n$$

and

$$MAR = k'\left[AR_{n-1} - k'\left(AR_{n-1} - AR_n\right)\right]\Delta t_n + \sum_{x=max}^{x=n-1} AR_x \Delta t_x$$

10 Test report

The test report shall contain the following information:

a) reference to this part of ISO 9073, i.e. ISO 9073-12;

b) identification of the test pieces;

c) side of test piece tested;

d) identification of the liquid, including the surface tension, together with the method of measurement used;

e) absorbed mass (A) against time (t) data recorded for each test piece;

f) curve A/t for each test piece;

g) demand absorbency capacity (DAC) individual results, mean, max., min., coefficient of variation;

h) maximum absorbency rate (MAR) individual results, mean, max., min., coefficient of variation;

i) T_f individual results, mean, max., min., coefficient of variation (if requested);

j) any deviations from the standard method.

Annex A
(normative)

Determination of flow through the porous medium using the data acquisition system

A.1 Apparatus

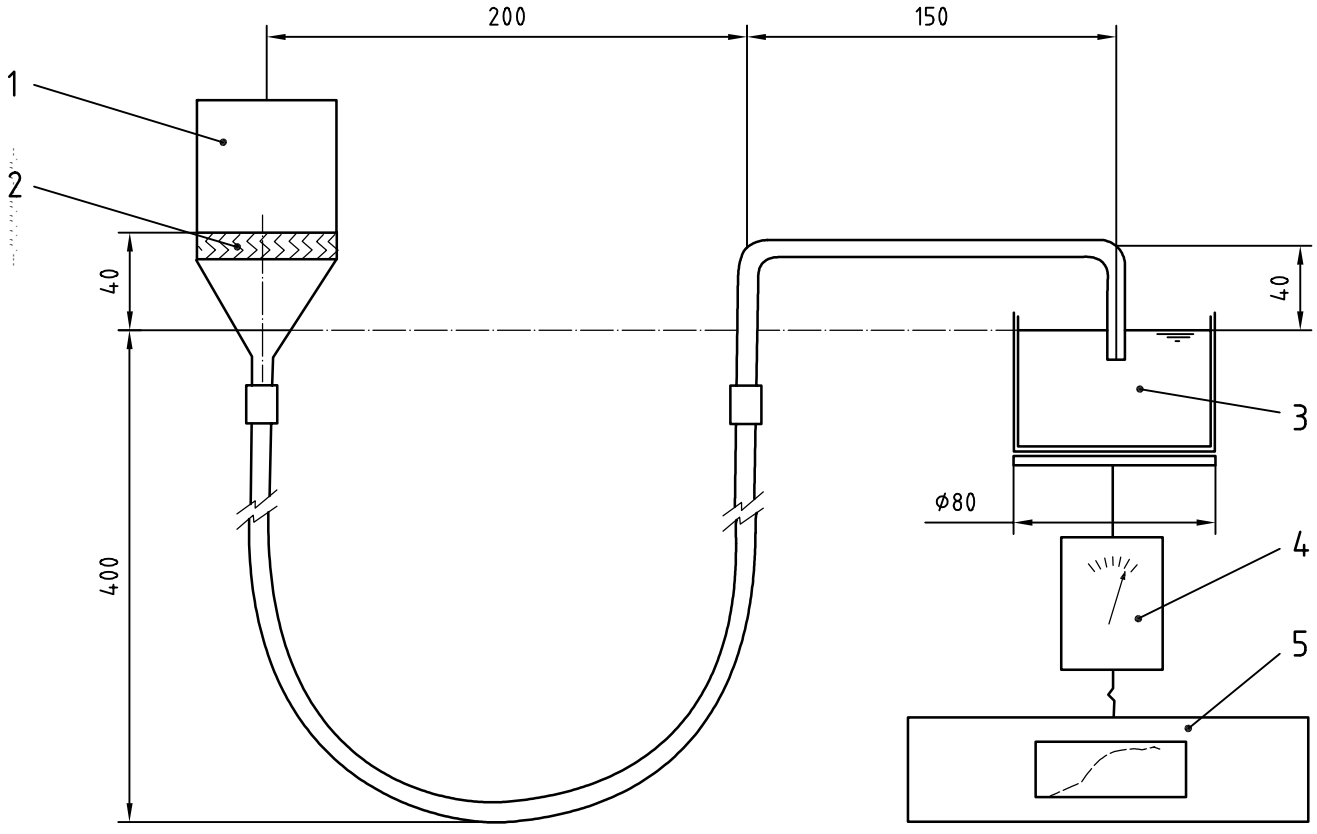
The apparatus is the same as for the test method. See clause 5.

The test liquid is demineralized water.

A.2 Assembly

See clause 6. and Figure A.1.

Dimensions in millimetres



Key

1 Cup
2 Porous glass plate
3 Reservoir
4 Electronic balance
5 Data system

Figure A.1 — Calibration assembly

Form a cup from the porous medium by wrapping adhesive tape around it. It need not be perfectly watertight and a small leakage will have no effect on the results.

A.3 Procedure

Start the data acquisition system

Pour 11 ml of demineralized water into the cup.

Record the increasing mass of the reservoir and water contained, with time. Ensure that the mass increases by a minimum of 10 g.

Once the flow into the reservoir has stopped, stop the data acquisition system and draw a mass versus time curve. See Figure A.2.

Determine the discharge times t_3 and t_7 corresponding to 3 g and 7 g of water mass increase.

Calculate the flow rate, FR, in grams per second:

$$FR = \frac{4}{t_7 - t_3}$$

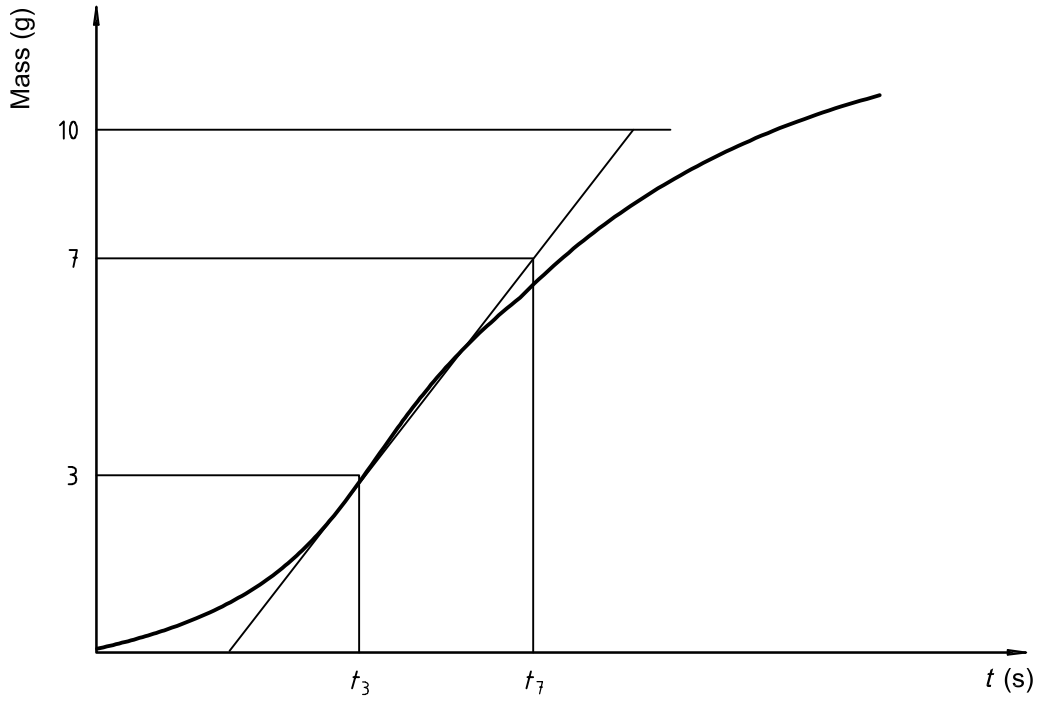


Figure A.2 — Calibration of the porous medium

Annex B
(informative)

MAR calculation explanation

DATA TABLE

NOTE A constant sampling time interval of 0,133 s is used in this example.

T s	m g	Δm g	**Rank**
0,133	243,270 m_o	0	–
0,266	243,260	0,010	–
0,400	243,220	0,040	–
0,766	242,920	0,130 = Δm_n	8
0,800	242,770	0,150 = Δm_{n-1}	7
0,933	242,600	0,170	3
1,066	242,440	0,160	4
1,200	242,250	0,190 = Δm_{max}	1
1,333	242,060	0,190 = Δm_{max-1}	2
1,466	241,900	0,160	5
1,500	241,750	0,150	6
2,266	241,590	0,040	–
2,400	241,560	0,030	–
2,533 $T_f - \Delta T$	241,560 m_f	0	–
2,666	241,560	0	–
7,600 (T_f)	241,560 m_f	0	–

NOTE 1 Number of time steps n = 8, in accordance with 9.4:

$n\,\Delta t = 8 \times 0{,}133$ s = 1,06 s > 1 s, $(n-1)\,\Delta t = 7 \times 0{,}133$ s = 0,93 s $\leqslant$ 1 s

NOTE 2 Factor $k = \left[1-(n-1)\Delta t\right]/\Delta t$ = (1 – 7 × 0,133)/0,133 = 0,52

NOTE 3 $\mathrm{MAR} = \Delta m_{max} + \Delta m_{max-1} + \Delta m_{max-2} + \ldots + \Delta m_{n-1} + k\left[\Delta m_{n-1} - k\left(\Delta m_{n-1} - \Delta m_n\right)\right]$

$\mathrm{MAR} = 0{,}19 + 0{,}19 + 0{,}17 + 016 + 0{,}16 + 0{,}15 + 0{,}15 + 0{,}52\ (0{,}15 - 0{,}01) = 1{,}25$ g/s

Annex C
(informative)

Precision

Figures for the repeatability and reproducibility of this method are the result of collaborative studies carried out by EDANA with the data listed in Tables C.1 and C.2.

Table C.1 — Demand absorbency capacity

Parameter	Tests			
	A	B	C	D
No. of laboratories	5	5	5	5
Average (g/g)	4,50	4,34	7,62	5,61
s_r	0,301	0,121	0,289	0,116
s_R	0,393	0,321	0,767	0,499
C_r	6,74 %	2,80 %	3,78 %	2,04 %
C_R	8,80 %	7,46 %	10,01 %	8,81 %
r	0,842	0,338	0,810	0,324
R	1,100	0,899	2,147	1,398

Table C.2 — Maximum absorption rate

Parameter	Tests			
	A	B	C	D
No. of laboratories	4	4	4	4
Average (g/s)	0,70	0,51	0,44	0,37
s_r	0,035	0,043	0,085	0,024
s_R	0,062	0,065	0,135	0,031
C_r	5,0 %	8,4 %	19,4 %	6,6 %
C_R	8,8 %	12,8 %	30,6 %	8,5 %
r	0,098	0,12	0,238	0,067
R	0,174	0,182	0,378	0,087

where

s_r is the standard deviation of repeatability;

s_R is the standard deviation of reproducibility;

C_r is the coefficient of repeatability;

C_R is the coefficient of reproducibility;

r is the repeatability limit ($2{,}8 \times s_r$);

R is the reproducibility limit ($2{,}8 \times s_R$).

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