INTERNATIONAL STANDARD

ISO 10952

Second edition
2008-10-15

Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Determination of the resistance to chemical attack for the inside of a section in a deflected condition

Systèmes de canalisations en matières plastiques — Tubes et raccords en plastiques thermodurcissables renforcés de verre (PRV) — Détermination de la résistance à une attaque chimique à l'intérieur d'un tronçon de tube soumis à déflexion

Reference number
ISO 10952:2008(E)

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Published in Switzerland

Foreword

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

ISO 10952 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 6, *Reinforced plastics pipes and fittings for all applications*.

This second edition cancels and replaces the first edition (ISO 10952:1999), of which it constitutes a technical revision.

Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Determination of the resistance to chemical attack for the inside of a section in a deflected condition

1 Scope

This International Standard specifies a method for determining the chemical resistance properties of glass-reinforced thermosetting plastics (GRP) pipes and fittings in a deflected condition for nominal sizes DN 100 and larger.

In conjunction with ISO 10928, this International Standard provides a method for evaluating the effect of a chemical environment on the interior of a pipe or fitting after a specified period of time. Test conditions and requirements are specified in the referring standards such as ISO 10467.

NOTE It has been found that the effect of chemical environments can be accelerated by strain induced from deflection; hence, it is frequently referred to as strain corrosion.

2 Normative references

The following referenced documents are indispensable for the application 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 10928:—[1)], *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Methods for regression analysis and their use*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
mean diameter
d_m
diameter of the circle corresponding with the middle of the pipe wall cross section

NOTE 1 The mean diameter is given by either of the following equations:

$$d_m = d_i + e_m$$

$$d_m = d_e - e_m$$

1) To be published. (Revision of ISO 10928:1997)

where

d_e is the external diameter of the pipe;

d_i is the internal diameter of the pipe;

e_m is the mean wall thickness of the pipe at the bottom.

NOTE 2 The mean diameter and the dimensions used to calculate it are expressed in millimetres.

3.2
leak failure
failure which becomes apparent by the passage of the test liquid through the pipe wall

4 Principle

The interior of a test piece is exposed to a corrosive test liquid at a specified temperature while being maintained in a fixed diametrically deflected condition. The test is repeated at several deflection levels, using a fresh test piece each time and recording the time to leak failure at each deflection. The results are used to calculate an extrapolated deflection value for a specified period of time.

Alternatively the extrapolation can be performed using calculated or measured strains. Strain can be measured using strain gauges.

NOTE Use of strain allows testing using test pieces of variable thickness and stiffness classes. Deflection and strain are interrelatable by calculation.

It is assumed that the following test parameters are set by the standard making reference to this International Standard:

a) the composition of the test liquid (see Clause 5);

b) the number and length of test pieces (see Clause 7);

c) the pre-conditioning to be applied (see Clause 9);

d) the test temperature (see 10.1 or 11.1);

e) if failures do not occur (see 10.11 and 11.11), the specified deflection levels and related minimum time intervals;

f) the time to which the data have to be extrapolated (see Clause 12).

5 Test liquid

The test liquid shall be as specified in the referring standard. The quantity shall be sufficient to achieve and maintain for the duration of the test the specified depth within the test piece (see 10.7 or 11.7).

6 Apparatus

6.1 Loading frame, comprising two parallel steel sections and threaded rods which can maintain a constant deflection of the test piece (see Figure 1). The sections shall be sufficiently stiff such that visible bending or deformation of the sections does not occur during the compression of the test piece. Each section shall have a length equal to the length of the test piece plus at least 30 mm and a width of at least 100 mm.

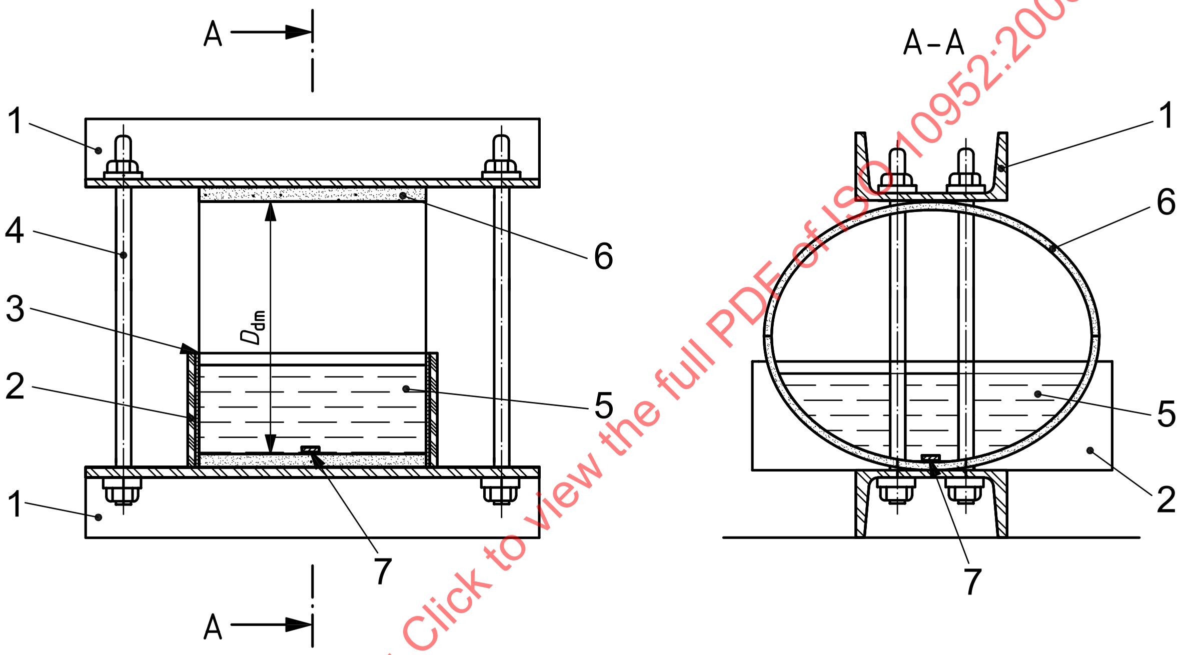
6.2 Dimensional measuring devices, capable of determining:

a) the dimensions (length, diameter, wall thickness) to an accuracy of within ± 0,5 %;

b) the change in diameter of the test piece in the vertical direction to an accuracy of within ± 1,0 % of the maximum value of the change;

c) if used, strain gauges of the foil type, single element suitable for the maximum anticipated strain level and a length appropriate for the pipe diameter.

Strain gauges of length 6 mm and 12 mm have been found to be effective for pipe diameters 300 mm to 600 mm. Consult the strain gauge manufacturer for gauge length recommendations for other pipe diameters.



Key

1 steel channel section
2 dam
3 sealant
4 threaded rod
5 test liquid
6 test piece
7 strain gauge (optional)
D_{dm} deflected diameter

Figure 1 — Typical test set-up

7 Test pieces

7.1 Preparation

The test piece shall comprise a complete ring cut from the pipe or fitting to be tested. The length of the test piece shall be as specified in the referring standard, with permitted deviations of ± 5 %.

The cut ends shall be smooth and perpendicular to the axis of the test piece.

Two straight lines, diametrically opposed, shall be drawn longitudinally on the inside of the test piece.

7.2 Number

The number of test pieces shall be as specified in the referring standard, provided that for regression analysis the number of test pieces is such that a minimum of 18 data points in accordance with 10.2 or 11.2 can be obtained.

8 Determination of the dimensions of the test piece

8.1 Length

Measure the length of the test piece along each line with sufficient accuracy to determine whether or not each test piece conforms with the requirements of Clause 7. Trim or replace, as applicable, each test piece that does not conform.

8.2 Mean wall thickness

Measure (6.2), to an accuracy of within ± 1,0 %, the wall thickness of the test piece at six equally spaced locations along one of the longitudinal lines specified in 7.1. (This line then becomes the bottom of the test piece.) Calculate the mean wall thickness, e_m, as the arithmetic average of the six measured values.

8.3 Mean diameter

Measure (6.2), to an accuracy of within ± 1,0 %, either the internal diameter, d_i, of the test piece at mid-length, by means of e.g. a calliper, or the external diameter, d_e, of the test piece, by means of e.g. a circumferential wrap steel tape.

Determine the mean diameter, d_m (see 3.1), of the test piece by calculation using the values obtained for mean wall thickness, e_m, and either the internal or the external diameter.

9 Conditioning

Unless otherwise specified by the referring standard, the test pieces shall be stored under testing conditions for at least 8 h.

10 Test procedure using deflection measurement

WARNING — Contain any fragmentation or leakage that can occur during the test.

10.1 During the following procedure, maintain the temperature specified in the referring standard.

10.2 Select the range of estimated deflections such that the times to failure of at least 18 test pieces are distributed between 0,1 h and over 10 000 h, and the distribution of failure times of at least 10 values conforms to the limits given in Table 1.

NOTE Deflections in excess of 28 % of diameter can cause local flattening of the pipe and lead to erratic strain distribution. For deflections approaching 28 % improved accuracy is obtained by use of additional strain gauges or by establishing, for a typical test piece, a calibration of deflection versus measured strain. This calibration technique is also useful at all deflection levels as a check of the calculations which assume that the neutral axis is at the midpoint of the test piece wall.

Table 1 — Failure time distribution

Failure time t_f h	Minimum number of failures
$10 \leqslant t_f \leqslant 1\,000$	4
$1\,000 < t_f \leqslant 6\,000$	3
$t_f > 6\,000$	3 [a]

[a] At least one of these shall exceed 10 000 h.

10.3 Place the test piece in the apparatus such that the lines on the test piece are vertically aligned, parallel to, and centred on the axes of the plates or sections.

By visual inspection, ensure that the contact between the test piece and loading apparatus is as uniform as possible and that the plates or sections are not tilted.

10.4 Apply force to the apparatus to deflect the test piece while keeping the top and bottom plates or sections of the apparatus as parallel as possible.

When the applicable deflection is reached (see 10.2), note the time and lock the apparatus to maintain the test piece in the deflected condition.

10.5 Using a flexible sealant, install chemically inert dams so that only the inside surface of the test piece is exposed to the test environment. The dams shall not add support to the test piece.

10.6 Calculate the initial linear strain level, ε_0, expressed as a percentage, using Equation (1), which includes compensation for increased horizontal diameter with increasing deflection:

$$\varepsilon_0 = 100 \times \frac{4{,}28\, e_m\, d_{dm}}{\left(d_m + 0{,}5\, d_{dm}\right)^2} \qquad (1)$$

where

e_m is the mean wall thickness, in millimetres, of the test piece at bottom;

d_{dm} is the average vertical deflection, in millimetres, equal to $d_m - D_{dm}$,

in which D_{dm} is the deflected diameter, in millimetres (see Figure 1);

d_m is the mean diameter, in millimetres, of the test piece (see 3.1).

The calculation assumes that the neutral axis is at the test piece wall midpoint. For test piece wall constructions that produce an altered neutral axis position, it may be necessary to evaluate results substituting $2d$ for e, where d is the distance from the inside pipe surface to the neutral axis. The neutral axis position should be determined using strain gauge couples (6.2).

10.7 Within 2 h of the test piece reaching the selected deflection (see 10.4), introduce the test liquid between the dams to a depth of between 25 mm and 50 mm and record the time as the zero time.

The time permitted between loading the test piece and the zero time is chosen to minimize differences arising from stress relaxation. This time has also been chosen to facilitate preparation of the test piece.

10.8 Maintain the depth of the test liquid at not less than 25 mm until leak failure occurs or the test is stopped. For the duration of the exposure of the test piece, periodically check using suitable analytical methods and, if necessary, adjust the test solution to maintain it within ± 5 % of the specified concentration.

NOTE Solutions become more concentrated by the evaporation of water. It can be necessary, with some reagents, to clean the deflected test piece periodically and to replace the test solution with a fresh solution. A plastic film, cut carefully to fit between the dams and floated on top of the test solution, reduces evaporation.

10.9 Unless otherwise specified, inspect the test piece visually, without magnification, for signs of leak failure at the intervals given in Table 2, subject to the permitted deviations given in the rightmost column.

When a test solution is being replaced by a fresh solution, a detailed examination of the wet area can be made. Any visual observations such as cracking or delamination should be recorded.

To improve visibility of leak failure, if necessary, prepare the outer surface of the test piece by coating with a lime wash. The use of electronic timers has been found helpful in monitoring time to failure particularly on short-term tests.

Table 2 — Inspection intervals

Time since zero time h	Inspection interval	Permitted deviations on inspection interval
0 to 10	every 1 h	± 0,25 h
10 to 600	every 24 h	± 6 h
600 to 6 000	every 72 h	± 10 h
> 6 000	every week	± 1 day

10.10 Record the time to failure for each test piece. Test pieces that have not failed after more than 10 000 h may be included as failures to establish the regression line. The non-failed test pieces may be left under test, and the regression line recalculated as failures are obtained.

10.11 In the event that failures do not occur at any time, implement alternative procedures (typically called specified levels) as detailed in the referring standard.

11 Test procedure using strain measurement

WARNING — Contain any fragmentation or leakage that can occur during the test.

11.1 During the following procedure, maintain the temperature as specified in the referring standard.

11.2 Select the range of estimated strains such that the times to failure of at least 18 test pieces are distributed between 0,1 h and over 10 000 h, and the distribution of failure times of at least 10 values conforms to the limits given in Table 1.

11.3 Carefully align and attach three strain gauges (6.2) on the invert of the test piece in the circumferential direction to measure initial circumferential strain. Place the gauges equally spaced along one of the lines of the test piece. The adhesive used to attach the gauges shall, in total, not cover more than 37 % of the test piece length along the invert. Zero the gauges while the test piece is circular in shape.

It is recommended that the test piece be placed with its axis vertical to maintain roundness when the bridge is balanced to zero the instrument.

11.4 After installing the strain gauges, place the test piece in the test set-up (see Figure 1) with the strain gauges at the bottom. Take extreme care to ensure that the gauges are located at the point of maximum strain (the “6 o'clock” position), and that the lines on the test piece are parallel to and centred on the axes of the plates or sections.

IMPORTANT — Alignment of the test piece within the loading frame is critical.

11.5 Apply force to the apparatus to deflect the test piece while keeping the top and bottom plates or sections of the apparatus as parallel as possible. When the desired strain level is reached, lock the apparatus to maintain the test piece in the deflected condition. Read the gauges as soon as the apparatus is locked.

Record the initial strain measured by each strain gauge within 2 min after locking the apparatus. To validate the test condition, check that at least two gauges give readings within ± 2,5 % of the mean value. If any gauge reads more than 7,5 % from the average of the other two gauges, disregard the indication unless a thickness verification implies the strain gauge reading was accurate.

Average the valid gauge indications, and record as the initial strain.

11.6 Using a flexible sealant, install chemically inert dams so that only the inside surface of the test piece will be exposed to the test environment and the dams do not add support to the test piece.

11.7 Within 2 h of reaching the selected strain (see 11.2), introduce test liquid between the dams to a depth of between 25 mm and 50 mm and record the time as the zero time.

NOTE The time permitted between loading the test piece and the zero time is chosen to minimize differences arising from stress relaxation. This time has also been chosen to facilitate preparation of the test piece.

11.8 Maintain the depth of the test liquid at not less than 25 mm until failure occurs or the test is stopped. For the duration of the exposure of the test piece, periodically check and, if necessary, adjust the test solution to maintain it within ± 5 % of the specified concentration.

NOTE Solutions become more concentrated by the evaporation of water. It can be necessary, with some reagents, to clean the deflected test piece periodically and replace the test solution with a fresh solution. A plastic film, cut carefully to fit between the dams and floated on top of the test solution, reduces evaporation.

11.9 Unless otherwise specified, inspect the test piece visually, without magnification, for signs of leak failure at the intervals given in Table 2, subject to the permitted deviations given in the rightmost column.

NOTE When a test solution is being replaced by a fresh solution, an intensive examination of the wet area can be made.

To improve visibility of leak failure, if necessary, prepare the outer surface of the test piece by coating with a lime wash. The use of electronic timers has been found helpful in monitoring time to failure particularly on short-term tests.

11.10 Record the time to failure for each test piece. Test pieces that have not failed after more than 10 000 h may be included as failures to establish the regression line. Using the results from non-failed test pieces will result in a lower extrapolated strain. The non-failed test pieces may be left under test, and the regression line recalculated as failures are obtained.

11.11 In the event that failures do not occur at any time, implement the procedure using specified levels as detailed in the referring standard.

12 Calculation of extrapolated value

Using the data obtained in accordance with Clause 10 or Clause 11, determine in accordance with ISO 10928:—, method A, the extrapolated deflection or strain value at the relevant time specified in the referring standard.