INTERNATIONAL STANDARD

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Thermoplastics materials for pipes and fittings for pressure applications — Classification, designation and design coefficient

Matières thermoplastiques pour tubes et raccords pour applications avec pression — Classification, désignation et coefficient de calcul

Reference number
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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

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 12162 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 12162:1995), which has been technically revised.

Introduction

The revision of this International Standard incorporates the introduction of a $CRS_{\theta,t}$ value (categorized required strength at a temperature θ and time t), in addition to the MRS classification and the introduction of minimum design coefficients for additional materials.

The classification in this International Standard does not qualify a material for a specific application. For specific applications, the relevant product standards require that additional mechanical and physical properties be met.

Thermoplastics materials for pipes and fittings for pressure applications — Classification, designation and design coefficient

1 Scope

This International Standard establishes the classification of thermoplastics materials in pipe form and specifies the material designation. It also specifies a method for calculating the design stress.

It is applicable to materials intended for pipes and fittings for pressure applications.

NOTE 1 Classification, minimum design coefficient and calculation method are based on the resistance to internal pressure with water at 20 °C for 50 years, derived by extrapolation using the method given in ISO 9080.

NOTE 2 Design coefficients for multilayer pipes are described in the appropriate product (system) standards.

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 1043-1, *Plastics — Symbols and abbreviated terms — Part 1: Basic polymers and their special characteristics*

ISO 9080, *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*

3 Terms and definitions

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

3.1
long-term hydrostatic strength
σ_{LTHS}
quantity, with the dimension of stress, which represents the predicted mean strength at a temperature θ and time t

NOTE 1 The quantity is expressed in megapascals.

NOTE 2 Temperature, θ, is expressed in degrees Celsius and time, t, is expressed in years.

3.2
lower confidence limit of the predicted hydrostatic strength
σ_{LPL}
quantity, with the dimensions of stress, which represents the 97,5 % lower confidence limit of the predicted hydrostatic strength at a temperature θ and time t

NOTE 1 The quantity is expressed in megapascals.

NOTE 2 Temperature, θ, is expressed in degrees Celsius and time, t, is expressed in years.

3.3
minimum required strength
MRS
value of σ_{LPL} at 20 °C and 50 years, rounded down to the next smaller value of the R10 series or the R20 series

NOTE The R10 series conforms to ISO 3[1] and the R20 series conforms to ISO 497[2].

3.4
categorized required strength at temperature θ and time t
$CRS_{\theta, t}$
value of σ_{LPL} at temperature θ and time t, rounded down to the next smaller value of the R10 series or the R20 series

NOTE 1 $CRS_{\theta, t}$ at 20 °C and 50 years equals MRS.

NOTE 2 Temperature, θ, is expressed in degrees Celsius and time, t, is expressed in years.

NOTE 3 The R10 series conforms to ISO 3[1] and the R20 series conforms to ISO 497[2].

3.5
design coefficient
C
coefficient with a value greater than 1, which takes into consideration service conditions as well as properties of the components of a piping system other than those represented in the lower confidence limit

NOTE 1 The minimum value of C, C_{min}, is defined and given for various thermoplastics pipe systems in Clause 6.

NOTE 2 The design coefficient for a given application is specified in the relevant product (system) standard.

3.6 Design stress

3.6.1
design stress based on MRS classification
σ_s
stress derived by dividing MRS by the design coefficient C, i.e. $\sigma_s = MRS/C$

NOTE 1 The maximum allowable design stress for a given material is derived by dividing MRS by the minimum design coefficient, C_{min}, i.e. $\sigma_s = MRS/C_{min}$.

NOTE 2 Design stress for a specific application is specified in the relevant product (system) standard.

3.6.2
design stress based on $CRS_{\theta, t}$ value
$\sigma_{s, \theta, t}$
stress derived by dividing $CRS_{\theta, t}$ by the design coefficient C, i.e. $\sigma_{s, \theta, t} = CRS_{\theta, t}/C$

NOTE 1 The maximum allowable design stress for a given material is derived by dividing $CRS_{\theta, t}$ by the minimum design coefficient, C_{min}, i.e. $\sigma_{s, \theta, t} = CRS_{\theta, t}/C_{min}$.

NOTE 2 Design stress for a specific application is specified in the relevant product (system) standard.

4 MRS classification of materials in pipe form

A thermoplastics material shall be classified by its σ_{LPL} values at 20 °C and 50 years, rounded down to the next smaller value of the R10 series for $\sigma_{LPL} < 10$ MPa or to the next smaller value of the R20 series for $\sigma_{LPL} \geqslant 10$ MPa. This constitutes the MRS.

The classification number for a thermoplastics material shall be 10 times the MRS (when expressed in megapascals) as indicated in Table 1.

Table 1 — MRS classification at 20 °C and 50 years

Range of lower confidence limits σ_{LPL} MPa	Minimum required strength MRS MPa	Classification number[a]
$1 \leqslant \sigma_{LPL} < 1,25$	1	10
$1,25 \leqslant \sigma_{LPL} < 1,6$	1,25	12.5
$1,6 \leqslant \sigma_{LPL} < 2$	1,6	16
$2 \leqslant \sigma_{LPL} < 2,5$	2	20
$2,5 \leqslant \sigma_{LPL} < 3,15$	2,5	25
$3,15 \leqslant \sigma_{LPL} < 4$	3,15	31.5
$4 \leqslant \sigma_{LPL} < 5$	4	40
$5 \leqslant \sigma_{LPL} < 6,3$	5	50
$6,3 \leqslant \sigma_{LPL} < 8$	6,3	63
$8 \leqslant \sigma_{LPL} < 10$	8	80
$10 \leqslant \sigma_{LPL} < 11,2$	10	100
$11,2 \leqslant \sigma_{LPL} < 12,5$	11,2	112
$12,5 \leqslant \sigma_{LPL} < 14$	12,5	125
$14 \leqslant \sigma_{LPL} < 16$	14	140
$16 \leqslant \sigma_{LPL} < 18$	16	160
$18 \leqslant \sigma_{LPL} < 20$	18	180
$20 \leqslant \sigma_{LPL} < 22,4$	20	200
$22,4 \leqslant \sigma_{LPL} < 25$	22,4	224
$25 \leqslant \sigma_{LPL} < 28$	25	250
$28 \leqslant \sigma_{LPL} < 31,5$	28	280
$31,5 \leqslant \sigma_{LPL} < 35,5$	31,5	315
$35,5 \leqslant \sigma_{LPL} < 40$	35,5	355
$40 \leqslant \sigma_{LPL} < 45$	40	400
$45 \leqslant \sigma_{LPL} < 50$	45	450
$50 \leqslant \sigma_{LPL} < 56$	50	500

[a] If the classification number is not an integer, a full stop is used instead of a comma.

5 CRS$_{\theta,\,t}$ value for specific design purposes

For design purposes at times other than 50 years and constant temperatures other than 20 °C, materials may be further described by a CRS$_{\theta,\,t}$ value. These values are not intended for use in applications with temperature profiles, e.g. as defined in ISO 10508[3] for hot and cold water installations.

CRS$_{\theta,\,t}$ is determined from the value of σ_{LPL} at a temperature θ and a time t, by rounding it down to the next smaller value of the R10 series for $\sigma_{LPL} < 10$ MPa or by rounding down to the next smaller value of the R20 series for $\sigma_{LPL} \geqslant 10$ MPa. This constitutes the CRS$_{\theta,\,t}$ value as indicated in Annex A.

6 Design coefficient

The values of the design coefficient, C, are specified in the relevant product standards.

The values of the minimum design coefficient, C_{min}, at 20 °C for thermoplastics piping systems shall be equal to the value given in Table 2.

Higher design coefficients may be chosen in the case of:

a) specific requirements for the products, such as additional stresses and other effects which are considered to occur in the application;

b) influence of temperature and time (if different from 20 °C, 50 years) and/or influence of environment;

c) standards that are based on MRS, where other temperatures of operation are required.

Table 2 — Values of C_{min}

Thermoplastics piping system	C_{min}
ABS	1,6
PB	1,25
PE (all types)	1,25
PE-X	1,25
PP copolymer	1,25
PP homopolymer	1,6
PVC-C	1,6
PVC-HI	1,4
PVC-U	1,6
PVC-O (for MRS $\leqslant$ 40)	1,6[a]
PVC-O (for MRS > 40)	1,4[a]
PVDF copolymer	1,4
PVDF homopolymer	1,6
PA11	1,6
PA12	1,6
PPSU	1,4

a In accordance with Table 1 of ISO 16422:2006 [4]

7 Calculation of design stress based on MRS classification

The design stress, σ_s, shall be calculated using Equation (1) and rounded to the next lower value in the R20 series:

$$\sigma_s = \frac{\mathrm{MRS}}{C} \qquad (1)$$

where

MRS is the value of the minimum required strength (see 3.3);

C is the applicable value of design coefficient in accordance with Clause 6.

Unless otherwise specified in the relevant product standards, the maximum allowable design stress shall be calculated using the minimum design coefficient, C_{min}.

8 Designation of materials in pipe form

The designation of materials in pipe form shall include the following:

— the symbol of the material in accordance with ISO 1043-1;

— its classification number in accordance with Clause 4, unless otherwise specified in the product standards.

Example of the MRS designation of a PVC-U, with an MRS value of 25 MPa*:*

PVC-U 250

A material may be designated to the next lower classification number.

Annex A
(normative)

The $CRS_{\theta,\,t}$ value

A.1 The $CRS_{\theta,\,t}$ value

The $CRS_{\theta,\,t}$ values are given in Table A.1.

The selected $CRS_{\theta,\,t}$ time, t, shall not exceed 100 years. The extrapolation time factors stated in ISO 9080 shall be respected. The selected $CRS_{\theta,\,t}$ temperature, θ, shall neither exceed the maximum ISO 9080 test temperature for the material in question, nor be more than 20 °C below the lowest ISO 9080 test temperature, provided that the material is still suitable for the intended application.

Table A.1 — $CRS_{\theta,\,t}$ values

Range of lower confidence limits σ_{LPL} MPa	Categorized required strength $CRS_{\theta,\,t}$ MPa
$1 \leqslant \sigma_{LPL} < 1{,}25$	1
$1{,}25 \leqslant \sigma_{LPL} < 1{,}6$	1,25
$1{,}6 \leqslant \sigma_{LPL} < 2$	1,6
$2 \leqslant \sigma_{LPL} < 2{,}5$	2
$2{,}5 \leqslant \sigma_{LPL} < 3{,}15$	2,5
$3{,}15 \leqslant \sigma_{LPL} < 4$	3,15
$4 \leqslant \sigma_{LPL} < 5$	4
$5 \leqslant \sigma_{LPL} < 6{,}3$	5
$6{,}3 \leqslant \sigma_{LPL} < 8$	6,3
$8 \leqslant \sigma_{LPL} < 10$	8
$10 \leqslant \sigma_{LPL} < 11{,}2$	10
$11{,}2 \leqslant \sigma_{LPL} < 12{,}5$	11,2
$12{,}5 \leqslant \sigma_{LPL} < 14$	12,5
$14 \leqslant \sigma_{LPL} < 16$	14
$16 \leqslant \sigma_{LPL} < 18$	16
$18 \leqslant \sigma_{LPL} < 20$	18
$20 \leqslant \sigma_{LPL} < 22{,}4$	20
$22{,}4 \leqslant \sigma_{LPL} < 25$	22,4
$25 \leqslant \sigma_{LPL} < 28$	25
$28 \leqslant \sigma_{LPL} < 31{,}5$	28
$31{,}5 \leqslant \sigma_{LPL} < 35{,}5$	31,5
$35{,}5 \leqslant \sigma_{LPL} < 40$	35,5
$40 \leqslant \sigma_{LPL} < 45$	40
$45 \leqslant \sigma_{LPL} < 50$	45
$50 \leqslant \sigma_{LPL} < 56$	50

As an example of the use of the $\text{CRS}_{\theta,\,t}$ value, material with $\sigma_{\text{LPL}} = 6{,}4$ MPa at a given temperature of 70 °C and time of 20 years is described as follows:

EXAMPLE $\text{CRS}_{70\,°\text{C, 20 years}} = 6{,}3$ MPa

A.2 Calculation of the design stress based on $\text{CRS}_{\theta,\,t}$ value

The design stress, $\sigma_{\text{s},\theta,\,t}$, shall be calculated using Equation (A.1):

$$\sigma_{\text{s},\,\theta,\,t} = \frac{\text{CRS}_{\theta,t}}{C} \tag{A.1}$$

where

$\text{CRS}_{\theta,\,t}$ is the value of the categorized required strength (see 3.4);

C is the applicable value of design coefficient in accordance with Clause 6.

Unless otherwise specified in the relevant product (system) standards, the maximum allowable design stress shall be calculated using C_{min}.

Bibliography

[1] ISO 3, *Preferred numbers — Series of preferred numbers*

[2] ISO 497, *Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers*

[3] ISO 10508, *Plastics piping systems for hot and cold water installations — Guidance for classification and design*

[4] ISO 16422:2006, *Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure — Specifications*