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

**Part 1:
General test method**

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

Partie 1: Méthode générale d'essai



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.

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.

International Standard ISO 6259-1 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*.

ISO 6259 consists of the following parts, under the general title *Thermoplastics pipes — Determination of tensile properties*:

- *Part 1: General test method*
- *Part 2: Pipes made of unplasticized poly(vinyl chloride) (PVC-U), chlorinated poly(vinyl chloride) (PVC-C) and high-impact poly(vinyl chloride) (PVC-HI)*
- *Part 3: Polyolefin pipes*

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Introduction

This part of ISO 6259 specifies a short-term tensile test method for determining the tensile properties of thermoplastics pipes.

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, such applications requiring the appropriate impact, creep and fatigue tests.

The tests of tensile properties should 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.

ISO 6259 has been drawn up on the basis of ISO 527.

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 should be made to ISO 527.

It should however be noted that ISO 527 is applicable to materials in sheet form, whereas ISO 6259 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 are those in the choice of test piece.

ISO 527 specifies test pieces a few millimetres thick, whereas the thickness of a pipe can be up to around 60 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, ISO 6259 comprises three parts. The first part gives the general conditions under which the tensile properties of thermoplastics pipes are to be determined. The other two parts provide, respectively, particular information on the execution of tests on pipe 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 1: General test method

1 Scope

This part of ISO 6259 specifies a method of determining the tensile properties of thermoplastics pipes, including in particular the following properties:

- stress at yield point;
- elongation at break.

This part of ISO 6259 is applicable to all types of thermoplastics pipe, regardless of their intended use.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 6259. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 6259 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1167:1996, *Thermoplastics pipes for the conveyance of fluids — Resistance to internal pressure — Test method.*

ISO 2602:1980, *Statistical interpretation of test results — Estimation of the mean — Confidence interval.*

ISO 5893:1993, *Rubber and plastics test equipment — Tensile, flexural and compression types (constant rate of traverse) — Description.*

ISO 6259-2:1997, *Thermoplastics pipes — Determination of tensile properties — Part 2: Pipes made of unplasticized poly(vinyl chloride) (PVC-U), chlorinated poly(vinyl chloride) (PVC-C) and high-impact poly(vinyl chloride) (PVC-HI).*

ISO 6259-3:1997, *Thermoplastics pipes — Determination of tensile properties — Part 3: Polyolefin pipes.*

3 Principle

Test pieces of given shape and dimensions are obtained from a thermoplastics pipe, in the longitudinal direction, by cutting or machining.

The tensile properties are measured using a test machine under specified conditions.

4 Apparatus

4.1 Tensile-testing machine, complying with ISO 5893 and meeting the specifications given in 4.2 to 4.4, as follows.

4.2 Grips, for holding the test piece and attached to the machine so that the major axis of the test piece coincides with the direction of pull through the centreline of the assembly. This can be achieved, for example, by using centering pins in the grips.

The test piece shall be held such that slip relative to the grips is prevented as far as possible and this shall be effected with the type of grip that maintains or increases pressure on the test piece as the force applied to the test piece increases.

The clamping system shall not cause premature fracture at the grips.

4.3 Load indicator, incorporating a mechanism capable of showing the total tensile load carried by the test piece when held by the grips. The mechanism shall be essentially free from inertia lag at the specified rate of testing, and shall indicate the load with an accuracy of within 1 % of the actual value. Attention is drawn to ISO 5893.

4.4 Extensometer, suitable for determining the gauge length of the test piece at any moment during the test.

The instrument shall be essentially free from inertia lag at the specified test speeds and shall be capable of measuring deformation to an accuracy of within 1 %. Where a mechanical extensometer is used, this shall be fixed to the test piece in such a way that the test piece undergoes the minimum damage and distortion and no slip occurs between it and the extensometer.

The measurement of elongation of the test piece on the basis of the movement of the grips lacks accuracy and shall be avoided whenever possible.

NOTE — It is desirable, but not essential, for this instrument to record this length, or any variation in it, automatically as a function of the stress in the test piece.

4.5 Micrometer or equivalent, capable of reading to 0,01 mm or less and suitable for measuring the thickness and width of the test piece.

4.6 Cutting die, conforming to the relevant profile in ISO 6259-2 or ISO 6259-3, as applicable.

4.7 Milling machine and cutter, capable of producing the test piece specified in ISO 6259-2 or ISO 6259-3, as applicable.

5 Test pieces

5.1 Nature of the test pieces

The test pieces shall conform to the relevant type specified in ISO 6259-2 or ISO 6259-3, as applicable.

5.2 Preparation of test pieces

5.2.1 Sampling from the pipe

Cut strips from the pipe as supplied, i.e. which has not been heated or flattened, so that their axis is parallel to the axis of the pipe and the positions from which the strips are taken conform to item a) or item b) below, as applicable:

a) Pipes of nominal outside diameter less than or equal to 63 mm

Use lengths of pipe of approximately 150 mm.

Cut strips from these various lengths, distributing them around the circumference starting from a generating line taken as the reference line.

Unless otherwise specified, cut at least three strips from each sample so as to be able to take three test pieces (see table 1).

Table 1 — Recommended number of test pieces

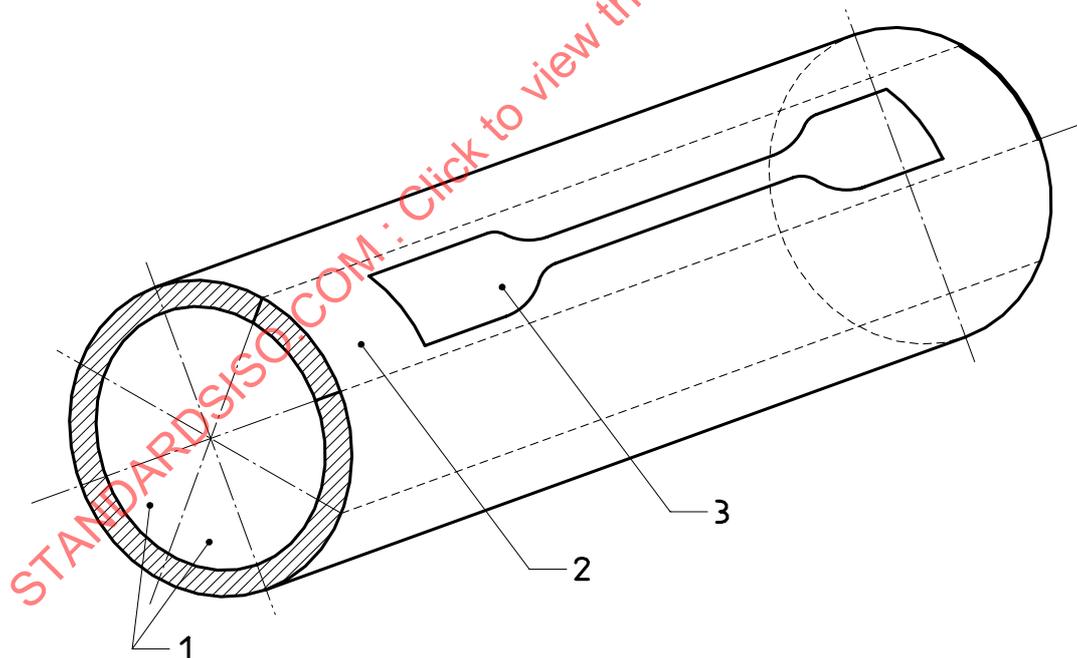
Nominal outside diameter, d_n mm	$15 \leq d_n < 75$	$75 \leq d_n < 280$	$280 \leq d_n < 450$	$d_n \geq 450$
Number of sectors or strips	3	5	5	8

b) Pipes of nominal outside diameter greater than 63 mm

Use a length of pipe of approximately 150 mm.

Cut strips from the length in such a way that they are equally distributed around the circumference of the pipe as shown in figure 1.

Unless otherwise specified, divide the circumference of the pipe length into a number of sectors, depending on the diameter of the pipe, as given in the table 1. Cut out one test piece per strip.



Key

- 1 Sectors
- 2 Strip
- 3 Test piece

Figure 1 — Preparation of test pieces

5.2.2 Selection of test pieces

5.2.2.1 Selection

Select the test pieces from the centre of the strips taken from the length of pipe either by die cutting or machining, in accordance with information relating to the applicable material given in the appropriate product standard.

5.2.2.2 Cutting method

Use the cutting die (4.6) with clean cutting edges, free from notches, with the profile shown in ISO 6259-2 or ISO 6259-3, as applicable.

Cut the test piece from the strip (see 5.2.1).

5.2.2.3 Machining method

Produce the specimen by milling, where necessary using a milling jig.

The shape of the milling cutter and the machining conditions (speed of rotation and advance) are at the discretion of the operator. They shall however be chosen so as to avoid any heating of the test piece and deterioration of its surface such as cracks, scratches or other visible flaws.

NOTE — For the machining procedure, it is recommended that the user consult ISO 2818.

5.2.2.4 Gauge marks

These shall be approximately equidistant from the mid-point, and the distance between the marks shall be measured to an accuracy of 1 % or better.

Gauge marks shall not be scratched, punched or impressed upon the test piece in any way that may damage the material being tested. It shall be ensured that the marking medium has no detrimental effect on the material being tested and that, in the case of parallel lines, they are as narrow as possible.

5.2.2.5 Number of test pieces

Carry out the test on the number of test pieces as shown in table 1 according to the thickness unless specified otherwise by the referring standard.

6 Conditioning

6.1 Prior to testing, condition the test pieces at a temperature of (23 ± 2) °C for a period of not less than the time specified in table 1 of ISO 1167:1996 according to the thickness of the test piece.

The test pieces shall not be tested within a period of 15 h after the production of the pipes, except for manufacturing checks, unless otherwise specified in the referring standard.

6.2 Conditioning and testing may also be carried out at (27 ± 2) °C (in conformity with ISO 291), but in this case the values obtained shall be corrected to 23 °C (reference temperature).

7 Test speed

The test speed depends on the constituent material and wall thickness of the pipe and shall be as specified in the applicable product standard or in ISO 6259-2 or ISO 6259-3.

8 Procedure

- 8.1** Carry out the following procedure at a temperature of (23 ± 2) °C.
- 8.2** Measure, to within 0,01 mm, the width and minimum thickness of the central part of the test piece between the gauge marks. Calculate the minimum cross-sectional area.
- 8.3** Place the test piece in the tensile-testing machine (4.1) in such a way that the axis of the test piece coincides more or less with the direction of the tensile force. Clamp the grips (4.2) uniformly and tightly to avoid any slippage of the test piece.
- 8.4** Where necessary, place and adjust the extensometer (4.4) on the gauge length (the part between the gauge marks) of the test piece.
- 8.5** Adjust the test speed to the value specified and set the machine in motion.
- 8.6** Record the stress/strain curve up to the rupture of the test piece and record on this curve the force at the yield point and the gauge length at rupture, or note directly the value of the force at yield and the gauge length after rupture.

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.

9 Expression of results

9.1 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 the following equation:

$$\sigma = \frac{F}{A}$$

where

- σ is the tensile stress at yield, expressed in megapascals¹⁾;
- F is the force at yield, expressed in newtons;
- A is the initial cross-sectional area of the test piece, expressed in square millimetres.

Express the result to three significant figures.

NOTE — The yield stress should, in fact, 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.

9.2 Elongation at break

Calculate, for each test piece, the elongation at break, using the following formula:

$$\varepsilon = \frac{l - l_0}{l_0} \times 100$$

1) 1 MPa = 1 N/mm²