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Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Determination of the resistance to chemical attack from 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 par l'intérieur d'un tronçon de tube soumis à déflexion

Reference number
ISO 10952:1999(E)

Foreword

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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 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*, in collaboration with CEN/TC 155, *Plastics piping systems and ducting systems*.

This standard is one of a series of standards on test methods which support standards for plastics piping systems and ducting systems.

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

1 Scope

This 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 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.

This method shall also be used as the basis for conducting tests according to so called "specified levels" as allowed by referencing system standards. The specified level approach does not involve extrapolation of test data.

NOTE 1: It has been found that the effect of chemical environments can be accelerated using strain induced by deflection, hence it is frequently referred to as strain corrosion.

2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the edition indicated was 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 edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards. For undated references the latest edition of the publication referred to applies.

ISO 10928;1997, *Plastics piping systems — Glass-reinforced thermosetting plastics (GRP) pipes and fittings — Methods for regression analysis and their use.*

3 Definitions

For the purposes of this standard, the following definitions apply:

3.1 mean diameter (d_m): The diameter of the circle corresponding with the middle of the pipe wall cross section.

It is given, in millimetres, by either of the following equations:

$$d_m = d_i + e$$

$$d_m = d_e - e$$

where:

d_i is the internal diameter, in millimetres;

d_e is the external diameter, in millimetres;

e is the wall thickness of the pipe, 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 by the use of strain gauges.

NOTE 1: Use of strain allows testing using test pieces of variable thickness and stiffness classes. Deflection and strain are interrelatable by calculation.

NOTE 2: It is assumed that the following test parameters are set by the standard making reference to this standard:

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

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

c) if applicable, 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 or 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).

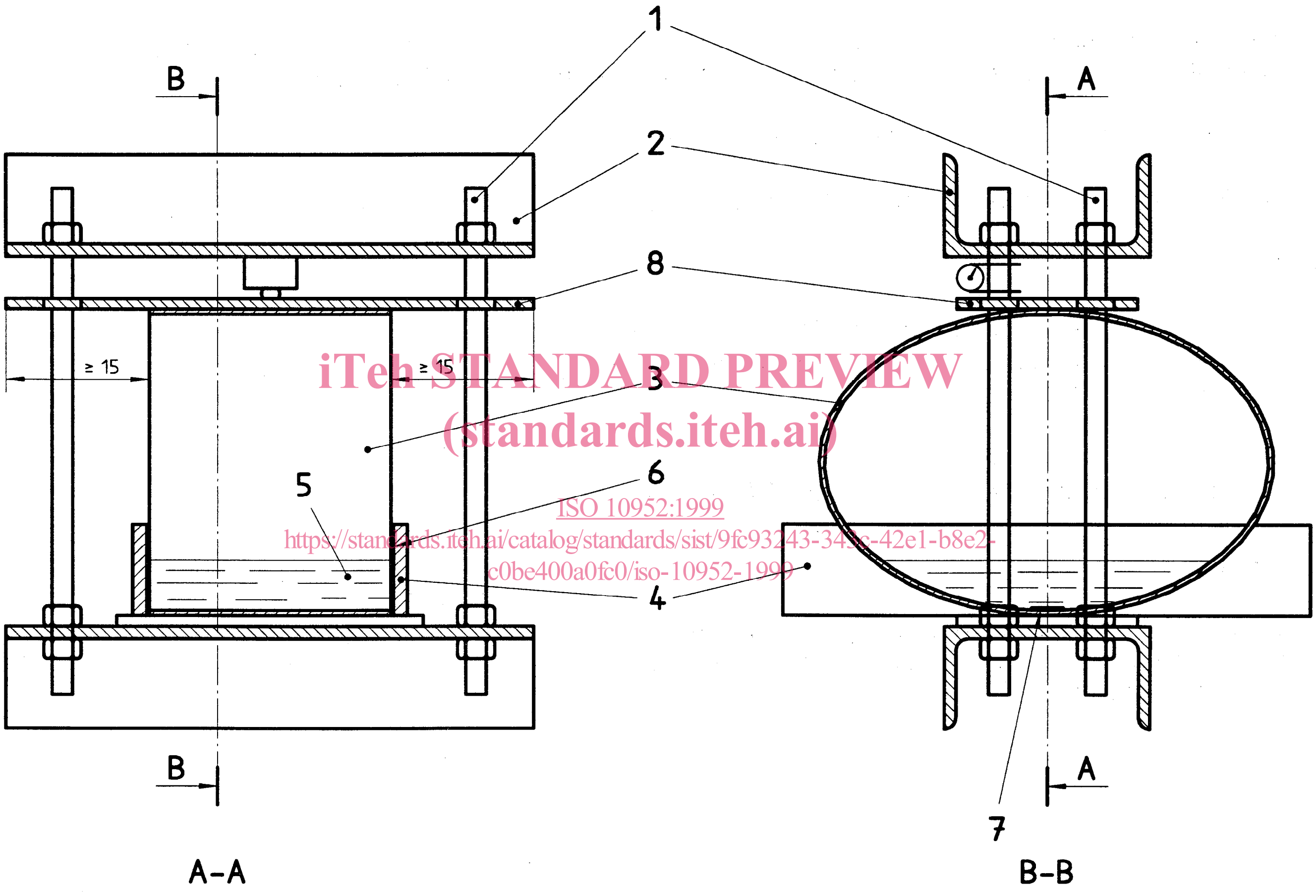
5 Test liquid

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

6 Apparatus

6.1 Loading frame, comprising two parallel steel sections, with or without bearing plates, and threaded rods which can maintain a constant deflection of the test piece (see figure 1). The surfaces in contact with the test piece shall be hard, flat, smooth and clean. The sections and bearing plates shall be sufficiently stiff such that visible bending or deformation of the sections or plate does not occur during the compression of the test piece. Each section or plate shall have a length at least equal to the length of the test piece plus 30 mm and a width of at least 100 mm.

Dimensions in millimetres



Key

1 Threaded rod
2 Steel section
3 Test piece
4 Dam
5 Test liquid
6 Sealant
7 Strain gauge(s)
8 Bearing plate (optional)

Figure 1 — Typical test arrangement

6.2 Dimensional measurement devices, capable of determining:

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

6.3 Strain gauges of the foil type, single element suitable for strain levels up to 1,5 % strain and a length appropriate for the pipe diameter.

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 pipe or fitting.

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 (see clause 7) with sufficient accuracy to determine whether or not each test piece conforms to clause 7. Trim or replace, as applicable, each test piece that does not conform.

8.2 Mean wall thickness

Measure to within ± 1,0 % the wall thickness of the test piece at each end of the test piece at three positions equally distributed around the circumference. Calculate the mean wall thickness, e, as the average of the six measured values.

8.3 Mean diameter

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

9 Conditioning

Unless otherwise specified by the referring standard, the test pieces shall not be conditioned.

10 Test procedure using deflection measurement

WARNING: Precautions should be taken to 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 10000 h and the distribution of failure times of at least 10 values conforms to the limits given in table 1.

Table 1: Failure time distribution

Failure time h	Minimum number of failures
≥ 10 and ≤ 1000	4
> 1000 and ≤ 6000	3
> 6000	3 *)
*) At least one of these shall exceed 10000 h	

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.

10.3 Place the test piece in the apparatus in contact with the upper and lower bearing plate or steel section 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 each bearing plate or steel section 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 will be exposed to the test environment. The dams shall not add support to the test piece.

10.6 Calculate the initial strain level using the following equation, which includes compensation for increased horizontal diameter with increasing deflection:

$$\varepsilon_t = 100 \times \frac{4{,}28 \times e \times y_{av}}{\left(d_m + 0{,}5 \times y_{av}\right)^2}$$

where:

ε_t is the initial strain, in percent;

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

y_{av} is the average vertical deflection, in millimetres;

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

NOTE: 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 2 x z for e, where z is the distance from the inside pipe surface to the neutral axis. The neutral axis position should be determined using strain gauge couples.

10.7 Within 2 h of 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.

10.7.1 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: Some solutions become more concentrated by the evaporation of water. It may be necessary, with some reagents, to periodically clean the deflected test piece and replace the test solution with a fresh solution.

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 column 3.

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

Table 2: Inspection intervals

Column 1	Column 2	Column 3
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 6000	every 72 h	± 10 h
after 6000	every week	± 1 day

To improve visibility of leak failure, if necessary, prepare the outer surface of the test piece by coating with a lime wash.

10.10 Record the time to failure for each test piece.

10.11 In the event that failures do not occur, implement the procedure using specified levels detailed in the referring standard.

11 Test procedure using strain measurement

WARNING: Precautions should be taken to 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 10000 h and the distribution of failure times of at least ten values conforms to the limits given in table 1.

11.3 Carefully align and attach three strain gauges 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.

NOTE: 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 arrangement (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 (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.

NOTE: 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.