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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

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Foreword

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This document 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 forth edition cancels and replaces the third edition (ISO 10952:2014), which has been technically revised.

The main changes compared to the previous edition are as follows:

— The tolerances for the dimensional measuring devices in 6.2 were changed.

— The measurement of the mean wall thickness in 8.2 and the mean diameter in 8.3 were precised.

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 document 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 document 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 International Standard. ISO 23856 references this document.

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 documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 23856, *Plastics piping systems for pressure and non-pressure water supply, drainage or sewerage — Glass-reinforced thermosetting plastics (GRP) systems based on unsaturated polyester (UP) resin*

ISO 10928, *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 to entry: The mean diameter is given by either of the following formulae:

$$d_m = d_i + e_m$$

$$d_m = d_e - e_m$$

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 to entry: 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

Note 1 to entry: Failures of the test sample have been observed at the spring-line location without leakage of the test liquid. While leakage is not observed, this can be considered a failure of the test sample as the strain levels in the sample will be altered invalidating any continuation of the test. The test can be discarded or optionally counted as a failure occurring at the time of spring-line breakage.

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 International 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 preconditioning 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 International 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

The frame comprises of two parallel steel sections and threaded rods which can maintain a constant deflection of the test piece (see Figure 1 for typical test set-up). 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

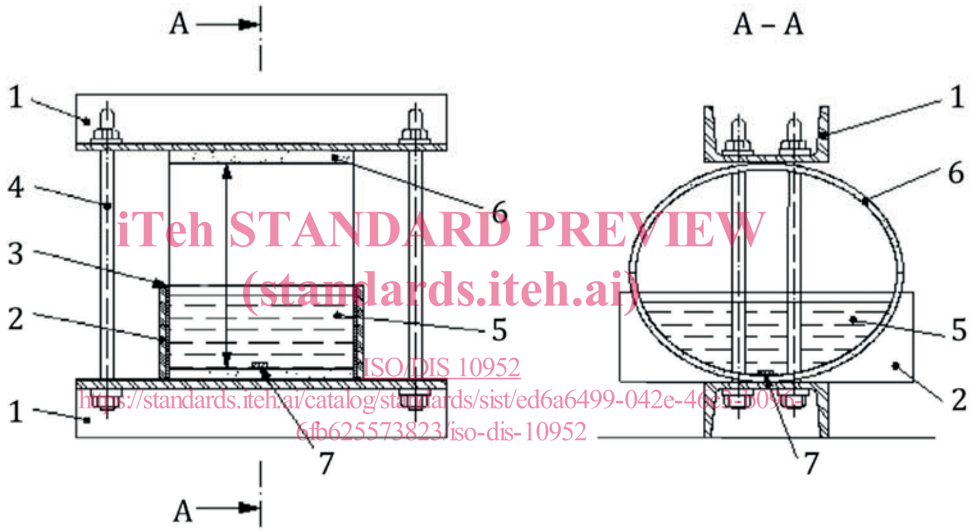
These devices have to determine:

a) the dimensions (length, diameter, and wall thickness) of the test pieces. The devices shall be calibrated to an accuracy of within ±1,0 %;

b) the change in diameter of the test piece in the vertical direction. The device shall be calibrated to an accuracy of within ±1,0 %;

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	5	test liquid
2	dam	6	test piece
3	sealant	7	strain gauge (optional)
4	threaded rod	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 International 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 International 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) 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) 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 International 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 International 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.

Table 1 — Failure time distribution

Failure time t_f h	Minimum number of failures
$10 \leq t_f \leq 1\,000$	4
$1\,000 < t_f \leq 6\,000$	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 Formula (1), which includes compensation for increased horizontal diameter with increasing deflection:

$$\varepsilon_0 = \frac{4{,}28 \times e_\mathrm{m} \times \Delta y \times 100}{\left(d_\mathrm{m} + \dfrac{\Delta y}{2} \right)^2} \qquad (1)$$

where

e_m is the mean wall thickness, in millimetres, of the test piece at bottom (see 8.2);

Δy is the average vertical deflection, in millimetres, equal to $d_\mathrm{i} - D_\mathrm{dm}$, where D_dm is the deflected diameter, in millimetres (see Figure 1), and d_i is the internal diameter (see 3.1);

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 can be necessary to evaluate results substituting 2*d* 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).

NOTE Deflections in excess of 28% of diameter can cause local flattening of the pipe and lead to strain distribution which cannot be easily be computed. 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.

10.7 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.

