INTERNATIONAL STANDARD

**ISO 10119**

Second edition
2002-05-01

# Carbon fibre — Determination of density

*Fibre de carbone — Détermination de la masse volumique*



Reference number
ISO 10119:2002(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.ch
Web www.iso.ch

Printed in Switzerland

# Contents

Page

## 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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 10119 was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 13, *Composites and reinforcement fibres*.



This second edition cancels and replaces the first edition (ISO 10119:1992), which has been technically revised.



Annex A forms a normative part of this International Standard.

# Carbon fibre — Determination of density

## 1 Scope

This International Standard specifies three methods for the determination of the density of carbon fibre yarn:

— method A: liquid-displacement method;

— method B: sink/float method;

— method C: density-gradient column method.

Method C is the reference method.

## 2 Normative references



The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard 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 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 1675, *Plastics — Liquid resins — Determination of density by the pyknometer method*

ISO 10548, *Carbon fibre — Determination of size content*

## 3 Term and definition

For the purposes of this International Standard, the following term and definition apply.

**3.1**
**density**
the mass per unit volume of a substance at a specified temperature

NOTE This property is expressed in grams per cubic centimetre or in kilograms per cubic metre at the specified temperature. The recommended temperature is 23 °C.

## 4 Test specimens — General requirements

Test specimens shall be taken from desized samples unless otherwise agreed between the supplier and the customer. To remove the size, use the solvent extraction, chemical digestion or pyrolysis method specified in ISO 10548. The determination of the density may also be carried out on sized fibre by agreement between customer and supplier. The density of sized fibre may be taken to be identical to that of unsized fibre when the size content is low.

## 5 Conditioning and test conditions

Before testing, test specimens shall be conditioned in a standard test atmosphere as specified in ISO 291. During the test, the test apparatus and specimens shall be maintained at the same conditions as used for conditioning. The preferred conditions are 23 °C ± 2 °C and (50 ± 10) % relative humidity.

## 6 Test methods

### 6.1 Method A: Liquid-displacement method

#### 6.1.1 Principle

A specimen is weighed in air and then in a liquid which completely wets out the specimen and which has a known density at least 0,2 g/cm$^3$ less than that of the specimen. The difference in weight of the specimen in the two media is due to the Archimedean upthrust.

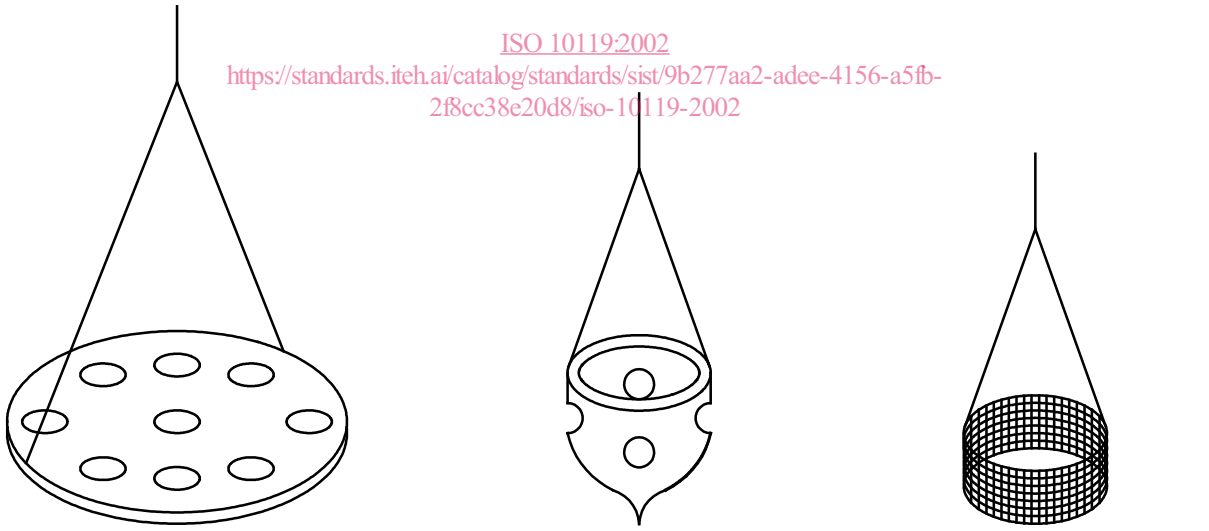
#### 6.1.2 Apparatus and materials

Standard laboratory apparatus and the following:

**6.1.2.1** **Analytical balance,** readable to 0,1 mg, with a maximum permissible error of 0,5 mg, and with a range from 0 g to 100 g.

**6.1.2.2** **Suspension wire,** made of stainless steel, of diameter 0,4 mm or less, or a **specimen support**, made of glass or stainless steel, with perforations so that it can be immersed easily in the immersion liquid (see Figure 1).





**Perforated stainless-steel support** **Perforated glass support** **Stainless-steel gauze support**

**Figure 1 — Examples of test specimen supports**

**6.1.2.3** **Pyknometer** or **hydrometer,** maximum permissible error 0,001 g/cm$^3$.

**6.1.2.4** **Beaker,** made of borosilicate glass.

**6.1.2.5** **Vacuum pump** (optional).

**6.1.2.6** **Ultrasonic device** (optional).

**6.1.2.7 Immersion liquids** (examples):

| | |
|---|---|
| ethanol | $\rho_{23}$ = 0,79 g/cm$^3$; |
| acetone | $\rho_{23}$ = 0,79 g/cm$^3$; |
| methanol | $\rho_{23}$ = 0,80 g/cm$^3$; |
| dichloroethane | $\rho_{23}$ = 1,25 g/cm$^3$; |
| *o*-dichlorobenzene | $\rho_{23}$ = 1,31 g/cm$^3$; |
| trichloroethane | $\rho_{23}$ = 1,35 g/cm$^3$; |
| trichloromethane | $\rho_{23}$ = 1,48 g/cm$^3$; |
| carbon tetrachloride | $\rho_{23}$ = 1,59 g/cm$^3$. |

**WARNING — Take the necessary safety precautions when handling these liquids.**

### 6.1.3 Test specimen

Take a continuous length of yarn and form it into a convenient shape, for example a bow or knot.

### 6.1.4 Procedure



**6.1.4.1** Carry out all weighings using the analytical balance (6.1.2.1).

**6.1.4.2** Determine the exact density of the immersion liquid (6.1.2.7) at the temperature of the test, using the pyknometer (see 6.1.2.3) in accordance with ISO 1675, or the hydrometer (see 6.1.2.3).



**6.1.4.3** Weigh the specimen in air to the nearest 0,1 mg ($w_1$). If the specimen is weighed using a suspension wire or specimen support (6.1.2.2), the wire or support shall be tared or weighed and, if weighed, its weight shall be deducted from subsequent weighings of the specimen.

**6.1.4.4** Immerse the test specimen in the beaker (6.1.2.4) containing the immersion liquid (6.1.2.7) and remove any air bubbles by agitating the specimen or by pressing it. Weigh the specimen to the nearest 0,1 mg ($w_2$), watching the balance display for a few seconds to make sure that it does not drift as a result of convection currents.

NOTE 1 The main sources of error are:

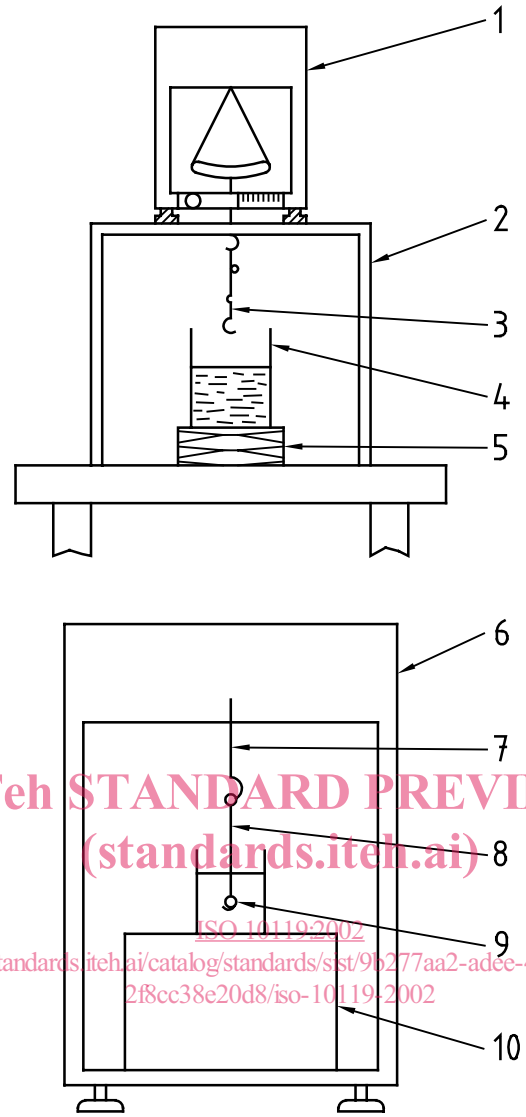
a) air bubbles adhering to the surfaces of the specimen when weighing in the immersion liquid;

b) surface tension effects on the specimen or suspension wire;

c) convection currents in the liquid in which the specimen is suspended, to minimize which the temperature of the liquid and of the air in the balance case should be the same.

NOTE 2 A vacuum pump (6.1.2.5) or ultrasonic device (6.1.2.6) may be used to eliminate air bubbles.

NOTE 3 In order to minimize the adherence of air bubbles to the test specimen, it is recommended that one of the immersion liquids listed in 6.1.2.7 is used. If water is used, it is permissible to add a trace (say 1 part in 10 000) of surface-active material such as a detergent to the water.






**Key**

| | | | |
|---|---|---|---|
| 1 | Balance | 6 | Balance |
| 2 | Support framework | 7 | Suspension hook |
| 3 | Suspension wire | 8 | Suspension wire |
| 4 | Beaker | 9 | Test specimen |
| 5 | Beaker support jack | 10 | Support bridge |

**Figure 2 — Examples of apparatus for determining density by the liquid-displacement method**

### 6.1.5 Expression of results

The density, in grams per cubic centimetre, of the test specimen at a temperature $\theta$ is given by the equation:

$$\rho_\theta = \frac{w_1}{w_1 - w_2} \times \rho_L$$

where

$w_1$ is the weight, in grams, of the specimen in air;

$w_2$ is the weight, in grams, of the specimen in the immersion liquid;

$\rho_L$ is the density, in grams per cubic centimetre, of the immersion liquid.

## 6.2 Method B: Sink/float method

### 6.2.1 Principle

This method is based on the observation of the state of equilibrium of the carbon fibre in a liquid mixture that has the same density as the fibre.

Two versions of this method are specified:

— method B1: a dynamic method in which the mixture of liquids required to hold the test specimen in uniform suspension is made progressively;

— method B2: test portions of finely chopped yarn are placed in a series of liquid mixtures of different known densities.

### 6.2.2 Apparatus and materials

**6.2.2.1 Thermometer.**

**6.2.2.2 Pyknometer** or **hydrometer,** maximum permissible error 0,001 g/cm$^3$.



**6.2.2.3 Test tubes** or **sample tubes,** of 5 cm$^3$ capacity, fitted with stoppers resistant to the liquid employed.

**6.2.2.4 Measuring cylinder,** of 250 cm$^3$ capacity.



**6.2.2.5 Thermostatic bath,** capable of maintaining the temperature of the solution in the tubes at 23 °C ± 0,1 °C.

**6.2.2.6 Tweezers.**

**6.2.2.7 Razor blades.**

**6.2.2.8 Liquid-storage flask,** of 250 cm$^3$ capacity.

**6.2.2.9 Immersion liquids:** Two liquids which, when mixed, will cover the range of densities required (examples):

| | |
|---|---|
| acetone, methanol, ethanol, petroleum spirit | $\rho_{23}$ = 0,8 g/cm$^3$; |
| trichloroethane | $\rho_{23}$ = 1,35 g/cm$^3$; |
| carbon tetrachloride | $\rho_{23}$ = 1,59 g/cm$^3$; |
| dibromoethane | $\rho_{23}$ = 2,17 g/cm$^3$; |
| bromoform | $\rho_{23}$ = 2,89 g/cm$^3$. |

**WARNING — Take the necessary safety precautions when handling these liquids.**

### 6.2.3 Test specimens

Take lengths of yarn with a mass of approximately 10 mg to 20 mg (method B1) or approximately 100 µg portions of finely chopped fibre (method B2).