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Plastics piping systems for industrial applications — Poly(vinylidene fluoride) (PVDF) — Specifications for components and the system

Systèmes de canalisations en matières plastiques pour les applications industrielles — Poly(fluorure de vinylidène) (PVDF) — Spécifications pour les composants et le système

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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.

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 10931 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 first edition of ISO 10931 cancels and replaces ISO 10931-1:1997, ISO 10931-2:1997, ISO 10931-3:1996, ISO 10931-4:1997 and ISO 10931-5:1998, of which it constitutes a technical revision.

Introduction

This International Standard specifies the characteristics and requirements for a piping system and its components made from poly(vinylidene fluoride) (PVDF) intended to be used for industrial applications, above-ground, by authorities, design engineers, certification bodies, inspection bodies, testing laboratories, manufacturers and users.

At the date of publication of this International Standard, International Standards for piping systems of other plastics used for industrial applications were ISO 15493, for acrylonitrile-butadiene-styrene (ABS), unplasticized poly(vinyl chloride) (PVC-U), chlorinated poly(vinyl chloride) (PVC-C) and ISO 15494, for polybutene (PB), polyethylene (PE), polypropylene (PP).

Plastics piping systems for industrial applications — Poly(vinylidene fluoride) (PVDF) — Specifications for components and the system

IMPORTANT — Requirements for industrial valves are given in this International Standard and/or in other International Standards. Valves may be used with components conforming to this International Standard provided they conform additionally to its relevant requirements. Where existent, national regulations for specific applications (e.g. water treatment) apply. Other application areas are permitted if the requirements of this International Standard and/or applicable national requirements are fulfilled. Relevant regulations in respect of fire behaviour and explosion risk are applicable if applications are envisaged for inflammable media. Components conforming to any of the product standards listed in the Bibliography or to national standards, as applicable, may be used with components conforming to this International Standard, provided they conform to the requirements for joint dimensions and the relevant requirements of this International Standard.

1 Scope

This International Standard specifies the characteristics and requirements for components such as pipes, fittings and valves made from poly (vinylidene fluoride) (PVDF), intended to be used for thermoplastics piping systems in the field of industrial applications above-ground.

It is applicable to PVDF pipes, fittings, valves and ancillary equipment, their joints and to joints with components of other plastics and non-plastics materials, depending on their suitability, intended to be used for the conveyance of liquid and gaseous fluids as well as of solid matters in fluids for industrial applications including

— chemical plants,

— industrial sewerage engineering,

— power engineering (cooling and general purpose water),

— electroplating and pickling plants,

— semiconductor industry,

— agricultural production plants, and

— water treatment.

This International Standard is applicable to PVDF piping systems for use at temperatures up to 150 °C. However, for applications above 120 °C, which depend upon the crystalline melting point of the PVDF material, it is advisable to seek the advice of the manufacturer of the component (the components have to withstand the mechanical, thermal and chemical demands to be expected and to be resistant to the fluids to be conveyed).

Characteristics and requirements which are applicable for PVDF in general are covered by the relevant clauses of this International Standard. Those characteristics and requirements which depend on the material used are given in Annex A.

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 7-1, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 265-1, *Pipes and fittings of plastics materials — Fittings for domestic and industrial waste pipes — Basic dimensions: Metric series — Part 1: Unplasticized poly(vinyl chloride) (PVC-U)*

ISO 472, *Plastics — Vocabulary*

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

ISO 1167:1996, *Thermoplastics pipes for the conveyance of fluids — Resistance to internal pressure — Test method.* Incorporating ISO 1167:1996/Cor 1:1997

ISO 1183-2, *Plastics — Methods for determining the density of non-cellular plastics — Part 2: Density gradient column method*

ISO 2505-1:1994, *Thermoplastics pipes — Longitudinal reversion — Part 1: Determination methods*

ISO 2505-2:1994, *Thermoplastics pipes — Longitudinal reversion — Part 2: Determination parameters*

ISO 3126, *Plastics piping systems — Plastics components — Determination of dimensions*

ISO 4065, *Thermoplastics pipes — Universal wall thickness table*

ISO 9080:2003, *Plastics piping and ducting systems — Determination of the long-term hydrostatic strength of thermoplastics materials in pipe form by extrapolation*

ISO/TR 10358, *Plastics pipes and fittings — Combined chemical-resistance classification table*

ISO 11357-3, *Plastics — Differential scanning calorimetry (DSC) — Part 3: Determination of temperature and enthalpy of melting and crystallization*

ISO 11922-1:1997, *Thermoplastics pipes for the conveyance of fluids — Dimensions and tolerances — Part 1: Metric series*

ISO 12092:2000, *Fittings, valves and other piping system components made of unplasticized poly(vinyl chloride) (PVC-U), chlorinated poly(vinyl chloride) (PVC-C), acrylonitrile-butadiene-styrene (ABS) and acrylonitrile-styrene-acrylester (ASA) for pipes under pressure — Resistance to internal pressure — Test method*

ISO 15853:1999, *Thermoplastic materials — Preparation of tubular test pieces for the determination of the hydrostatic strength of materials used for injection moulding*

ISO 12162:1995, *Thermoplastics materials for pipes and fittings for pressure applications — Classification and designation — Overall service (design) coefficient*

ISO 16135, *Industrial valves — Ball valves of thermoplastics materials* [1)]

ISO 16136, *Industrial valves — Butterfly valves of thermoplastics materials* [1)]

ISO 16137, *Industrial valves — Check valves of thermoplastics materials* [1)]

ISO 16138, *Industrial valves — Diaphragm valves of thermoplastics materials* [1)]

ISO 16139, *Industrial valves — Gate valves of thermoplastics materials* [1)]

ISO 21787, *Industrial valves — Globe valves of thermoplastics materials*

IEC 60364-1, *Electrical installations of buildings — Part 1: Scope, object and fundamental principles*

IEC 60449, *Voltage bands for electrical installations of buildings*

IEC 60529, *Degrees of protection provided by enclosures (IP-code)*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 472 and ISO 1043-1, and the following apply.

3.1 Geometrical definitions

NOTE The symbols d_e and e correspond to d_{ey} and e_y given in other International Standards such as ISO 11922-1.

3.1.1
nominal outside diameter
d_n
specified outside diameter of a component which is identical to the minimum mean outside diameter, $d_{em,min}$, in millimetres

NOTE The nominal inside diameter of a socket is equal to the nominal outside diameter of the corresponding pipe.

3.1.2
outside diameter at any point
d_e
measured outside diameter through the cross-section at any point of a pipe or the spigot end of a fitting, rounded up to the next 0,1 mm

3.1.3
mean outside diameter
d_{em}
measured length of the outer circumference of a pipe or the spigot end of a fitting divided by π (≈ 3,142), rounded up to the next 0,1 mm

3.1.4
mean inside diameter of a socket
arithmetical mean of two measured inside diameters perpendicular to each other

1) To be published.

3.1.5
nominal size of flange
DN
numerical designation of the size of a flange, used for reference purposes and related to the manufacturing dimension in millimetres

3.1.6
out-of-roundness
⟨pipe/spigot end of fitting⟩ difference between the measured maximum outside diameter and the measured minimum outside diameter in the same cross section of a pipe or the spigot end of a fitting

3.1.7
out-of-roundness
⟨socket⟩ difference between the measured maximum inside diameter and the measured minimum inside diameter in the same cross section of a socket

3.1.8
nominal wall thickness
e_n
wall thickness, in millimetres, corresponding to the minimum wall thickness, e_{min}

3.1.9
wall thickness at any point
e
measured wall thickness at any point around the circumference of a component, rounded up to the next 0,1 mm

3.1.10
pipe series S
S
dimensionless number related to the nominal outside diameter, d_n, and the nominal wall thickness, e_n

NOTE 1 The pipe series S is related to a given pipe geometry as shown in Equation (1):

$$S = \frac{d_n - e_n}{2e_n} \quad (1)$$

NOTE 2 Flanges are designated on the basis of PN.

3.1.11
standard dimension ratio
SDR
ratio of the nominal outside diameter, d_n, of a pipe to its nominal wall thickness, e_n

NOTE According to ISO 4065, the standard dimension ratio, SDR, and the pipe series S are related as shown in Equation (2):

$$SDR = 2S + 1 \quad (2)$$

3.2 Material definitions

3.2.1
virgin material
material in a form such as granules or powder that has not been subjected to use or processing other than that required for its manufacture and to which no reprocessable or recyclable materials have been added

3.2.2
own reprocessable material
material prepared from rejected unused pipes, fittings and valves, including trimmings from the production of pipes, fittings and valves, that will be reprocessed in a manufacturer's plant after having been previously processed by the same manufacturer by a process such as moulding or extrusion and for which the complete formulation or material specification is known

NOTE Only those thermoplastics parts of valves made from material conforming to this International Standard are used.

3.3 Definitions related to material characteristics

3.3.1
lower confidence limit
σ_{LCL}
quantity, expressed in megapascals, which can be considered as a material property, representing the 97,5 % lower confidence limit of the predicted long-term hydrostatic strength for water at a given temperature, T, and time, t

3.3.2
minimum required strength
MRS
value of σ_{LCL} for water at 20 °C for 50 years, rounded to the next lower value of the R10 series when σ_{LCL} is less than 10 MPa, or to the next lower value of the R20 series when σ_{LCL} is $\geqslant$ 10 MPa

NOTE The R10 and R20 series are given in ISO 3 and ISO 497.

3.3.3
design stress
σ_s
allowable stress, in megapascals, for a given application or service condition

NOTE It is derived by dividing the MRS by the coefficient C, as given in Equation (3), then rounding to the next lower value of the R10 series or R 20 series, as applicable:

$$\sigma_s = \frac{MRS}{C} \tag{3}$$

3.3.4
overall service coefficient
design coefficient
C
overall coefficient with a value greater than one which takes into consideration service conditions as well as the properties of the components of a piping system other than those represented in the lower confidence limit, σ_{LCL}

3.4 Definitions related to service conditions

3.4.1
nominal pressure
PN
numerical designation used for reference purposes related to the mechanical characteristics of the components of a piping system

NOTE 1 A pressure, in bar, with the numerical value of PN is identical to the pressure, p_s, as defined by EU Directive 97/23/ECC (PED), if both pressures are taken at 20 °C.

NOTE 2 For plastics piping systems conveying water, it corresponds to the maximum continuous operating pressure, in bar, which can be sustained for water at 20 °C for 50 years, based on the minimum overall service/design coefficient and calculated using Equation (4):

$$PN = \frac{10\sigma_s}{S} = \frac{20\sigma_s}{SDR - 1} \quad (4)$$

where

σ_s is the design stress, expressed in newtons per square millimetre;

PN is expressed in bar [2].

3.4.2
hydrostatic stress
σ
stress induced in the wall of a pipe when an internal hydrostatic pressure is applied

NOTE The hydrostatic stress, in megapascals, is related to the applied internal hydrostatic pressure, p, the wall thickness, e, at any point and the mean outside diameter, d_{em}, of a pipe and calculated using Equation (5):

$$\sigma = p\frac{d_{em} - e}{2e} \quad (5)$$

NOTE Equation (5) is applicable for pipes only.

3.4.3
long-term hydrostatic stress

constant hydrostatic stress that is maintained in a component during a sustained period of time

4 Symbols and abbreviated terms

4.1 Symbols

C overall service (design) coefficient (design factor)

d nominal outside diameter of the test piece

d_e outside diameter (at any point)

d_{em} mean outside diameter

d_n nominal outside diameter

DN nominal size of flange

e wall thickness (at any point)

e_n nominal wall thickness

l_0 free length

p internal hydrostatic pressure

p_s maximum allowable pressure

2) 1 bar = 0,1 MPa = 0,1 N/mm^2 = 10^5 N/m^2.

T temperature

t time

ρ material density

σ hydrostatic stress

σ_{LCL} lower confidence limit

σ_s design stress

4.2 Abbreviations

MOP maximum operating pressure

MRS minimum required strength

PN nominal pressure

PS maximum allowable pressure

PT test pressure

PVDF poly(vinylidene fluoride)

S pipe series S

SDR standard dimension ratio

5 Material

5.1 General

The PVDF material from which the components are made shall be homopolymer resin.

NOTE Only homopolymers are covered by this edition of ISO 10931. It is intended that copolymer materials also be covered at a later date.

5.2 Hydrostatic strength properties

The material shall be evaluated according to ISO 9080 where a pressure test is carried out according to ISO 1167 to find the MRS value in accordance with ISO 12162. The test shall be carried out using test pieces of pipe series S $\leqslant$ 10.

Conformity of PVDF to the reference curves given in Annex A shall be proved according to that annex. At least 97,5 % of the data points shall be on or above the reference curves.

The material shall be classified by the raw material producer.

Where fittings and valves are manufactured from the same material as pipes, the material classification shall be the same as for pipes.

For the classification of a material intended only for the manufacture of fittings and valves, the test piece shall be an injection-moulded or extruded test piece in the form of a pipe (see Figure 1) where a test pressure is applied according to ISO 1167. The free length l_0 shall be $3d_n$, as defined in ISO 15853.