TECHNICAL REPORT

ISO TR 8584-2

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Thermoplastics pipes for industrial applications under pressure — Determination of the chemical resistance factor and of the basic stress —

Part 2:
Pipes made of halogenated polymers

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Tubes en thermoplastiques pour les applications industrielles sous pression — Détermination du facteur de résistance chimique et de la contrainte de base —

Partie 2: Tubes en polymères halogénés

Reference number
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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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

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— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

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— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 8584-2, which is a Technical Report of type 2, 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*.

This document is being published as a type 2 Technical Report in order to obtain standardized test data to confirm the validity of the test method described, in particular with respect to the following assumptions:

— that the chemical resistance factor f'_{CR} (see 3.4) determined in experiments using slowly increasing pressure can be treated as if it was an f_{CR} determined in experiments using constant pressure;

— that the method used in ISO/TR 9080 to extrapolate the test results of the first part of the stress curve to lower temperatures can also be used in experiments with chemical fluids at increasing pressure.

ISO 8584 consists of the following parts, under the general title *Thermoplastics pipes for industrial applications under pressure — Determination of the chemical resistance factor and of the basic stress*:

— *Part 1: Polyolefin pipes*

— *Part 2: Pipes made of halogenated polymers* [Technical Report]

Annexes A, B, C and D of this part of ISO 8584 are for information only.

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Introduction

The test method described in this Technical Report is based on long-term tests using slowly increasing pressures and is suitable for the determination of the chemical resistance factor of pipes made of halogenated polymers which, with water, give long-term stress curves in the form of straight lines, with no knees (abrupt transition points) over the time and temperature ranges relevant to practical use.

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Thermoplastics pipes for industrial applications under pressure — Determination of the chemical resistance factor and of the basic stress —

Part 2:
Pipes made of halogenated polymers

1 Scope

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1.1 This Technical Report describes a method for the evaluation of the chemical resistance under pressure of pipes made of thermoplastics based on halogenated polymers.

1.2 It defines the chemical resistance factor f_{CR} for the first part of the basic stress function represented by a bilinear model.

1.3 It specifies a procedure for the determination of f_{CR} based on long-term tests at various constant rates of pressure increase.

For the evaluation of the chemical resistance in the absence of applied pressure and other stress, the user is referred to ISO 4433.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Technical Report 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 1167:1973, *Plastics pipes for the transport of fluids — Determination of the resistance to internal pressure.*

ISO 4433:1984, *Polyolefin pipes — Resistance to chemical fluids — Immersion test method — System for preliminary classification.*

ISO 8584-1:1990, *Thermoplastics pipes for industrial applications under pressure — Determination of the chemical resistance factor and of the basic stress — Part 1: Polyolefin pipes.*

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 Technical Report, definitions 3.5 to 3.9 in ISO 8584-1:1990 apply, plus the following definitions specific to testing at increasing pressure:

3.1 stress rate, $\dot{\sigma}_e$**:** The continuous increase in stress (caused by increasing the test pressure) with time until failure of the test specimen.

3.2 time to failure, t'_R**:** The interval between the first application of pressure and the appearance of a failure (i.e. a leak) because of bursting or cracking under stress or weeping.

3.3 mean failure time, t_G: The geometric mean of the failure times t'_R of n test pieces of equal dimensions tested simultaneously, that is:

$$\lg t_G = (\lg t'_{R1} + \lg t'_{R2} + ... + \lg t'_{Rn})/n$$

3.4 chemical resistance factor, f_{CR}: For a given test stress rate $\dot{\sigma}$ and temperature T, the ratio of the mean failure times of two series of five test pieces, taken from the same pipe and filled respectively with a chemical fluid and water:

$$f_{CR} = \frac{t_{G,fluid}}{t_{G,water}}$$

where

$t_{G,fluid}$ is the mean failure time, in hours, of the test pieces containing chemical fluid;

$t_{G,water}$ is the mean failure time, in hours, of the test pieces containing water.

The mean values thus determined must belong to the first part of the group of curves representing the basic stress versus time at different temperatures. Only the f_{CR} values calculated from these failure times may be used for extrapolation.

NOTE 1 Experimental evidence has shown that, in the absence of a knee, the mean values of t_G obtained with different increasing pressure rates lie on a straight line which is parallel to the long-term stress line obtained by the constant-pressure method; the stress values are normally higher than those obtained at constant pressure.

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4 Symbols

The symbols used in this Technical Report are listed in table 1.

5 Principle

The principle described in ISO 8584-1 is valid, but the test pressure is raised continuously at a slow rate or in small increments. Tests are carried out at several stress rates and at two temperatures, so as to determine the possible influence of these two parameters.

6 Apparatus

The apparatus shall be identical to that described in clause 5 and annex A of ISO 8584-1:1990. Following a set programme, the pressure is increased either continuously or at constant time intervals chosen so small that, with water, it takes 50 or more equal increments to reach failure.

If the necessary pressure increase per day is more than 4 % of the estimated failure pressure, i.e. if the probable failure time is less than 600 h, it may be helpful to use an automatic control facility (e.g. a linear ramp generator) for the pressure increases.

7 Test temperature

The test temperature shall be chosen from the temperatures given in table 2.

8 Choice of stress rate and calculation of test pressure rate

8.1 Stress rate

Choose at least three stress rates and apply each of these rates to a series of five test pieces of a given material.

Two of the stress rates shall be chosen so that they lead to a mean failure time of 200 h to 1 000 h and more than 7 000 h, respectively; the failure time for the third rate shall be in between.

Run the tests with water and the test fluid in the same way at each test temperature. If the results obtained and presented as a plot of $\lg \sigma$ vs. $\lg t$ indicate the presence of a knee, a supplementary test at a lower stress rate than the third one shall be carried out.

NOTE 2 In this case, it may be useful also to carry out a test at a higher rate, selected to give a failure at approximately 10 h, in order to have at least one point on the first part of the curve.

8.2 Test pressure rate

Calculate the pressure increase per unit time for the chosen stress rate as indicated for the calculation of the test pressure in 9.3.1 of ISO 8584-1:1990.

If several test pieces are connected in parallel to the same pressure system, use the arithmetic mean of the test pressure values to calculate the common test pressure rate.

9 Test procedure

Sub-clause 6.2 (Sampling) and clause 7 (Test fluids) of ISO 8584-1:1990 are also valid for this Technical Report.

Table 1 — Symbols

Parameter	Symbol
Safety factor	C
Chemical resistance factor measured at increasing pressure	f'_{CR}
Chemical resistance factor measured at constant pressure	f_{CR}
Extrapolation time factor	K_e
Test pressure	p_e
Rate of change of test pressure (test pressure rate)	$\dot{p}_e$
Pre-pressurization pressure	p_p
Pipe series	S
Basic stress	σ_B
Test stress	σ_e
Rate of change of test stress (stress rate)	$\dot{\sigma}_e$
Nominal stress	σ_N
Extrapolation time limit	t_e
Given or reference time with chemical (test) fluid	t_{fluid}
Mean failure time (geometric)	t_G
Creep strength time to failure	t'_R
Reference time with water	t_{water}
Temperature difference	ΔT
Service temperature	T_S

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Table 2 — Test temperatures

Material	Test temperatures °C					
Unplasticized poly(vinyl chloride)					60 ± 1	40 ± 1
Chlorinated poly(vinyl chloride)			100 ± 1*)	80 ± 1	60 ± 1	
Poly(vinylidene fluoride)	140 ± 1	120 ± 1	100 ± 1*)	80 ± 1		
*) For testing in a water bath, use 95 °C ± 1 °C.						

9.1 Cut out the necessary number (see 3.4) of test pieces in accordance with the instructions in 6.2 of ISO 8584-1:1990.

9.2 Clean the test pieces, if necessary.

9.3 Fit the ends on to the test pieces and check for leakproofness by immersing them in a bath of water and applying a low air pressure (0,2 MPa to 0,3 MPa) for 1 min.

9.4 Fill the test pieces with the test fluid (clause 7 of ISO 8584-1:1990); the composition and concentration of the fluid shall be kept constant within the specified limits during the test.

9.5 Connect the test pieces to the equipment and start applying pressure at the specified pressure rate to an accuracy of ± 2 %.

In order to avoid boiling of the liquid when heating it to the test temperature, it may be necessary to pre-pressurize to p_p. Since this would involve a reduction in the original time schedule for pressurizing, p_p is kept constant for a time interval given by

$$t = \frac{p_p}{\dot{p}}$$

before starting to increase the pressure.

9.6 Note the times to failure t'_{R1} to t'_{R5} and calculate the geometric mean time t_G (see 3.3) for the fluid and the water, and the chemical resistance factor as defined in 3.4.

The mean failure times $t_{G,fluid}$ and $t_{G,water}$ have to be determined, by definition, for a given stress rate σ. Using test pieces taken from the same pipe, the variation in stress rate is normally less than ± 3 %. If not, it is necessary to correct $t_{G,water}$ in proportion to the difference between the stress rates, i.e. to calculate f_{CR} with the corrected value $t^{*}_{G,water}$ given by the equation

$$t^{*}_{G,water} = \frac{\dot{\sigma}_{water}}{\dot{\sigma}_{fluid}} \times t_{G,water}$$

9.7 The test shall be discontinued if

a) the variation in the level of the fluid is too large due to permeation or loss of liquid through the ends;

b) the failure is produced outside the heated zone of the test piece or in the neighbourhood of the end-sealing devices (see ISO 1167);

c) the increase in pipe diameter exceeds 20 %;

d) the composition or concentration of the fluid changes, during exposure to the test conditions, beyond the specified values.

9.8 Tabulate, for each of the stress rates $\dot{\sigma}_e$, the individual failure times, in hours, with the fluid and with water, and their geometric means, as well as the corresponding chemical resistance factors f_{CR}.

10 Test report

The test report shall include the following information:

a) a reference to this Technical Report;

b) all details necessary for complete identification of the sample, i.e. manufacturer, type of material, code number and manufacturing lot number;

c) the dimensions of each test piece;

d) the test pressure rates;

e) details of the test fluid used (i.e. type, composition and concentration);

f) a table indicating, for each test stress rate and temperature, the individual failure times observed, in hours, their geometric means and the corresponding chemical resistance factors f_{CR};

g) details of any unusual behaviour observed during the test;

h) if necessary, the plots of the basic stresses obtained, by extrapolation, for the proposed operating conditions, and the appropriate pipe series chosen;

i) the dates of the test.

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Annex A
(informative)

Method of extrapolation and choice of pipe series

A.1 Basic curves for long-term creep strength with water

For the application of this Technical Report, it is necessary that the family of curves $\sigma_B = f(t,T)$, with water, be available for tubes manufactured with the polymer under test. When presented as a plot of lg t vs. lg σ_B, the curve for each service temperature envisaged is a straight line which corresponds by definition to the regression line of creep strength, with water, corrected for the safety coefficient C_M for the material of the pipe under test.

A further safety factor C_A related to the application for which the pipe is intended shall be applied when calculating the design stress, in order to take account of different conditions of use.

NOTE 3 Examples of basic curves for PVC-U and PVC-C are given in informative annexes C and D.

A.2 Determination of the basic stress function for a given fluid at the operating temperature and of the basic stress for a given period of use

A.2.1 Determination of the basic stress function $\sigma_{B,T_s} = f(t_{fluid})$ by extrapolation of the chemical resistance factor

Take the straight line for water AB on the plot of the basic curves for the pipe and service temperature under consideration (see figure A.1).

Draw the straight line representing the stress rate $\dot{\sigma}_{e1}$ through point A_{e1}. The coordinates of A_{e1} may typically be:

$$\lg \sigma = 0 \left(\text{i.e. } \sigma = 1 \text{ N/mm}^2\right)$$

and therefore

$$\lg t = -\lg \dot{\sigma}_e$$

calculated from $t = 1/\dot{\sigma}_e$ hours.

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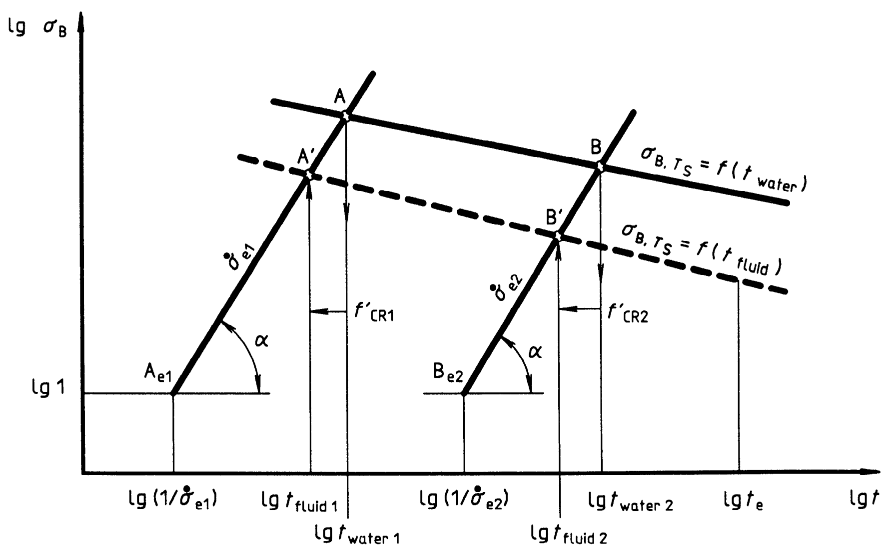

Figure A.1 — Graphical representation of the basic stress in a pipe for a given fluid