



SLOVENSKI STANDARD
SIST EN 2378:2001

01-junij-2001

Aerospace series - Fibre reinforced plastics - Determination of water absorption by immersion

Aerospace series - Fibre reinforced plastics - Determination of water absorption by immersion

Luft- und Raumfahrt - Faserverstärkte Kunststoffe - Bestimmung der Wasseraufnahme durch Einlagerung

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Série aérospatiale - Plastiques renforcés de fibres - Détermination de l'absorption d'eau par immersion

[SIST EN 2378:2001](https://standards.iteh.ai/catalog/standards/sist/2db1f8e8-4337-468f-8b6f-c3550019402a/sist-en-2378-2001)

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en

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EUROPEAN STANDARD

EN 2378

NORME EUROPÉENNE

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English version

**Aerospace series - Fibre reinforced plastics -
Determination of water absorption by immersion**

Série aérospatiale - Plastiques renforcés de fibres - Détermination de l'absorption d'eau par immersion

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CEN

European Committee for Standardization
Comité Européen de Normalisation
Europäisches Komitee für Normung

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Foreword

This European Standard has been prepared by the European Association of Aerospace Manufacturers (AECMA).

After inquiries and votes carried out in accordance with the rules of this Association, this Standard has successively received the approval of the National Associations and the Official Services of the member countries of AECMA, prior to its presentation to CEN.

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of an identical text or by endorsement, at the latest by March 1996, and conflicting national standards shall be withdrawn at the latest by March 1996.

According to the CEN/CENELEC Internal Regulations, the following countries are bound to implement this European Standard:

Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

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0 Introduction

The absorption of water into reinforced plastics involves phenomena which are characterised by the following points :

- They obey diffusion laws which are still not fully understood (2-parameter Fick model, 4-parameter Langmuir-type model), see annex A ;
- The anisotropy of the material is a variable which affects the diffusion parameters ;
- The surface finish and more generally the absorption conditions determine its behaviour ;
- Determination of diffusion parameters is never simple and requires complex calculations which can only be undertaken with relatively powerful computers regardless of the mathematical model selected.

For all these reasons this standard confines itself to the laying down of a simple test method for which the specimens and the procedure are defined as precisely as possible, so as to eliminate as many variables as possible.

1 Scope

This standard specifies the method for the determination of water absorption by immersion.

It applies to fibre reinforced plastics in sheet form and enables :

- a comparison between two materials ;
- the determination of diffusion parameters at a later date. The choice of these depends on the model adopted (see annex A).

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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.

- | | |
|---------|--|
| EN 2331 | Aerospace series - Textile glass fibre preimpregnates - Test method for the determination of the resin and fibre content and mass of fibre per unit area |
| EN 2564 | Aerospace series - Carbon fibre laminates - Test method for the determination of the fibre and resin fractions and porosity content ¹⁾ |
| EN 2744 | Aerospace series - Non-metallic materials - Preferred test temperature |

¹⁾ Published as AECMA Prestandard at the date of publication of this standard

3 Principle

To determine the water absorption curve with time of immersion of a specimen of specified shape in demineralised water at a given temperature.

The absorption characteristics are obtained at right angles to the plane of the specimen.

The specimen is designed so that the edge effect can be disregarded.

4 Reagents

Demineralised water with a resistivity $\geq 3 \text{ M}\Omega\cdot\text{cm}$

5 Apparatus

5.1 Glass beakers of a size suited to the number of specimens

5.2 Temperature-controlled vessel capable of maintaining the beakers at the immersion temperature accurate to $\pm 2 \text{ }^\circ\text{C}$

If necessary, provide means of water vapour recovery.

5.3 Thermometer of appropriate scale and accuracy

5.4 Air circulating oven which can be maintained at the specified temperature accurate to $\pm 2 \text{ }^\circ\text{C}$

5.5 Desiccator containing silica gel or equivalent

5.6 Balance accurate to 0,1 mg

5.7 Stirrer

6 Specimens

6.1 Determination of absorption

6.1.1 Take at least five identical specimens meeting the conditions of 6.1.5 for each immersion temperature and for each material.

6.1.2 Using a diamond wheel cut the specimens to the dimensions specified in figure 1 and table 1.

6.1.3 Record the particulars of the surface finish of the specimens (machining, mould release agents,...).

6.1.4 Record the orientation of the fibres or of the warp of the fabric.

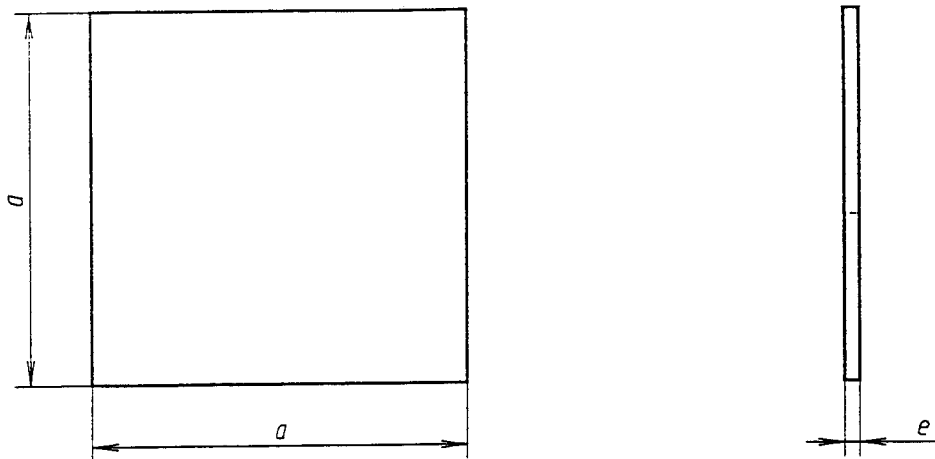


Figure 1

Table 1

	Dimensions in mm	
	a	e
All surfaces machined	50 ± 0,1	1 ± 0,05
Unmachined surfaces Machined edges	50 ± 0,1	1 ¹⁾

¹⁾ The number of plies shall be calculated in such a way that the thickness of the laminate is as near to this value as possible.

6.1.5 In all cases the thicknesses of specimens shall satisfy the following condition :

$$\frac{e \text{ max.} - e \text{ min.}}{e \text{ mean}} \leq 0,05$$

If this condition is not fulfilled, remove specimen with extreme thickness values.

6.1.6 It is not permitted to drill holes in the specimens.

6.2 Determination of fibre content

EN 2564 or EN 2331 according to the material on each sheet used for sampling of absorption specimens (see 6.1).

7 Procedure

7.1 Conditioning the specimens

Place the specimens in the oven maintained at $(70 \pm 2) ^\circ\text{C}$ until a constant mass is obtained. To do this, check weighings shall be made at regular intervals ; these shall be reported as a drying curve.

Record the mass M_0 which represents the last weighing of the specimen to the nearest 0,1 mg and then place the specimen in the desiccator.

7.2 Immersion bath

7.2.1 Preparation

Use at least 4 ml of demineralised water per square centimeter of total specimen surface area.

When the specimens are of identical composition it is possible to put several into the same beaker provided they do not touch each other.

Ensure that the contact between specimens and beaker walls or specimen supports is point contact to ensure that as much as possible of the specimen is wetted.

7.2.2 Maintenance

For immersions of long duration, replace the water every seven days. Analyse the bath regularly to ensure it has not been contaminated by the decomposition products from the material. If it has, the water shall be renewed and replaced more frequently.

7.3 Immersion temperature

Choose by preference $(23 \pm 2) ^\circ\text{C}$ or $(70 \pm 2) ^\circ\text{C}$. If other temperatures are used they shall be selected from EN 2744 with a tolerance of $\pm 2 ^\circ\text{C}$. Ensure that the temperature selected is not too close to the glass transition temperature of the laminate.

7.4 Duration of immersion

The total immersion time is not specified because it depends on the material, immersion temperature, etc.

The total immersion time and the times for intermediate measurements conducted during the course of immersion shall be selected according to table 2.

Table 2

Hours									Weeks						
1	2	4	8	16	24	48	96	168	2	4	6	8	16	26	52
AA	AB	AC	AD	AE	AF	AG	AH	AJ	BA	BB	BC	BD	BE	BF	BG
Designation codes															

7.5 Immersion (for each specimen)

7.5.1 Remove the specimen from the desiccator without finger contact.

7.5.2 Immediately place the specimen into the water at the specified temperature and immerse it completely.

Fit the cover.

Place the entire apparatus in the dark, or in lighting conditions specified.

Stir the bath regularly, at least once a day, using the stirrer.

7.5.3 Whenever the cumulative immersion time (t) has reached one of the values listed in 7.4, remove the specimen from the water.

7.5.4 If necessary bring the specimen to ambient temperature by immersing it in demineralised water at (23 ± 2) °C for 15 min.

7.5.5 Dry the specimen with filter paper or a lint-free cloth.

7.5.6 Weigh immediately and record the mass $M(t)$ to the nearest 0,1 mg, as a function of the cumulative immersion time (t) at the specified temperature.

7.5.7 Repeat the procedure from 7.5.2 to 7.5.6 as often as necessary until the end of the test.

8 Expression of results

8.1 For each cumulative immersion time (t) at the specified temperature calculate the percentage of water absorbed $P(t)$:

$$P(t) = \frac{M(t) - M_0}{M_0} \times 100$$

8.2 Plot the absorption curve (figure 2) as a function of \sqrt{t} for each specimen.

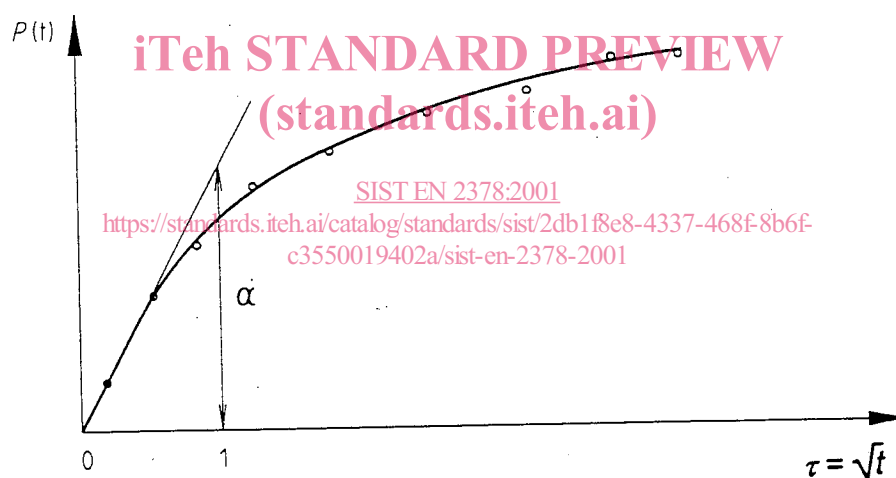


Figure 2

8.3 Plot the average absorption curve $P_M(t)$ obtained by plotting the average value of water absorption at the specified temperature as a function of \sqrt{t} :

$$P_M(t) = \frac{1}{N} \sum_{i=1}^N P_i(t)$$

where:

$P_i(t)$ is the percentage of water absorbed by specimen "i" ($i = 1$ to N);

N is the total number of specimens.