
**Thermoplastics pipes —
Determination of tensile properties —**

Part 2:

**Pipes made of unplasticized
poly(vinyl chloride) (PVC-U), oriented
unplasticized poly(vinyl chloride)
(PVC-O), chlorinated poly(vinyl
chloride) (PVC-C) and high-impact
poly(vinyl chloride) (PVC-HI)**

*Tubes en matières thermoplastiques — Détermination des
caractéristiques en traction —*

*Partie 2: Tubes en poly(chlorure de vinyle) non plastifié (PVC-U),
poly(chlorure de vinyle) non plastifié orienté (PVC-O), poly(chlorure
de vinyle) chloré (PVC-C) et poly(chlorure de vinyle) à résistance au
choc améliorée (PVC-HI)*



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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.

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).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

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 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 5, *General properties of pipes, fittings and valves of plastic materials and their accessories — Test methods and basic specifications*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 155, *Plastics piping systems and ducting systems*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This second edition cancels and replaces the first edition (ISO 6259-2:1997), which has been technically revised.

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

- the introduction of PVC-O pipes;
- the correction of cross-references to ISO 6259-1:2015;
- the introduction of stress at break as an additional characteristic to be measured and recorded;
- the addition of extended sampling for pipe dimensions above or equal to 250 mm;
- updated informative annexes.

A list of all parts in the ISO 6259 series can be found on the ISO website.

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.

Introduction

This document specifies a method for determining the tensile properties of pipes made of PVC-U, PVC-O, PVC-C and PVC-HI.

NOTE In some countries, PVC-HI is designated as PVC-M or PVC-A.

It can provide data for further testing for the purpose of research and development.

It cannot be regarded as significant for applications in which the conditions of application of the force differ considerably with those in this test method, as such applications require the appropriate impact, creep and fatigue tests.

The tests of tensile properties are intended to be principally regarded as tests of material in the form of pipe. The results can be useful as a material process control test, but are not a quantitative assessment of long term pipe performance.

This document has been developed on the basis of ISO 527-1 and ISO 527-2.

For ease of use, it has been thought preferable to draw up a complete document that can be used for determining the tensile properties of thermoplastics pipes. For greater detail, reference can be made to the ISO 527 series.

However, the ISO 527 series is applicable to materials in sheet form, whereas the ISO 6259 series is applicable to materials in pipe form.

As it was considered essential to test the pipes as supplied, i.e. without reduction in thickness, difficulties arose in the choice of test piece.

The ISO 527 series specifies test pieces a few millimetres thick, whereas the thickness of a pipe can be in excess of 50 mm. This is why certain changes have been made on this point.

For thin-walled pipes, the test piece can be obtained by die cutting, while for thick pipes, it can be obtained only by machining.

At present, the ISO 6259 series comprises three parts:

- ISO 6259-1 gives the general conditions under which the tensile properties of thermoplastics pipes are to be determined.
- ISO 6259-2 (this document) and ISO 6259-3 provide, respectively, specific information on the execution of tests on pipes made from different materials (see the Foreword).

The basic specifications for the various materials are given in informative annexes in the relevant parts.

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Thermoplastics pipes — Determination of tensile properties —

Part 2:

Pipes made of unplasticized poly(vinyl chloride) (PVC-U), oriented unplasticized poly(vinyl chloride) (PVC-O), chlorinated poly(vinyl chloride) (PVC-C) and high-impact poly(vinyl chloride) (PVC-HI)

1 Scope

This document specifies a method for determining the tensile properties of pipes made of unplasticized poly(vinyl chloride) (PVC-U), oriented unplasticized poly(vinyl chloride) (PVC-O), chlorinated poly(vinyl chloride) (PVC-C) and high-impact poly(vinyl chloride) (PVC-HI, PVC-M or PVC-A), and in particular the following properties:

- the stress at yield and stress at break;
- the elongation at break.

NOTE The general method of test for the determination of the tensile properties of thermoplastics pipes is given in ISO 6259-1.

This document also gives, for information purposes only, the corresponding basic specifications in [Annexes A, B, C and D](#).

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 6259-1:2015, *Thermoplastics pipes — Determination of tensile properties — Part 1: General test method*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 6259-1 and the following apply.

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/>

3.1 Definitions related to material characteristics

3.1.1

force at break

F_b

force measured at the break

Note 1 to entry: It is expressed in Newton (N).

Note 2 to entry: It is the value of force on the force-strain curve directly prior to the separation of the specimen, i.e. directly prior to the load drop caused by crack initiation.

3.1.2

stress at break

σ_b

stress measured at the break

Note 1 to entry: It is expressed in megapascal (MPa).

Note 2 to entry: It is the value of stress on the stress-strain curve directly prior to the separation of the specimen, i.e. directly prior to the load drop caused by crack initiation.

4 Principle

See ISO 6259-1:2015, Clause 4, applicable to thermoplastics materials which are in the scope of this document.

5 Apparatus

See ISO 6259-1:2015, Clause 5, applicable to thermoplastics materials which are in the scope of this document.

6 Test pieces

6.1 General

The test pieces shall be obtained by die cutting or machining. The method is determined by the thickness of the pipe wall and thermoplastics material.

Care should be taken when using die cutting to avoid damaging the test specimen or producing non-parallel sides.

6.2 Dimensions of test pieces

Depending on the method by which they are prepared (see [6.3](#)), the shape and dimensions of the test pieces shall conform to [Table 1](#) and [Figure 1](#) or [Table 2](#) and [Figure 2](#), as applicable.

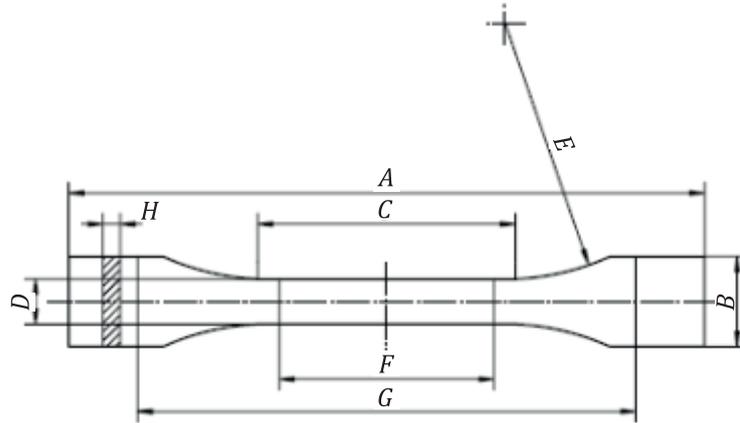
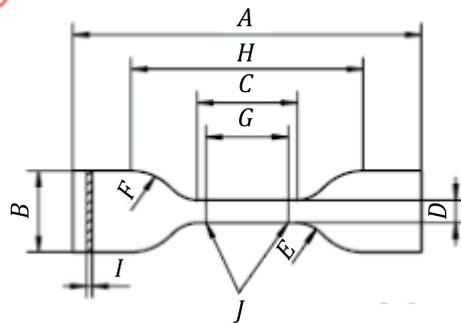


Figure 1 — Test piece obtained by machining (type 1)

Table 1 — Dimensions of test pieces prepared by machining

Symbol	Description	Dimensions mm
A	Minimum total length	115
B	Width of ends	≥15
C	Length of narrow, parallel-sided portion	33 ± 2
D	Width of narrow, parallel-sided portion	6 ^{+0,4}
E	Radius	14 ± 1
F	Gauge length	25 ± 1
G	Initial distance between grips	80 ± 5
H	Thickness	That of the pipe



Key

J positions of gauge marks

Figure 2 — Test piece obtained by die cutting (type 2)

Table 2 — Dimensions of test pieces obtained by die cutting

Symbol	Description	Dimensions mm
A	Minimum total length	115
B	Width of end	25 ± 1
C	Length of narrow, parallel-sided portion	33 ± 2
D	Width of narrow, parallel-sided portion	6 ^{+0,4}
E	Small radius of curvature	14 ± 1
F	Large radius of curvature	25 ± 2
G	Gauge length	25 ± 1
H	Initial distance between grips	80 ± 5
I	Thickness	That of the pipe

6.3 Preparation of test pieces

6.3.1 Sampling from the pipe

The test pieces from the pipe shall be in accordance with ISO 6259-1:2015, 6.2.1 and with [6.2](#) of this document, as applicable.

The minimum number of test pieces is given in ISO 6259-1:2015, Table 1. For the dimensions above and including 250 mm, more intensive sampling shall be applied as shown in [Table 3](#).

Table 3 — Minimum number of test pieces

Nominal outside diameter, d_n (mm)	$75 \leq d_n < 250$	$250 \leq d_n < 710$	$d_n \geq 710$
Number of strips	5	8	12

6.3.2 Preparation of test specimen

The pipe wall thickness and material determine the number of test specimens and how these are prepared. The test specimens shall be taken from the centre of strips cut from the length of pipe in accordance with ISO 6259-1:2015, 6.2.1 and with [6.3.3](#) or [6.3.4](#) of this document, as applicable.

For unplasticized poly(vinyl chloride) (PVC-U) pipes and pipes made of high-impact poly(vinyl chloride) (PVC-HI), test pieces shall be prepared in accordance with item a) or item b) as applicable:

- a) Pipes of wall thickness less than or equal to 12 mm.

The test pieces may be prepared either by die cutting (see [6.3.3](#) and [Figure 2](#)), or by machining (see [6.3.4](#) and [Figure 1](#)), with the exception that for interlaboratory comparison and reference tests, the test pieces shall be machined.

- b) Pipes of wall thickness greater than 12 mm.

The test pieces may be prepared only by machining (see [Figure 1](#)).

- c) For oriented unplasticized poly(vinyl chloride) (PVC-O) pipes, chlorinated poly(vinyl chloride) (PVC-C) pipes and pipes made from a mixture of unplasticized poly(vinyl chloride) and chlorinated poly(vinyl chloride) (PVC-U/PVC-C), the test pieces shall only be prepared by machining, regardless of the thickness.

6.3.3 Cutting method

Use a cutting die (See ISO 6259-1:2015, 5.6) with a profile as shown in [Figure 2](#).

Heat the strip in an oven maintained at a temperature between 125 °C and 130 °C, for 1 min per millimetre of thickness.

Cut out the test piece as soon as the strip is taken out of the oven, applying the die cutter to the inner surface of the strip and exerting a continuous uniform pressure. Then, leave it to cool at ambient temperature in still air.

6.3.4 Machining method

See ISO 6259-1:2015, 6.2.2.3.

For pipes of nominal outside diameter equal or greater than 50 mm, machine the strip as cut.

For pipes of nominal outside diameter less than 50-mm, machine the strip after it has been flattened under the following conditions (except for PVC-O pipes because if heated they will lose the orientation):

- a) temperature:
 - 125 °C to 130 °C for PVC-U or PVC-HI pipes;
 - 135 °C to 140 °C for PVC-C pipes or pipes made from PVC-U/PVC-C mixtures;
- b) duration of heating: 1 min per millimeter of thickness;
- c) flattening pressure: a value such that it does not cause any reduction in the thickness of the plate.

Cool in air to ambient temperature.

7 Conditioning

See ISO 6259-1:2015, Clause 7.

8 Test speed

The test speed, i.e. the speed of separation of the grips, shall be $(5 \pm 0,5)$ mm/min for all test pieces, regardless of thickness.

9 Procedure

ISO 6259-1:2015, Clause 9 is applicable with the following modifications:

Replacement/Modification:

9.6 Record the stress/strain curve up to the rupture of the test piece and record on this curve the force at yield, the force at break if required and the gauge length at break, or note directly the value of the force at yield, the force at break and the gauge length after break.

Discard any test pieces which slip in the grips, those which break at one of the shoulders and those which deform, thus changing the width of the shoulders, and retest an identical number of test pieces.

10 Expression of results

10.1 General

ISO 6259-1:2015, Clause 10 is applicable with the following modifications.

Replacement/Modification:

10.2 Stress at yield and stress at break

10.2.1 Stress at yield

Calculate, for each test piece, the tensile stress at yield on the basis of the initial cross-sectional area of the test piece, using [Formula \(1\)](#):

$$\sigma_y = \frac{F}{A} \tag{1}$$

where

σ_y is the tensile stress at yield, in megapascals (MPa) (1 MPa = 1 N/mm²);

F is the force at yield, in Newtons (N);

A is the initial cross-sectional area of the test piece, expressed in square millimetres (mm²).

Express the result to three significant figures.

NOTE In theory, the yield stress would be calculated using the cross-sectional area of the test piece at yield, but for reasons of convenience, the initial cross-sectional area is used.

10.2.2 Stress at break (if required)

Calculate, for each test piece, the tensile stress at break on the basis of the initial cross-sectional area of the test piece, using [Formula \(2\)](#):

$$\sigma_b = \frac{F_b}{A} \tag{2}$$

where

σ_b is the tensile stress at break point, in megapascals (MPa) (1 MPa = 1 N/mm²);

F_b is the force at break point, in Newtons (N);

A is the initial cross-sectional area of the test piece, in square millimetres (mm²).

Express the result to three significant figures.

NOTE In theory, the stress at break would be calculated using the cross-sectional area of the test piece at break point, but for reasons of convenience, the initial cross-sectional area is used.

11 Test report

ISO 6259-1:2015, Clause 11 is applicable with the following modification:

Replacement/Modification:

- g) the stress at yield and stress at break if required (individual values, arithmetic mean, and standard deviation).

Annex A (informative)

Unplasticized poly(vinyl chloride) (PVC-U) pipe — Basic specification

The recommended minimum tensile properties of PVC-U pipes, measured under the test conditions given in ISO 6259-1 and this document are:

- a) Pipes for pressure applications:
 - Individual values of stress at yield or at break: $\sigma_y/\sigma_b \geq 45$ MPa;
 - Individual values of elongation at break: $\varepsilon_b \geq 80$ %.
- b) Pipes for non-pressure applications:
 - Individual values of elongation at break: $\varepsilon_b \geq 80$ %.

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Annex B
(informative)

**Oriented unplasticized poly(vinyl chloride) (PVC-O) pipes —
Basic specification**

The recommended minimum tensile properties of PVC-O pipes, measured under the test conditions given in ISO 6259-1 and this document are:

- Individual values of stress at yield or at break: $\sigma_y / \sigma_b \geq 48$ MPa.

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