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TECHNICAL CORRIGENDUM 1

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Thermoplastics pipes for the conveyance of fluids — Resistance to internal pressure — Test method

TECHNICAL CORRIGENDUM 1

Tubes en matières thermoplastiques pour le transport des fluides — Résistance à la pression interne — Méthode d'essai

RECTIFICATIF TECHNIQUE 1

Technical Corrigendum 1 to International Standard ISO 1167:1996 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.*

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Tables A.4 and A.5

In the first column (test temperature), replace "100" by "110".

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ISO 1167

Second edition
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Thermoplastics pipes for the conveyance of fluids — Resistance to internal pressure — Test method

Tubes en matières thermoplastiques pour le transport des fluides — Résistance à la pression intérieure — Méthode d'essai

Reference number
ISO 1167:1996(E)

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 1167 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*.

This second edition cancels and replaces the first edition (ISO 1167:1973), of which it constitutes a technical revision.

Annex A of this International Standard is for information only.

International Organization for Standardization
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Thermoplastics pipes for the conveyance of fluids — Resistance to internal pressure — Test method

1 Scope

This International Standard specifies a method for determination of the resistance of thermoplastics pipes to constant internal water pressure at constant temperature.

It is applicable to thermoplastics pipes intended for the conveyance of fluids.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard 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 161-1:1996, *Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series.*

ISO 3126:1974, *Plastics pipes — Measurement of dimensions.*

ISO/TR 9080:1992, *Thermoplastics pipes for the transport of fluids — Methods of extrapolation of hydrostatic stress rupture data to determine the long-term hydrostatic strength of thermoplastics pipe materials.*

3 Definitions

For the purposes of this International Standard, the definitions given in ISO 161-1 apply.

4 Principle

After conditioning, test pieces are subjected to a specified constant internal hydrostatic pressure for a specified period of time or until failure.

Throughout the test, the test pieces are kept in an environment at a specified constant temperature: this is water ("water-in-water" test), another liquid ("water-in-liquid" test) or air ("water-in-air" test).

5 Test parameters

The following test parameters are set by the standard making reference to this International Standard:

a) the type of end cap to be used (see 6.1);

b) the size and S-series of pipe to be used (see 7.1);

c) the test temperature (see 6.2 and 10.1);

d) for pipes of nominal outside diameter d_n greater than 315 mm, the free length of the test piece, if other than 1 000 mm (see 7.1.1);

e) the number of test pieces (see 7.2);

f) the test pressure p or the hoop stress σ to be induced by the test pressure (see 8.2.2);

g) the conditioning period (see clause 9), if other than as specified in table 1;

h) the type of test, i.e. water-in-water/air/liquid (see clause 4 and 10.1);

i) the duration of the test under pressure and the criteria for a failure (see 10.3);

j) the requirements, or patterns of requirements, if any, which determine the initiation of additional testing.

6 Apparatus

6.1 End caps, fixed to the ends of the pipe.

By means of an appropriate system, they shall allow sealing and connection to the pressurizing equipment.

The end cap shall be of one of the following types:

a) Type A: Fittings rigidly connected to the test piece but not to each other, and hence transmitting the hydrostatic end thrust to the test piece, e.g. as shown in figure 1 a). They may comprise flanged plates on the ends of a large-diameter pipe, optionally welded when flanges, caps, plugs or plates are of a material compatible with that of the test pieces.

b) Type B: Sockets, made of metal, fitted with joints ensuring sealing onto the external surface of the test piece and connected to one another, and hence not transmitting the hydrostatic end thrust to the test piece. They may comprise one or more metal rods, as shown in figure 1 b), allowing sufficient longitudinal movement at the ends of the test piece to avoid buckling due to thermal expansion.

Other than toothed grips, any sharp edges which would come into contact with the outside surface of the pipe shall be rounded off.

The constituent material of the end cap shall not have any known adverse effect on the pipe under test.

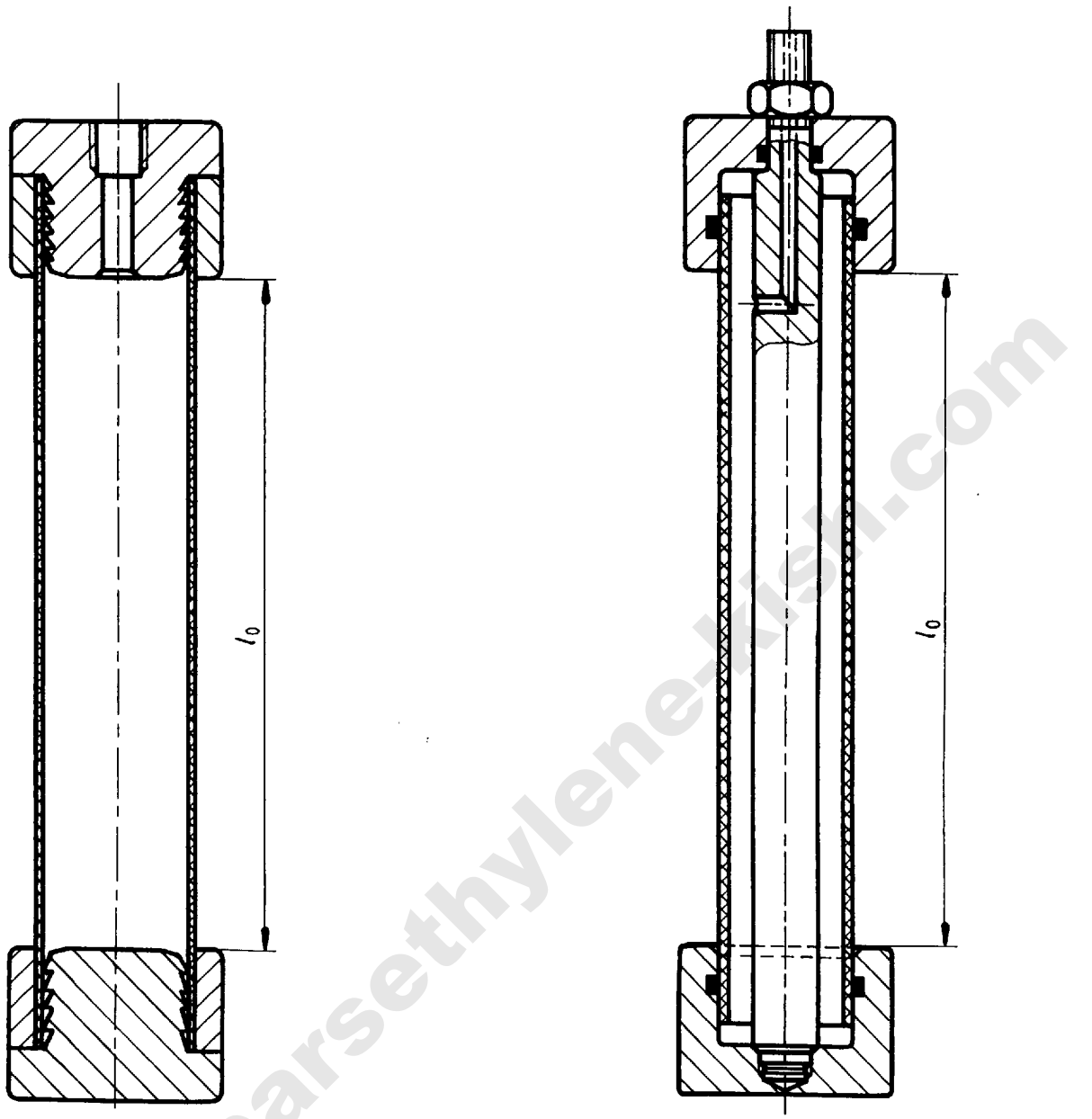
NOTES

1 In general, times to failure with type B end caps are shorter than those obtained with type A end caps because of differences of stress in deformation.

2 When no precautions are taken, type B end caps can cause buckling of the test piece when the test piece is assembled with the end caps at a lower temperature than the test temperature.

For the evaluation of pipe and/or fitting materials in accordance with ISO/TR 9080, type A end caps shall be used unless otherwise specified in the referring standard.

The reference end cap is the type A end cap.



a) Type A, without metal rod
(hydrostatic end thrust transmitted to the test piece)

b) Type B, with metal rod
(hydrostatic end thrust not transmitted to the test piece)

Figure 1 — Examples of devices for the internal pressure testing of pipes

6.2 Tank, filled with water or another liquid, kept at a constant temperature, as specified in the referring standard, to within a mean of ± 1 °C and a maximum deviation of ± 2 °C (see 10.2), or **oven**, the temperature of which shall be kept at the specified value to within a mean of $^{+3}_{-1}$ °C and maximum deviations of $^{+4}_{-2}$ °C.

When an environment other than water is used, all necessary precautions shall be taken, in particular those concerning safety and any interaction between liquids and the material(s) of the test piece.

When environments other than water are used, tests which are intended to be comparative shall be carried out in the same environment.

As the results are strongly influenced by temperature, the tolerance on temperature shall be kept as small as possible within the specified limits, e.g. by using forced circulation of the fluid. When testing in air, it is recommended that the pipe surface temperature is checked in addition to the air temperature.

The water shall not contain any impurities which could affect the results.

6.3 Supports or **hangers**, enabling test pieces to be placed in the tank or oven (6.2) in such a way that there is no contact between them or with the side walls of the tank or oven.

6.4 Pressurizing equipment, capable of applying the required pressure gradually and smoothly in accordance with 10.1 and then of keeping it constant to within $^{+2}_{-1}$ % for the duration of the test.

As the results are strongly influenced by pressure, the tolerance on pressure shall be kept as small as possible within the specified limits.

NOTES

1 The pressure should preferably be applied individually to each test piece. However, the use of equipment enabling the pressure to be applied simultaneously to several test pieces is also permitted if there is no danger of interference when failure occurs (e.g. by the use of an isolation valve or a test based on the first failure in a batch).

2 To maintain the pressure within the specified tolerance, it is recommended that a system be introduced which automatically resets the pressure, if it drops slightly (e.g. because of swelling of the test piece), to the specified value.

6.5 Pressure measurement devices, capable of checking conformity to the specified test pressure [see 8.2.2 and item f) in clause 5]. In the case of gauges or similar calibrated pressure measurement devices, the range of the gauge shall be such that the required pressure setting lies within the calibrated range of the device used (see 8.1).

The pressure measurement devices shall not contaminate the test fluid.

The use of master gauges for calibration of the apparatus is recommended.

6.6 Thermometer or equivalent, capable of checking conformity to the specified test temperature [see 6.2 and item c) in clause 5].

6.7 Timer, capable of recording the duration of the pressure applications up to the moment of failure or leakage.

NOTE — It is recommended that equipment be used which is sensitive to pressure variations due to leaks or a failure and which is capable of stopping the timer and, if necessary, closing the pressure circuit for the test piece concerned.

6.8 Means of measuring the wall thickness, conforming to ISO 3126, with hemispherical tips, and of such a design that measurements can be made along the whole length of the pipe.

NOTE — A calibrated ultrasonic measuring device can be used.

6.9 Means of measuring the mean outside diameter of the pipe, conforming to ISO 3126, e.g. a metal tape.

7 Test pieces

7.1 Dimensions

7.1.1 Free length

The free length l_0 of each test piece between the end caps shall be at least three times the outside diameter for pipes with a nominal outside diameter less than or equal to 315 mm, with a minimum of 250 mm. For pipes with a nominal outside diameter greater than 315 mm, a minimum free length of greater than or equal to 1 000 mm shall be used.

7.1.2 Total length

For type B end caps, the total length of the test piece shall be such that the test piece does not make contact with the end surface of the end caps during the test.

7.2 Number

Prepare a minimum of three test pieces unless specified in the referring standard.

The number of test pieces depends on the purpose of the test (e.g. performance test, internal and/or external quality control test).

8 Calibration of the apparatus and calculation of the test pressure

8.1 Calibration of the apparatus

The temperature and pressure control systems, and the equipment for measuring temperature, pressure and time, shall be calibrated to an accuracy compatible with the scales used and at a frequency commensurate with the conditions of use.

8.2 Calculation of the test pressure

8.2.1 Determine, in accordance with ISO 3126, the minimum wall thickness and the mean outside diameter of the free length of the test piece, using apparatus conforming to 6.8 and 6.9, respectively.

8.2.2 If necessary [see item f) in clause 5], calculate the test pressure p in bars [2)], to three significant figures, using the following equation:

$$p = 10\sigma \frac{2e_{min}}{d_{em} - e_{min}}$$

where

σ is the hoop stress, in megapascals, to be induced by the applied pressure;

d_{em} is the measured mean outside diameter, in millimetres, of the test piece;

e_{min} is the measured minimum wall thickness, in millimetres, of the free length of the test piece.

2) 1 bar = 10^5 Pa = 0,1 MPa

9 Conditioning

Clean and dry the test pieces (see clause 7) to remove any traces of dirt, oil, wax or any other contamination, and fit them with the end caps (6.1) chosen for the test. Fill the test pieces with water, which may be preheated to a temperature not more than 5 °C above the test temperature.

After filling, immerse the test pieces in the water bath or place in the oven at the required temperature and condition for the time period specified in table 1. When conditioning at temperatures in excess of 100 °C, apply some pressure to prevent vaporisation.

Table 1 — Conditioning periods

e_{min} mm	Conditioning period
$e_{min} < 3$	1 h ± 5 min
$3 \leq e_{min} < 8$	3 h ± 15 min
$8 \leq e_{min} < 16$	6 h ± 30 min
$16 \leq e_{min} < 32$	10 h ± 1 h
$32 \leq e_{min}$	16 h ± 1 h

The test pieces shall not be tested within a period of 15 h after production of the pipes, except for manufacturing checks, unless there are specifications to the contrary in the referring standard for the material involved.

10 Procedure

10.1 Select the type of test, i.e. "water-in-water", "water-in-air" or "water-in-liquid", as specified by the referring standard.

Connect the conditioned test pieces (see clause 9) to the pressurizing equipment (6.4) and bleed off the air. Progressively and smoothly apply the test pressure (calculated in accordance with 8.2.2) to $^{+2}_{-1}$ %, in the shortest time practicable between 30 s and 1 h, depending upon the material, the size of the pipe and the capability of the pressurizing equipment.

Start the timer (6.7) when the test pressure is reached.

10.2 Keep the test pieces suspended in the thermally controlled environment. Maintain a constant temperature (see the referring standard) and keep within a mean of ± 1 °C and a maximum deviation of ± 2 °C when a liquid environment is used, and within a mean of $^{+3}_{-1}$ °C and a maximum deviation of $^{+4}_{-2}$ °C in the case of an oven (see 6.2) until testing ceases in accordance with 10.3 or 10.4, as applicable.

10.3 Stop the test either when the specified duration is reached [see item i) in clause 5] or when a failure or leak occurs in the test piece, in which case record the time to failure unless the procedure given in 10.4 is applicable.

If a failure occurs, record the type, i.e. brittle or ductile.

NOTE — Failure is "brittle" if no plastic deformation has occurred in the failure zone. If the failure is accompanied by plastic deformation in the failure zone, visible without magnification, it is of the "ductile" type.

In the event of equipment failure, tests which have been under way for more than 1 000 h can be continued providing the equipment is reinstated within 3 days. For tests which have been under way for more than 5 000 h, the test can be continued providing the equipment is reinstated within 5 days. Following equipment failure, if the test pieces are closed off at the test pressure by a solenoid valve or other means the test can be continued in the

event of periods of breakdown in excess of that stated above. It should be noted that, in this situation, the pressure will gradually decrease due to continuing creep in the test piece. The time whilst the equipment is not able to function normally shall not be included in the test time.

10.4 If a break occurs in the test piece at a distance of less than 0,1 l_0 from an end cap, disregard the result and repeat the test using another test piece.

11 Test report

The test report shall include the following information:

a) a reference to this International Standard and to the referring standard;

b) all details necessary for the complete identification of the sample;

c) the type of material;

d) the nominal dimensions of the pipe;

e) the measured dimensions of the test pieces, in millimetres;

f) the test temperature and accuracy of its measurement;

g) the stress applied, in megapascals;

h) the calculated test pressure, in bars;

i) the nature of the environment, i.e. air, water or liquid (and the nature of the liquid, if used);

j) the type of end cap used;

k) the total and free lengths of the test pieces, in millimetres;

l) the number of test pieces tested;

m) the duration of the test;

n) the type of failure in each case, if any;

o) any observations made during and after the test;

p) details of any factor which may have affected the results, such as any incident or any operating detail not specified in this International Standard;

q) the date of the test or the dates between which the test was conducted.

Annex A
(informative)

Basic specifications

A.1 General

It is recommended that, at the temperatures and stresses given in tables A.1 to A.6, each of which corresponds to a different material, the time to failure of a pipe shall not be less than the minimum test time given in the appropriate table, measured in accordance with the test method specified in this International Standard.

A.2 Unplasticized poly(vinyl chloride) (PVC-U) pipes

See table A.1.

A.3 Chlorinated poly(vinyl chloride) (PVC-C) pipes

See table A.2.

A.4 Polyethylene (PE) pipes

See table A.3.

A.5 Polypropylene (PP) pipes

See table A.4.

A.6 Polybutene (PB) pipes

See table A.5.

A.7 Cross-linked polyethylene (PE-X) pipes

See table A.6.

Table A.1 — Unplasticized poly(vinyl chloride) (PCV-U)

Test temperature °C	Test time h	Induced stress σ MPa
20	1	42
	100	35
60	1 000	12,5

Table A.2 — Chlorinated poly(vinyl chloride) (PVC-C)

Test temperature °C	Test time h	Induced stress σ MPa
20	1	42
80	1	15
	250	8

Table A.3 — Polyethylene (PE)

Test temperature °C	Test time h	Induced stress σ MPa for an MRS of 10	8	6,3	5	4	3,2
		MRS class: PE100	PE80	PE63	PE50	PE40	PE32
20	100	12,4	9	8	7,5	7	6,5
80	165	5,5	4,6	3,5	2,8	2,5	2
	1 000	5	4	3,2	2,5	2	1,5

NOTE — If a material with a given MRS, determined in accordance with ISO/TR 9080 by the required series of tests, does not conform to the minimum test times given above, then the test times may be modified. For a material of a given MRS class which physically cannot conform to the requirements specified for 80 °C, less demanding test stresses may be used. These stresses shall be established by examining the data used to determine the MRS class of the material.

Table A.4 — Polypropylene (PP)

Test temperature °C	Test time h	Induced stress σ MPa for a homopolymer	for a block copolymer[1)]	for a random copolymer
20	1	21	16	16
95	1 000	3,55	2,65	3,5
100	8 760	1,95	1,4	1,9

1) Heterophasic.

Table A.5 — Polybutene (PB)

Test temperature °C	Test time h	Induced stress σ MPa
20	1	15,5
95	1 000	6
100	8 760	2,4

NOTE — After extrusion or moulding, PB undergoes a crystalline-phase transition before it develops its optimum properties. For quality-control purposes, therefore, samples shall be taken immediately after extrusion or moulding and be stored for 10 days in a conditioning room at 20 °C ± 5 °C prior to testing.

Table A.6 — Cross-linked polyethylene (PE-X)

Test temperature °C	Test time h	Induced stress σ MPa
20	1	12
95	1	4,8
	170	4,6
	1 000	4,4
110	8 760	2,4

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Descriptors: fluid pipelines, pipes (tubes), thermoplastic resins, plastic tubes, tests, pressure tests, determination, pressure resistance, internal pressure.

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