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Plastics piping systems for industrial applications — Poly(vinylidene fluoride) (PVDF) —

Part 1: General

Système de canalisation en matières plastiques pour les applications industrielles — Poly(fluorure de vinylidène) (PVDF) —

Partie 1: Généralités

Reference number
ISO 10931-1:1997(E)

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.

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 10931-1 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*.

ISO 10931 consists of the following parts, under the general title *Plastics piping systems for industrial applications — Poly(vinylidene fluoride) (PVDF)*:

— *Part 1: General*

— *Part 2: Pipes*

— *Part 3: Fittings*

— *Part 4: Valves and auxiliary equipment*

— *Part 5: Fitness for system purpose*

— *Part 6: Recommendations for installation*

Annexes A and B of this part of ISO 10931 are for information only.

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Introduction

ISO 10931, which is divided into six parts (see Foreword), specifies the properties of pipes and piping system components made of poly(vinylidene fluoride) (PVDF) for industrial applications. It includes recommendations for installation (see ISO 10931-6) and is intended to be used by authorities, design engineers, testing and certification institutes and manufacturers. This part of ISO 10931 covers general aspects of such piping systems.

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Plastics piping systems for industrial applications — Poly(vinylidene fluoride) (PVDF) —

Part 1:
General

1 Scope

This part of ISO 10931 specifies the general requirements for piping systems made of poly(vinylidene fluoride) (PVDF) intended for industrial applications which include the conveyance of water and chemicals in liquid and gaseous forms. In conjunction with parts 2 to 6 of ISO 10931, it covers PVDF pipes, fittings, valves and ancillary equipment, as well as information related to methods of jointing to components made of other plastics and nonplastics materials.

It also specifies the parameters for the test methods referred to in this part of ISO 10931.

It is applicable to PVDF pipe systems for use at temperatures up to 150 °C. However, for applications above 120 °C, which depend upon the crystalline melting point of the specific PVDF grade being used, the advice of the pipe and fittings manufacturers should be sought.

NOTE — For information about the resistance of PVDF piping components in contact with chemicals, see ISO/TR 10358.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 10931. At the time of publication, the editions indicated were valid. All standards are subject to revisions, and parties to agreements based on this part of ISO 10931 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 3:1973, *Preferred numbers — Series of preferred numbers.*

ISO 7686:1992, *Plastics pipes and fittings — Opacity — Test method.*

ISO/TR 8584-2:1993, *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.*

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.*

ISO 11922-1:1997[1)], *Thermoplastics pipes for transport of fluids — Dimensions and tolerances — Part 1: Metric series.*

1) To be published.

3 Definitions, symbols and abbreviations

For the purposes of ISO 10931, the definitions, symbols and abbreviations given in ISO 11922-1 apply, together with the following definitions, symbols and abbreviations.

3.1 Definitions

3.1.1 nominal outside diameter, d_n**:** A numerical designation of size, which is common to all components in a thermoplastics piping system other than flanges and components designated by thread size. It is a convenient round number for reference purposes.

NOTE — The d_n for thermoplastics pipes and spigots of fittings is related to the minimum outside diameter, and for socketed fittings and pipe joints to the inside diameter of the socket. Fittings, valves and auxiliaries have the same nominal outside diameters as the connecting pipe for which they are designed.

3.1.2 nominal size of flange, DN: A numerical designation of flange diameter for reference purposes and only loosely related to the manufacturing dimension.

3.1.3 mean inside diameter of socket, d_{im}**:** Arithmetic mean of two diameters measured at right angles to each other at the midpoint of the socket length.

3.1.4 pipe series, S: Dimensionless number related to the nominal outside diameter, d_n, and nominal wall thickness, e_n, by the following equation:

$$S = \frac{d_n - e_n}{2e_n}$$

NOTE — See ISO 4065 for further details on pipe series S.

3.1.5 standard dimension ratio, SDR: Nominal outside diameter, d_n, divided by the nominal wall thickness, e_n.

NOTES

1 The relationship between SDR and S is expressed as follows:

$$\mathrm{SDR} = \frac{d_n}{e_n} = 2S + 1$$

2 See ISO 4065 for further details on standard dimension ratio, SDR.

3.1.6 hydrostatic stress, σ**:** Stress induced in the wall of a pipe when the pipe is filled with a fluid under pressure.

NOTE — The hydrostatic stress, expressed in megapascals, is related to the pressure, the wall thickness and the outside diameter of the pipe by the following equation:

$$\sigma = \frac{p(d_e - e)}{2e}$$

where

p is the hydrostatic pressure, in megapascals;

d_e is the outside diameter, in millimetres;

e is the wall thickness, in millimetres.

3.1.7 long-term hydrostatic stress, σ_{LTHS}**:** A constant hydrostatic stress that can be maintained in the pipe during a sustained period of time.

3.1.8 stress at the lower confidence limit, σ_{LCL}**:** For PVDF pipe, the 97,5 % lower confidence limit of σ_{LTHS} for water at 20 °C over 50 years, as determined by the standard extrapolation method described in ISO/TR 9080.

3.1.9 minimum required strength, MRS: For PVDF pipe, value of σ_{LCL}, rounded down to the next lower value in the R10 or R20 series of preferred numbers in accordance with ISO 3.

NOTE — For the classification of thermoplastics materials by their MRS values, see ISO 12162.

3.1.10 design stress, σ**:** Maximum permissible stress in a pipe wall due to the action of static internal pressure for a given fluid.

Design stress depends, for a given fluid, on temperature and time.

3.1.11 basic stress, σ_S (50 years - 20 °C - H_2O)**:** Maximum permissible stress that can be sustained by the PVDF pipe using water at 20 °C for a duration of 50 years. Basic stress is equal to MRS divided by a material-related coefficient C ($C \geqslant 1$) (overall service coefficient).

NOTE — C_{min} is the minimum value of C which can be used for water under static conditions. For PVDF homopolymers, a value of 1,6 has been adopted for the coefficient C_{min}.

3.1.12 hydrostatic pressure: Internal pressure acting in a piping system.

3.1.13 maximum allowable working pressure, PMA: Maximum pressure at which the piping system may be used in continuous service at 20 °C for 50 years. For water, the maximum allowable working pressure, in megapascals, is given by the following equation:

$$\mathrm{PMA}_{\mathrm{water}} = \frac{\mathrm{MRS}}{C_{\min} \cdot \mathrm{S}}$$

The maximum allowable working pressure is generally designated as the nominal pressure PN, in bars, which corresponds to 10 × $\mathrm{PMA}_{\mathrm{water}}$.

3.1.14 maximum allowable pressure for fluid chemicals: Maximum pressure for the use of a piping system in contact with a fluid chemical at a given temperature for a given time.

It is determined on the basis of the regression curve for water at the temperature concerned, taking into account the chemical resistance factor as defined in ISO/TR 8584-2, the result then being divided by a coefficient C_{spec}, specified in the applicable user specification.

3.2 Symbols

d_{n}	nominal outside diameter
d_{e}	outside diameter
d_{em}	mean outside diameter
$d_{\mathrm{e,\,min}}$	minimum outside diameter
$d_{\mathrm{e,\,max}}$	maximum outside diameter
d_{ey}	outside diameter at any point
d_{i}	inside diameter
d_{im}	mean inside diameter
e_{n}	nominal wall thickness
e_{y}	wall thickness at any point
$e_{\min}$	minimum wall thickness
$e_{\max}$	maximum wall thickness
e_{m}	mean wall thickness
ρ	material density
C	overall service (design) coefficient
$C_{\min}$	minimum value of C; material coefficient
C_{spec}	coefficient for special user application requirements
f_{CR}	chemical resistance factor
σ_{s}	design stress
σ_{LCL}	stress at the lower confidence limit.

3.3 Abbreviations

LCL	lower confidence limit
MRS	minimum required strength
PMA	maximum allowable working pressure
PN	nominal pressure (e.g. PN 10)
PVDF	poly(vinylidene fluoride)
R	series of preferred numbers (e.g. R10)
S	pipe series (e.g. S8)
SDR	standard dimension ratio (e.g. SDR 17)
SEM	standard extrapolation method

4 Material

4.1 PVDF material categories

The PVDF material from which pipes, fittings, valves and other components are made is divided into the following categories:

Category 1: Unpigmented homopolymer resin of natural colour (natural grade) and polymers containing small proportions of additives, in each case with a fluoropolymer content of more than 98 % and a crystalline melting point ⩾ 155 °C.

NOTE — Category 1 materials contain only vinylidene fluoride monomer units in the polymer chain. Typical values for the properties of category 1 PVDF are given in annex A, for guidance purposes.

Category 2: Unpigmented homopolymer resin of natural colour (natural grade) and polymers containing small proportions of additives, in each case with a fluoropolymer content of more than 98 % and a crystalline melting point ⩾ 125 °C.

NOTE — Category 2 materials contain a high percentage of a fluorocomonomer other than vinylidene fluoride in the polymer chain.

Category 3: Polymer resins containing more than 2 % of additives, intended to give special properties, e.g. electrical conductivity, high strength, etc.

NOTE — At the present time only category 1 materials are covered by ISO 10931. Category 2 and category 3 materials will be covered by later amendments.

4.2 Material requirements

The PVDF material from which the pipes, fittings and other components are made shall conform to the requirements specified in ISO 10931-2 for pipes and ISO 10931-3 for fittings (as applicable). Material requirements for valves and ancillary equipment will be covered in ISO 10931-4.

4.3 Reworked material

Clean reworked PVDF material produced during the manufacture and works testing of products conforming to this part of ISO 10931 may be used in limited amounts, provided it is derived from the same compound as that used in production, and the properties of the final product conform to the requirements specified by the relevant part of ISO 10931.

4.4 Opacity

PVDF piping components which are declared opaque shall conform to the requirements specified in ISO 7686.

Annex A
(informative)

Material properties

Table A.1 gives typical values for the properties of Category 1 PVDF pipe system materials.

Table A.1

Property	Units	Typcal values	Test parameters	Test method
Density	g/cm^3	1,78		ISO 1183
Crystalline melting point	°C	⩾ 155		ISO 3146
Vicat softening temperature	°C	⩾ 134	(50 ± 1) N	ISO 2507
Coefficient of linear expansion	$°C^{-1}$	120×10^{-6}		
Brittle point	°C	–35		ISO 974
Tensile yield stress	MPa	⩾ 45	5 mm/min	ISO 527-2
E-Modulus (tensile)	MPa	⩾ 2 000		ISO 527-2
E-Modulus (flexural)	MPa	2 000		ISO 178
Hardness	—	⩾ 75	Shore D	ISO 868
Water absorption	%	< 0,05	24 h, 20 °C	ISO 62
Oxygen index	%	⩾ 40,0		ISO 4589-1 ISO 4589-2
NOTE — Property values may vary depending on the crystalline melting point.				