INTERNATIONAL STANDARD

ISO 4433-1

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Thermoplastics pipes — Resistance to liquid chemicals — Classification —

Part 1: Immersion test method

Tubes en matières thermoplastiques — Résistance aux liquides chimiques — Classification —

Partie 1: Méthode d'essai d'immersion

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 4433-1 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 3, *Plastics pipes and fittings for industrial applications*.

Together with the other parts (see below), this part of ISO 4433 cancels and replaces ISO 4433:1984, which has been technically revised.

ISO 4433 consists of the following parts, under the general title *Thermoplastics pipes — Resistance to chemical fluids — Classification*:

— *Part 1: Immersion test method*

— *Part 2: Polyolefin pipes*

— *Part 3: Unplasticized poly(vinyl chloride) (PVC-U), high-impact poly(vinyl chloride) (PVC-HI) and chlorinated poly(vinyl chloride) (PVC-C) pipes*

— *Part 4: Poly(vinylidene fluoride) (PVDF) pipes*

Annexes A to C of this part of ISO 4433 are for information only.

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Introduction

Because of their varied applications, thermoplastics pipes are frequently required to convey or be in contact with materials such as chemical products, fuels, lubricants, and sometimes their vapours.

Under the action of a liquid, the wall of a thermoplastics pipe can be the location for several concurrent phenomena; on the one hand, absorption of liquid and/or extraction of its soluble constituents from the pipe walls into the liquid; on the other hand, a chemical reaction usually involving a significant change in the properties of the pipe. The phenomena also differ according to the external and internal stresses affecting the pipes conveying the products (e.g. temperature, pressure, wall thickness).

By stresses are meant those forces caused by internal or external factors such as temperature, variation of temperature, inside pressure, bending, internal stresses. Internal stresses could be caused, for instance, by fast quenching of thick-walled pipes.

As the conditions of use vary a great deal, it is important to carry out a preliminary determination of the chemical resistance of thermoplastics pipes by means of simple, straightforward tests.

The purpose of this International Standard is to provide a procedure for the experimental test methods.

Some liquids (e.g. wetting agents) may cause cracking in specimens subject to tensile stress, whilst not affecting the properties of specimens not under stress. The strip bending test as specified in ISO 4599[3] (see annex C) or the constant tensile stress method as specified in ISO 6252[4] will give an indication of the susceptibility of the material to stress cracking. For polyolefin materials, attention is also drawn to ISO 13480[7].

The extrapolation of the results obtained with this method, expressed as:

satisfactory resistance	S
limited resistance	L
non-satisfactory resistance	NS

for any kind of pipe or fitting may be made only when high internal stresses are not induced in the pipe.

In order to assess the behaviour of pipes and fittings for the conveyance of liquids under pressure or in the presence of other stresses, in cases when the preliminary classification is S or L, it will be necessary to carry out further tests as specified in ISO 8584-1[5].

NOTES

1 This International Standard is also applicable to thermoplastics sheet as appropriate.

2 A collection of results obtained by this method for several types of plastics is contained in ISO/TR 10358.

Thermoplastics pipes — Resistance to liquid chemicals — Classification —

Part 1:
Immersion test method

1 Scope

1.1 This part of ISO 4433 specifies a method for carrying out a preliminary evaluation of the behaviour of thermoplastics pipes in relation to the liquid chemicals transported.

1.2 This method of classification provides information on the suitability of pipes for transporting liquid chemicals in the absence of pressure or stresses such as earth loads, dynamic stresses and internal stresses.

1.3 A full procedure for carrying out the test is also reported in ISO 175, which is devoted to plastics in general, and not specifically to thermoplastics pipes.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 4433. 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 4433 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 175:1981, *Plastics — Determination of the effects of liquid chemicals, including water.*

ISO 527-2:1993, *Plastics — Determination of tensile properties — Part 2: Test conditions for moulding and extrusion plastics.*

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

ISO 6259-2:—[1)], *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:—[1)], *Thermoplastics pipes — Determination of tensile properties — Part 3: Polyolefin pipes.*

1) To be published.

3 Principle

3.1 Standard test pieces (of the type used for tensile tests — see figure 1) are taken from pipes, of wall thickness preferably between 1,8 mm and 3,2 mm, made from the material to be tested (see ISO 527-2).

3.2 The test pieces are completely immersed in the liquid chemical being used for the test.

3.3 The immersion periods are standardized and chosen according to the change in mass of the test pieces as a function of time, in particular to the state of saturation or equilibrium as indicated by a plateau in the curve of change in mass.

NOTE — Additional information is required when

— the pipes are permeable to the liquids transported;

— electrostatic surface charges present a risk (liquids with a flash point of less than 55 °C; the flash point can be determined by ISO 1516[1] or ISO 3680[2]);

— the immersion liquid can produce particular effects, such as stress cracking phenomena, which this method does not cover.

4 Materials

4.1 Test liquids

4.1.1 When information is required on the behaviour of a thermoplastic pipe used to transport a specific liquid, this liquid shall normally be used.

4.1.2 The composition of industrial liquids is not, in general, absolutely constant; whenever possible, therefore, the test shall be carried out in defined chemical liquids used on their own or in mixtures, and so that it is as representative as possible of the action of the products in question.

4.1.3 The volume of liquid required for one immersion temperature shall be about 10 l.

4.2 Auxiliary materials

4.2.1 Filter paper or similar material, for drying the test pieces.

4.2.2 Petroleum ether or **ethanol,** for cleaning specimens.

5 Apparatus

5.1 Containers, with a cover or stopper, to hold the test liquid in cases where its vapour pressure is negligible at the immersion temperature, or containers with a reflux condenser or containers that can be sealed (e.g. autoclaves) for liquids which are volatile at the immersion temperature.

5.2 Controlled atmosphere enclosure, constant-temperature bath or **oven,** capable of maintaining the containers at the required temperature to within ± 2 °C.

5.3 Balance, with a limit of error of 1 mg.

5.4 Tall-form weighing bottle.

5.5 Micrometer or its equivalent, for measuring the test piece thickness and width to an accuracy of 0,02 mm.

5.6 Tensile-testing machine, with test speeds of 1 mm/min, 25 mm/min and 100 mm/min, an **extensometer** accurate to ± 2,5 % and a **clamping device**. The load capability and measurement accuracy shall be in accordance with ISO 5893.

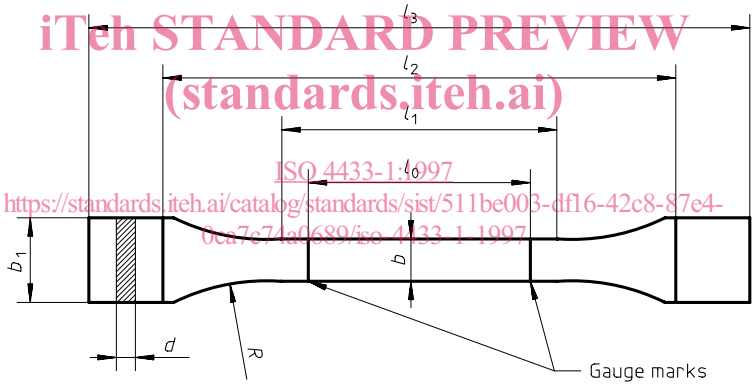
The load and elongation data shall be obtained as automatically recorded curves or by direct observation.

6 Test pieces

6.1 Shape and dimensions

The shape and dimensions of the test piece shall be as given in figure 1.

NOTE — This test piece is half the size of the type 1B test piece specified in ISO 527-2.



b	Width of narrow parallel-sided portion:	5 mm ± 0,5 mm
b_1	Width at ends:	10 mm ± 0,5 mm
d	Thickness:	see ISO 6259-2 and ISO 6259-3
l_0	Distance between gauge marks:	25 mm ± 0,5 mm
l_1	Length of narrow parallel-sided portion:	30 mm ± 0,5 mm
l_2	Initial distance between grips:	60 mm ± 5 mm
l_3	Overall length, min.:	75 mm
R	Radius, min.:	30 mm

Figure 1 — Test piece

6.2 Number of test pieces

The minimum number of test pieces to be prepared shall be 20 for each test liquid at each temperature.

6.3 Preparation of test pieces

The pipes used for providing test pieces shall conform to the following conditions:

— they shall have been extruded at least 3 days previously except for polybutylene (PB) for which the extrusion shall have been at least 10 days previously;

— they shall conform to the applicable specifications for thermoplastics pipes;

— the pipe shall have a wall thickness between 1,8 mm and 3,2 mm, preferably 2,2 mm ± 0,3 mm, and an outside diameter preferably from 75 mm to 110 mm.

Test pieces shall be prepared in such a way that their axis is parallel to that of the pipe and shall be taken regularly from around its circumference.

6.4 Conditioning of test pieces before testing

The immersion test and the tests on the non-immersed test pieces shall not be carried out until the test pieces have been kept at 23 °C ± 2 °C and (50 ± 5) % relative humidity for a minimum of 24 h.

7 Immersion procedure

7.1 General

Use the general test procedure given in ISO 175 with the following more detailed requirements.

7.2 Number and intended use of test pieces

a) use one set of at least five test pieces to determine the initial tensile properties;

b) use three sets of at least five test pieces to determine the change in mass and the change in tensile properties after immersion times t_1, t_2 and t_3 as defined in 7.5;

c) use additional test pieces as necessary to determine the initial immersion time (see 7.5).

7.3 Steps to be taken before every immersion

Immediately before immersion, measure the width and thickness of the gauge length to the nearest 0,02 mm and mark the test piece clearly to prevent any confusion.

7.4 Test temperature

Maintain the test liquid by suitable means at one of the temperatures indicated by a cross in table 1.

Table 1 — Test temperatures

Material	Immersion temperature °C				
	23 ± 2	40 ± 2	60 ± 2	80 ± 2	100 ± 2
PE (LD, MD, HD)	x	x	x	—	
PP	x	x	x	x	x
PB	x	x	x	x	x
PE-X	x	x	x	x	x
ABS	x	x	x	—	—
PVC (U; HI)	x	x	x	—	—
PVC-C	x	x	x	x	—
PVDF	x	x	x	x	x

If the boiling point of a test liquid lies below a temperature given in table 1, the test shall be carried out at the boiling point of the liquid.

NOTE — These test temperatures are the standard ones. Other test temperatures may be used, depending on the service temperature in the envisaged application and on the physical capability of the material tested.

7.5 Duration of immersion

To determine the initial time for the determination of the tensile properties, remove immersed test pieces from the liquid for tensile tests after three consecutive immersion periods t_1, t_2 and t_3 chosen from the following:

7 d 14 d 28 d 56 d 112 d

The initial time is normally given by the appearance of a plateau in the curve showing the change in mass as a function of time (see clause 8), but shall not exceed 28 d even if no plateau appears in the change in mass curve before 28 d. The plateau in the change in mass curve indicates that saturation or equilibrium has been reached (see curves No. 4 and No. 7 in annex B. If saturation or equilibrium is not reached after 112 days, continue the immersion test until a plateau is reached, or end the test with a classification of NS (not suitable).

7.6 Quantity of liquid used

Generally speaking (i.e. in the case of pipes not containing extractable products or products very prone to attack), use at least 4 ml of liquid per cm^2 of total test piece area or at least 60 ml per test piece, whichever is the greater.

NOTES

1 The total area of a half-size type 1B test piece 2,2 mm thick is approximately 15 cm^2.

2 For each test piece to be immersed in a minimum of 60 ml, 0,9 l of liquid are required for a set of 15 test pieces.

7.7 Positioning of test pieces

Immerse the test pieces under the following conditions and record the time when the immersion began:

a) if the test pieces are identical, several test pieces may be placed in the same container as long as they do not touch each other;