



National Standards Authority of Ireland

IRISH STANDARD

I.S. EN 13559:2003

ICS 91.140.70

National Standards
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**SPECIFICATIONS FOR IMPACT MODIFIED
COEXTRUDED ABS/ACRYLIC SHEETS FOR
BATHS AND SHOWER TRAYS FOR
DOMESTIC PURPOSES**

*This Irish Standard was
published under the
authority of the National
Standards Authority of
Ireland
and comes into effect on:
November 28, 2003*

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Údarás um Chaighdeáin Náisiúnta na hÉireann

EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 13559

September 2003

ICS 91.140.70

English version

**Specifications for impact modified coextruded ABS/Acrylic
sheets for baths and shower trays for domestic purposes**

Spécifications relatives aux feuilles en acrylique et ABS
coextrudées à résistance au choc modifiée pour baignoires
et receveurs de douche à usage domestique

Spezifizierung von coextrudierten schlagzäh-modifizierten
PMMA/ABS-Platten für Badewannen und Duschwannen für
den Hausgebrauch

This European Standard was approved by CEN on 26 June 2003.

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Ref. No. EN 13559:2003 E

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Foreword

This document (EN 13559:2003) has been prepared by Technical Committee CEN /TC 163, "Sanitary appliances" the secretariat of which is held by UNI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2004, and conflicting national standards shall be withdrawn at the latest by March 2004.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

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1 Scope

This European Standard specifies the properties of coextruded ABS sheets with impact modified acrylic top layer from which baths and shower trays for domestic purposes are manufactured.

Note : For the purposes of this standard the term "domestic purposes" includes use in hotels, accommodation for students, hospitals and similar buildings, except when special medical provisions are required.

2 Normative references

This European standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

prEN ISO 15015:1997, Extruded sheets of impact-modified acrylonitrile/styrene copolymers, (ABS, AES or ASA). Requirements and test methods (ISO/DIS 15015: 1997).

ISO 75-2, *Plastics. Determination of temperature of deflection under load - Part 2: Plastics and ebonite.*

ISO 105-A02, *Textiles. Tests for colour fastness. – Part A02 Grey scale for assessing change in colour.*

ISO 179, *Plastics. Determination of Charpy impact properties.*

ISO 527, *Plastics. Determination of tensile properties.*

ISO 4892, *Plastics. Methods of exposure to laboratory light sources.*

3 Terms and definitions

For the purpose of this standard, the following term and definition applies:

3.1

Coextruded impact modified PMMA/ABS sheet

coextruded sheet with ABS substrate and a top layer of modified PMMA.

4 Requirements

4.1 General requirements

The coextruded impact modified PMMA / ABS sheet shall comply with the requirements of table 1 when tested to the methods given in Table 1.

Table 1 General requirements for coextruded impact modified PMMA / ABS sheet

Property	Test method	Test conditions	Unit	Value	
				Minimum	Maximum
Tensile yield strength	ISO 527 ¹⁾	50 mm/min	MPa	38	-
E modulus	ISO 527 ¹⁾	1 mm/min	MPa	1800	-
Heat distortion temperature (HDT)	ISO 75 ²⁾		°C	100	-
Impact resistance (tensile zone PMMA)	ISO 179 1fn (unnotched)	with polishing ³⁾	kJ/m ²	20	-
Water absorption	§ 5.7 of this standard		mg	-	40

1) ISO 527 as specified in 5.1 of this standard.
 2) Annealing conditions: 24h at 80°C, then 16h at 23°C and 50% RH. Test flatwise with PMMA as surface layer on which the testing load is applied.
 3) Polishing conditions and specimen preparation according prEN 15015:1997 § 5.1.1.

4.2 Thickness

The total thickness of coextruded impact modified PMMA / ABS sheet shall not be less than 2,7 mm.

Tolerances on total thickness are given in Table 2.

Table 2 Tolerance on total thickness for coextruded impact modified PMMA/ABS sheet

Total thickness		Tolerance
from	to	
2,8	4,0	± 0,10 mm
4,1	6,0	± 0,15 mm
6,1	9,0	± 0,20 mm
9,1	11,0	± 0,30 mm

The minimum top layer thickness is 9 % of the total thickness of coextruded impact modified PMMA / ABS sheet for bathtub applications and 4 % of the total thickness of the coextruded impact modified PMMA / ABS sheet for shower tray applications.

4.3 Heavy metal contents

Limit values for heavy metal contents of coextruded impact modified PMMA/ABS sheets for baths and shower trays are given in the European Directive 91/338.

Informative note: 91/338/CEE: Council Directive of 19 June 1991 amending for the tenth time Directive 76/769/CEE The Approximation of the laws, regulations and administrative provisions of the member states relating to restriction of the marketing and use of certain dangerous substances and preparations.

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4.4 Colour

For coextruded impact modified PMMA / ABS sheets the top layer shall be transparent or coloured. In the case of coloured top layer, the colourant shall be incorporated during the manufacture of the sheet and the colour shall be throughout the thickness of the material. Colour standards shall be agreed between sheet manufacturer and fabricator.

4.5 Thermal stability

When tested according to the method given in 5.2 the coextruded impact modified PMMA / ABS sheets shall show no evidence of blistering.

4.6 Colour fastness

4.6.1 Resistance to UV light

When tested in apparatus complying with the requirements of the xenon arc lamp method of ISO 4892 for 250 h the colour change noted in the coextruded impact modified PMMA / ABS sheets shall be recorded in terms of the grey scale for assessing colour change specified in ISO 105-A02. The fastness rating shall be not less than grade 3.

The xenon lamp shall only be used when its age is between the limits stated by the manufacturer of the lamp to be the useful life of the lamp or, where the useful life is not stated, is between 10 h and 600 h.

4.6.2 Resistance to hot water

When tested in accordance with 5.3, the colour change noted in the coextruded impact modified PMMA / ABS sheets shall be recorded in terms of the grey scale for assessing colour change specified in ISO 105 A02. The fastness rating shall be not less than grade 3.

4.7 Chemical and stain resistance

When tested in accordance with 5.4 coextruded impact modified PMMA / ABS sheets shall show no permanent staining or deterioration.

4.8 Resistance to wet and dry cycling

When tested in accordance with 5.5 coextruded impact modified PMMA / ABS sheets shall not show any adverse changes in appearance such as blisters, crazes, cracks and discoloration.

4.9 Shrinkage

When tested according to clause 5.7.2 of prEN ISO 15015:1997 with a temperature of 150°C instead of 170°C, the coextruded impact modified PMMA/ABS sheet shall show no change in length exceeding those given in table 3.

Table 3 Permitted changes in length for coextruded impact modified PMMA/ABS sheets

Sheet total thickness	Maximum change in length %	
	In extrusion direction	Cross direction extrusion
2,1 to 3,0	10	2,5
3,1 to 4,0	8	2
4,1 to 6,0	7	2
> 6,1	5	1

4.10 Resistance to stress cracking

The coextruded impact modified PMMA/ABS sheet shall be tested in accordance with the requirements of 5.6. The time at which the first crack appears shall be reported.

5 Test methods

5.1 Determination of tensile strength

5.1.1

The test pieces shall be as described in ISO 527, Type 1 B. They shall be cut so that their length is parallel to extrusion direction. The thickness of the test piece shall be that of the sheet from which it is cut and the width and the thickness shall be measured on the parallel portion of the test piece by means of a micrometer to the nearest 0,025 mm.

5.1.2

The test shall be carried out at a temperature of $(23 \pm 2)^{\circ}\text{C}$ and the test pieces shall be conditioned to this temperature for at least two days before testing.

5.1.3

The speed of testing shall be (50 ± 1) mm/min (speed B).

5.1.4

The mean of three determinations shall be recorded as the tensile strength of the material but if a test piece breaks in the grips the result shall be disregarded and a further determination made. The tensile strength shall be determined according to ISO 527.

5.2 Determination of thermal stability

Hang two sheets 300 mm square, taken from the coextruded impact modified PMMA / ABS sheet, in a circulating oven at $(165 \pm 5)^{\circ}\text{C}$ for 20 minutes when this nominal temperature is reached. Remove the sheets from the oven, allow them to cool to room temperature while hanging vertically and visually examine them for the presence of blisters. If defects are present, repeat the test on new samples with preconditioning at $(80 \pm 2)^{\circ}\text{C}$ for 16h.

5.3 Determination of colour fastness to hot water

5.3.1

Cut a test piece 100 mm x 25 mm from the coextruded impact modified PMMA / ABS sheet and fix in a suitable carrier. Immerse the test piece in a water bath maintained at $(60 \pm 2)^{\circ}\text{C}$ for 30 min, remove and allow to drain and dry out in air for 30 min.

5.3.2

Repeat the cycle 100 times without interruption.

5.3.3

Allow 48 h for the test piece to dry out before it is compared with a sample of the sheet from which it was cut.

5.3.4

The colour fastness of the material shall be recorded in terms of the grey scale for assessing colour change specified in ISO 105-A02.

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5.4 Determination of resistance to domestic chemicals and stains

5.4.1 Reagents

The list of reagents is given in table 4. Each aqueous solution shall be prepared immediately before application. The reagents shall be made up and applied at $(23 \pm 5) ^\circ\text{C}$.

Table 4 – Reagents

Family	Product	Concentration
Acids	Acetic acid	10% v/v
Alkalis	NaOH	10% m/m
Alcohol	Ethanol	70% v/v
Bleaches	NaOCl	5% available chlorine
Staining agent	Methylene Blue	1% m/m

5.4.2 Apparatus

5.4.2.1 Borosilicate watch glasses

40 mm nominal diameter

5.4.2.2 Pipettes

5.4.2.3 Cleaning device

The cleaning device is shown in figure 1. It comprises a synthetic flexible open cell foam disc of 75 mm diameter and 15 mm thick. Use any rotating device applying a mass of $(1000 \pm 50)\text{g}$ which loosely fits with the device. The lateral cleaning force shall only be that exerted by the mass of the cleaning device; this can be effected by a floating action between the drive shaft and the disc.

5.4.2.4 Test specimens

Specimens shall measure $(100 \pm 5)\text{ mm} \times (100 \pm 5)\text{ mm}$.

5.4.3 Procedure

Use a separate test specimen for each reagent test. Clean the test area thoroughly with hot soapy water, rinse and dry with a clean soft cloth.

On each test specimen deposit a drop of the test solution. Cover the drop thus formed with a watch glass concave downwards. The drop size shall be determined in order to be completely covered by the watch glass. Allow to act for a time of $(120 \pm 5)\text{ min}$, at a temperature of $(23 \pm 5)^\circ\text{C}$ with the test areas protected from the effects of sunlight.

Thoroughly rinse the test specimen with demineralized water and check for adverse changes in appearance by visual examination. If deterioration exists, dip the foam disc of the cleaning device into demineralized water and place it on the surface to be cleaned. Rotate the device at 60 rotations per minute.

Clean for 30 revolutions.

Rinse with demineralized water and visually examine the test area. If deterioration persists repeat the cleaning process with an abrasive agent added to demineralized water. This abrasive agent is defined as follows : alumina used for surface polishing, with particle size comprised between $0,1\text{ }\mu\text{m}$ and $2\text{ }\mu\text{m}$ and centered on $0,5\text{ }\mu\text{m}$.

5.4.4 Results

Note whether or not the reagent causes a stain or deterioration, whether or not such stain or deterioration is removed and if so with water or water with abrasive agent. If the stain is not removed by the water with abrasive agent record as permanently stained.

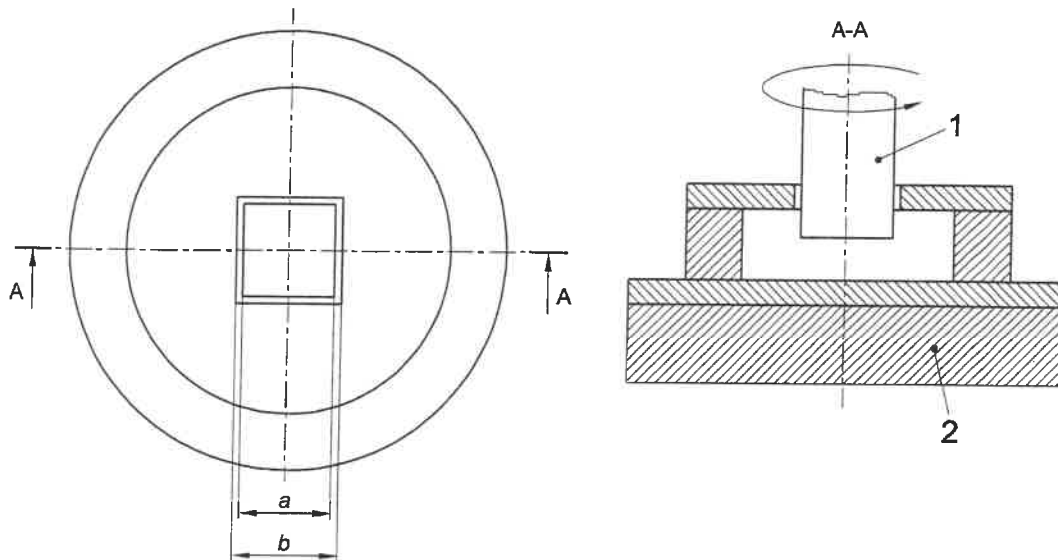


Figure 1 - Detail of cleaning apparatus

5.5 Determination of resistance to wet and dry cycling

5.5.1 Test pieces

The pieces to be tested shall be (100 ± 2) mm square. Prior to commencing the test examine the show faces of the samples and mark any surface defects.

5.5.2 Procedure

Place a maximum of 10 pieces to be tested vertically in a suitable carrier and place the carrier in a suitable open container. The carrier shall be arranged to avoid contact of one test piece with another.

Pour 2 litres of boiling water into the container. The container shall be sized so that 2 litres cover the samples to be tested completely.

Leave the test pieces in the water for $(8 \pm 0,25)$ h whilst allowing cooling to room temperature.

Remove the test pieces from the water, wipe the surfaces with a soft dampened cloth and place the test pieces for drying into an oven for $(16 \pm 0,5)$ h at a temperature of (50 ± 2) °C. When placing the test pieces in the oven ensure they do not touch the oven walls or each other.

Repeat this cycle 20 times using the same test pieces. In the event of an interruption of the test procedure, e.g. over the weekend, leave the test pieces in the oven at a temperature of (50 ± 2) °C.

After 20 cycles brush over the show face of each test piece with a solution of eosine (100g/l in water) to which is added 1 cm³/l of liquid detergent using a soft sponge or a paint brush. Leave the solution for (5 ± 1) minutes, then remove from the surface by wiping with a clean soft dampened cloth.

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5.5.3 Results

Verify and record any adverse changes in appearance (blisters, crazing, cracks etc.) by visual examination and by the presence of traces of eosine. When making the visual inspection ignore the 3 mm width along each side to exclude any influence caused by the cut edges.

5.6 Determination of resistance to stress cracking

5.6.1 General

The following test method is only to be used for comparative studies within one test installation. It has not proved possible to develop the test accuracy to a position where the test can be used for inter-laboratory testing. Variations in test results originates from small accidental changes in test procedure e.g. room temperature during testing or sheet thickness. Similarly only sheets of the same nominal thickness can be tested and compared by this procedure because different thicknesses of sheet experience different levels of skin stress within the test procedure, leading to changes within the time to stress crack.

5.6.2 Principle

A flat test specimen of rectangular shape is clamped over a former of constant radius in order to apply a flexural strain to the extended surface. After a relaxation time of 10 min a piece of cloth soaked with the test liquid is put on the extended surface. The time to stress cracking is determined by repeatedly lifting the cloth and visually examining the test specimen (see fig.2 and 3).

5.6.3 Test specimens

The test pieces (10) shall be prepared from the middle of the extrusion width of a sheet, to avoid potential test variation associated with samples taken from the edge of an extrusion direction. The sheet manufacturer shall indicate on it the extrusion direction. In the case where in production the width of the extrusion line leads to many different parallel parts, where the middle of one part do not represents automatically the middle of the extrusion line, the manufacturer shall also provide sheets taken from the middle of the extrusion width.

Test specimens shall be prepared by sawing. Sample edges may be de-burred prior to testing to minimise the effects of edge cut quality on chemical resistance.

Samples shall be tested both parallel and perpendicular to the extrusion directions. Major differences are seen between the chemical resistance measured on samples taken from different extrusion directions. Dimensions are :

- width : 40 mm
- length : 210 mm
- thickness : 4 mm (preferred). The thickness of sheet to be used within this test shall not vary from the nominal sheet thickness by more than +/- 1% . This is of greatest importance within comparative studies.

5.6.4 Conditioning

The test specimens are dried at 70°C for 16 h and stored at 23°C and 0% R.H. until the test is performed.

5.6.5 Pieces of cloth

Size 15 mm x 100 mm, made from cotton. The piece of cloth shall be placed in the centre of the specimen surface in order to avoid wetting of the specimen edges. Wetting of the rough edges might cause premature cracking. The piece of cloth shall be kept wet using a pipette in order to replace evaporating test fluid.

5.6.6 Test fluid

Dissolve 0,1 g of methylene blue in 100 g of isopropanol. Methylene blue is added to make the detection of cracks easier.

5.6.7 Flexural strain

The flexural strain ε_x in the extended surface is calculated from the thickness of the specimen d and the radius of the former r by :

$$\varepsilon_x = \frac{d}{2r + d} \cdot 100(\%)$$

If ε_x and d are given, the corresponding radius r can be determined. A flexural strain of 0.66% is suitable. For a specimen of 4 mm thickness, this can be achieved by using a former with a radius of 300 mm.

5.6.8 Test atmosphere

The test shall be carried out at a temperature of $(23 \pm 2)^\circ\text{C}$ and a relative humidity of $(50 \pm 5) \%$.

5.6.9 Procedure

5.6.9.1 Preparation

Submerge the test specimens in water of 55°C for 10 min. Remove the test specimens and let them cool down in air for 15 min. Dry the test specimens gently using a cotton cloth. Clamp the test specimens to the former, making sure that there is close contact between the test specimen and the former over a length of at least 100 mm in the centre portion of the specimen. After 10 min put a piece of cloth soaked with test liquid on the extended surface, avoiding wetting of the specimen edges. This defines the beginning of the experiment, at time $t = 0$.

5.6.9.2 Inspection

Lift the wet cloth, remove the test fluid from the extended specimen surface (with a dry cloth) and visually examine the test specimen for the formation of cracks. Cracks will be clearly visible as blue lines perpendicular to the long axis of the specimen. After inspection, immediately put the wet cloth back in its position on the extended specimen surface if no cracks are visible yet. Repeat the inspection at increasing time intervals, $t = 0.5, 1, 1.5, 2, 2.5, 3, 4, 5, 7.5, 10, 12, 5, 15, 20, 25, 30\text{min}$, until the first crack appears. Note the time t_{crack} at which the first crack appears. If no cracks appear after 30min, note "no cracking within 30min".

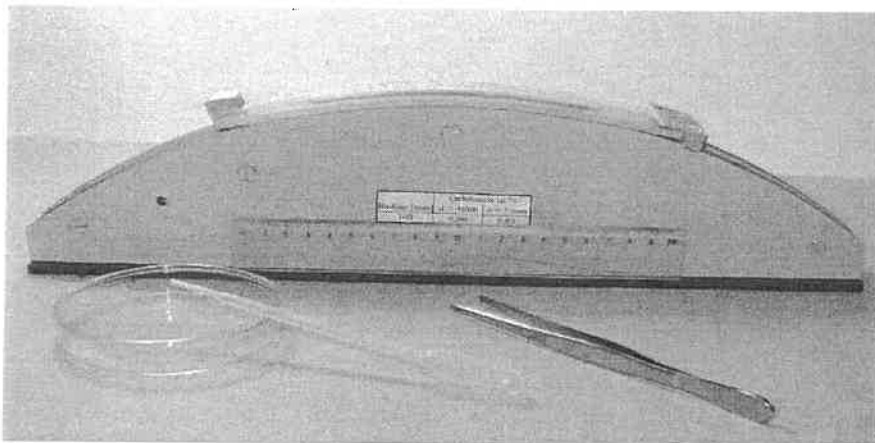


Figure 2 Testing apparatus

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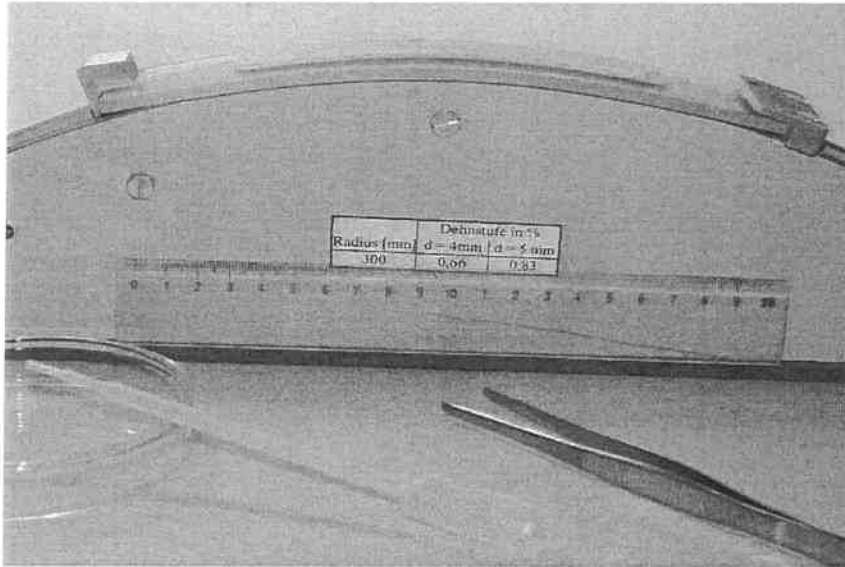


Figure 3 Detail of testing apparatus

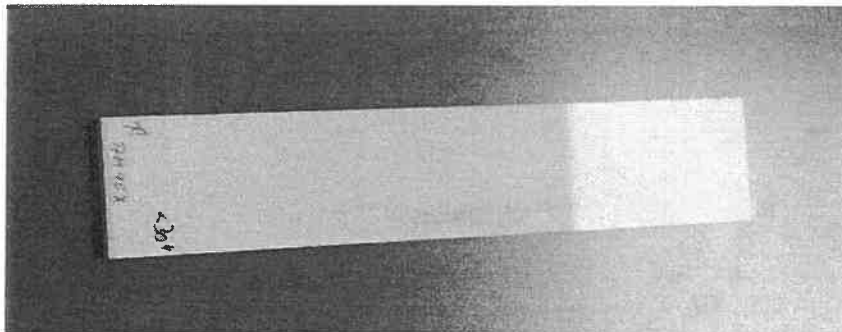


Figure 4 Example of cracked specimen (removed from the former), test fluid isopropanol containing 0,1% methylene blue.

5.7 Determination of water absorption

5.7.1 Principle

Complete immersion of test specimens in water for a specified period of time and at a specified temperature. Determination of changes in the mass of the test specimens after immersion in water.

5.7.2 Apparatus

5.7.2.1

Balance, with an accuracy of 1 mg.

5.7.2.2

Oven, capable of being controlled at $50 \pm 2^\circ\text{C}$.

5.7.2.3

Containers, containing distilled water, or water of equivalent purity, equipped with a means of heating and capable of being controlled at the temperature specified.

5.7.2.4

Dessiccator

5.7.3 Test specimens

Three specimens shall be tested. They may be obtained by machining. The cut surface shall be smooth and shall not show any trace of charring that may be due to the method of preparation.

The dimension of each specimen shall be 50 ± 1 mm.

The thickness of the test specimen shall be the same as that of the sheet under test if the nominal thickness of the sheet is equal to or less than 25 mm.

If the nominal thickness is greater than 25 mm and in the absence of special provisions in the relevant specification, the thickness of the test specimen shall be reduced to 25 mm by machining on one surface only.

5.7.4 General conditions

5.7.4.1

The volume of water used shall be at least 8 ml per square centimetre of the total surface of the test specimens, so as to avoid any extraction product becoming excessively concentrated in the water during the test.

5.7.4.2

In general, place each set of three test specimens in a separate container with the specimens immersed completely in the water.

However, when several samples of the same composition have to be tested, it is permissible to place several sets of test specimens in the same container.

In no case shall any significant area of the surface of a test specimen come into contact with the surface of other test specimens, or with the walls of the container.

5.7.5 Procedure

Dry three test specimens for (24 ± 1) h in the oven, controlled at $(50 \pm 2)^\circ\text{C}$, allow to cool to ambient temperature in the dessiccator and weigh each specimen to the nearest 1 mg (mass m_1). Place the specimens in a container containing boiling distilled water.

After immersion for (30 ± 1) min, take the specimens from the boiling water and allow them to cool for (15 ± 1) min in distilled water at ambient temperature. Take the specimens from the water and remove all surface water with a clean, dry cloth or with filter paper. Re-weigh the specimens to the nearest 1 mg within 1 min of taking them from the water (mass m_2).

5.7.6 Expression of results

Calculate for each test specimen the mass, in milligrams, of water absorbed, according to the formula.

$$m = m_2 - m_1$$

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Where

m_1 is the mass, in milligrams, of the test specimen before immersion,

m_2 is the mass, in milligrams, of the test specimen after immersion.

Express the result as the arithmetic mean of the three values of m obtained.

Bibliography

- [1] Directive 91/338/CEE, Council Directive of 19 June 1991 amending for the tenth time Directive 76/769/CEE The Approximation of the laws, regulations and administrative provisions of the member states relating to restriction of the marketing and use of certain dangerous substances and preparations.