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Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure — Specifications

Tubes et assemblages en poly(chlorure de vinyle) non plastifié orienté (PVC-O) pour le transport de l'eau sous pression — Spécifications

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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 16422 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 2, *Plastics pipes and fittings for water supplies*.

Introduction

Molecular orientation of thermoplastics results in improvement of physical and mechanical properties. Orientation is carried out at temperatures well above the glass transition temperature.

Orientation of PVC-U pipe-material can be induced by different processes.

One is the off-line process, where the thick-walled extruded tube is conditioned in a tubular mould at the desired temperature, and in which means are designed to activate the orientation process in the circumferential and axial directions.

A second option is the in-line process, where the thick-walled tube, directly after the extrusion process, is conditioned in-line at the orientation temperature, and in which means are incorporated to activate the orientation process in the circumferential and axial directions.

After the orientation process, the pipe is cooled down quickly to ambient temperature. The structure of this oriented pipe is stable up to the glass transition temperature (≈ 75 °C), above which the material will have a rubber phase where the pipe will shrink back to its original dimensions after extrusion.

The orientation of the molecules creates a laminar structure in the material of the pipe wall. This structure gives the ability to withstand brittle failure emanating from minor flaws in the material matrix or from scratches at the surface of the pipe wall. PVC-O can therefore be considered as highly resistant to notches and no testing is needed. Because of the morphology of oriented PVC-U pipe-material, there is no risk of long-line rapid crack propagation.

Improved hoop strength and improved resistance to impact also result.

Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure — Specifications

1 Scope

This International Standard specifies the general aspects of pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O), for piping systems intended to be used underground or above-ground where not exposed to direct sunlight, for water mains and services, pressurized sewer systems and irrigation systems.

The piping system according to this International Standard is intended for the conveyance of cold water under pressure, for drinking water and for general purposes up to and including 45 °C, and especially in those applications where special performance requirements are needed, such as impact loads and pressure fluctuations, up to pressure ratings of 25 bars[1)].

Joints constructed of other materials shall meet their own relevant standards in addition to the fitness-for-purpose requirements of this International Standard.

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

ISO 161-1, *Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series*

ISO 1167-1:2006, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 1: General method*

ISO 1628-2, *Plastics — Determination of the viscosity of polymers in dilute solution using capillary viscometers — Part 2: Poly(vinyl chloride) resins*

ISO 2045, *Single sockets for unplasticized poly(vinyl chloride) (PVC-U) and chlorinated poly(vinyl chloride) (PVC-C) pressure pipes with elastic sealing ring type joints — Minimum depths of engagement*

ISO 2507-1, *Thermoplastics pipes and fittings — Vicat softening temperature — Part 1: General test method*

ISO 2507-2, *Thermoplastics pipes and fittings — Vicat softening temperature — Part 2: Test conditions for unplasticized poly(vinyl chloride) (PVC-U) or chlorinated poly(vinyl chloride) (PVC-C) pipes and fittings and for high impact resistance poly(vinyl chloride) (PVC-HI) pipes*

ISO 2531, *Ductile iron pipes, fittings, accessories and their joints for water or gas applications*

1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2

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

ISO 3127, *Thermoplastics pipes — Determination of resistance to external blows — Round-the-clock method*

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

ISO 4422-2:1996, *Pipes and fittings made of unplasticized poly(vinyl chloride) (PVC-U) for water supply — Specifications — Part 2: Pipes (with or without integral sockets)*

ISO 4633, *Rubber seals — Joint rings for water supply, drainage and sewerage pipelines — Specification for materials*

ISO 6259-2:1997, *Thermoplastics pipes — Determination of tensile properties — Part 2: Pipes made of unplasticized poly(vinyl chloride) (PVC-U), chlorinated poly(vinyl chloride) (PVC-C) and high-impact poly(vinyl chloride) (PVC-HI)*

ISO 7686, *Plastics pipes and fittings — Determination of opacity*

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

ISO 9969, *Thermoplastics pipes — Determination of ring stiffness*

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

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

ISO 13783, *Plastics piping systems — Unplasticized poly(vinyl chloride) (PVC-U) end-load-bearing double-socket joints — Test method for leaktightness and strength while subjected to bending and internal pressure*

ISO 13844, *Plastics piping systems — Elastomeric-sealing-ring-type socket joints of unplasticized poly(vinyl chloride) (PVC-U) for use with PVC-U pipes — Test method for leaktightness under negative pressure*

ISO 13845, *Plastics piping systems — Elastomeric-sealing-ring-type socket joints for use with unplasticized poly(vinyl chloride) (PVC-U) pipes — Test method for leaktightness under internal pressure and with angular deflection*

ISO 13846, *Plastics piping systems — End-load-bearing and non-end-load-bearing assemblies and joints for thermoplastics pressure piping — Test method for long-term leaktightness under internal water pressure*

3 Terms and definitions

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

3.1
nominal outside diameter
d_n
numerical designation of size which is common to all components in a thermoplastics piping system other than flanges and components designated by thread size

NOTE 1 It is a convenient round number for reference purposes.

NOTE 2 For pipe conforming to ISO 161-1, the nominal outside diameter, expressed in millimetres, is the minimum mean outside diameter $d_{em, min}$.

3.2
nominal wall thickness
e_n
specified wall thickness, in millimetres

NOTE It is identical to the specified minimum wall thickness at any point $e_{y, min}$.

3.3
nominal pressure
PN
alphanumeric designation related to the mechanical characteristics of the components of a piping system and used for reference purposes

3.4
hydrostatic pressure
p
internal pressure applied to a piping system

3.5
working pressure
maximum pressure which a piping system can sustain in continuous use under given service conditions without pressure surge

NOTE For thermoplastics piping systems, the value of the nominal pressure is equal to the working pressure at a temperature of 20 °C, expressed in bar.

3.6
hydrostatic stress
σ
stress, expressed in megapascals, induced in the wall of a pipe when it is subjected to internal water pressure

NOTE 1 It is calculated using the following approximate equation:

$$\sigma = p\frac{(d_n - e_n)}{20e_n}$$

where

p is the applied internal pressure, in bar;

d_n is the nominal outside diameter of the pipe, in millimetres;

e_n is the nominal wall thickness, in millimetres.

NOTE 2 If σ and p are given in the same units, the denominator becomes $2e_n$

3.7
long-term hydrostatic strength for 50 years at 20 °C
σ_{LTHS}
quantity with the unit of stress, i.e. MPa, which can be considered to be a property of the material under consideration

NOTE It represents the 97,5 % lower confidence limit for the long-term hydrostatic strength and equals the predicted average strength at a temperature of 20 °C and for a time of 50 years with internal water pressure.

3.8
lower confidence limit of the predicted hydrostatic strength
σ_{LPL}
quantity with the dimension of stress, which represents the 97,5 % lower confidence limit of the predicted hydrostatic strength for a single value at a temperature T and a time t

NOTE 1 It is denoted as $\sigma_{LPL} = \sigma_{(T,t,0,975)}$.

NOTE 2 The value of this quantity is determined by the method given in ISO 9080.

3.9
minimum required strength
MRS
required value of σ_{LPL} for a temperature T of 20 °C and a time t of 50 years

NOTE 1 For a particular material, its MRS is established from the value of σ_{LPL} rounded to the next lower value of the R 10 series from ISO 3:1973, when σ_{LPL} is less than 10 MPa, or to the next lower value of the R 20 series when σ_{LPL} is greater than 10 MPa.

NOTE 2 See also ISO 4422-2:1996, Clause 5.

3.10
overall service (design) coefficient
C
overall coefficient with a value greater than one, which takes into consideration service conditions as well as properties of the components of a piping system other than those represented in σ_{LPL}

3.11
pipe series
S
dimensionless number for pipe designation

NOTE See ISO 4065.

3.12
standard dimension ratio
SDR
numerical designation of a pipe series which is a convenient round number approximately equal to the dimension ratio of the nominal outside diameter, d_n, and the nominal wall thickness e_n

NOTE According to ISO 4065, the standard dimension ratio, SDR, and the pipe series S are related, as expressed in the following equation:

$$SDR = 2S + 1$$

4 Symbols and abbreviated terms

4.1 Symbols

C overall service (design) coefficient

d_e outside diameter (at any point)

d_{em} mean outside diameter

d_i inside diameter (at any point)

d_{im} mean inside diameter of socket

d_n nominal (outside or inside) diameter

DN nominal size

e wall thickness (at any point)

e_m mean wall thickness

e_n nominal wall thickness

f_A derating (or uprating) factor for application

f_T derating factor for temperatures

K K-value

p internal hydrostatic pressure

p_T test pressure

PN nominal pressure

δ material density

σ hydrostatic stress

σ_s design stress

4.2 Abbreviations

LPL Lower predicted confidence limit

MRS minimum required strength

PFA allowable operating pressure

PVC-U unplasticized poly(vinyl chloride)

S pipe series

SDR standard dimension ratio

5 Material

5.1 General

The material from which the pipes are made shall be PVC-U compound. This compound shall consist substantially of PVC-U resin, to which shall be added only those additives necessary to facilitate the production of pipes and fittings in accordance with this International Standard. All additives shall be uniformly dispersed.

The K value of the PVC-U resin used shall be at least 64, when tested in accordance with ISO 1628-2.

When determined in accordance with ISO 2507-1 and ISO 2507-2, the Vicat softening temperature of the compound shall be not less than 80 °C.

5.2 Rework material

The use of the manufacturer's own reprocessable material, produced during the manufacture and works testing of products and conforming to the material requirements of this International Standard, is permitted. No reprocessable or recyclable material obtained from external sources shall be used.

6 Effect of materials on water quality

When used under the conditions for which they are designed, materials in contact with, or likely to come into contact with, drinking water shall not constitute a toxic hazard, shall not support microbial growth and shall not give rise to any unpleasant taste or odour, cloudiness or discoloration of the water.

Where applicable, pipes and their joints and the sealing rings shall conform to the current national regulations concerning materials in contact with drinking water.

7 Material classification

7.1 MRS value

Oriented pipes made from a defined PVC-U compound and with a well-defined orientation level, in tangential and axial direction, shall be evaluated according to the procedures of Annex A. The minimum required strength (MRS) values shall be classified in accordance with 7.3 and Table 1.

7.2 Overall service (design) coefficient

The overall service (design) coefficient of oriented PVC-U pipes shall be a minimum of 1,6. Alternatively, 1,4 is permitted for MRS 450 and MRS 500, provided that axial contraction of the pipe (due to higher design stress) does not result in pull-out of the joints. In this case, evidence shall be given according to Annex B.

7.3 Design stress

The design stress shall be based on the value of the lower confidence limit σ_{LPL} of the long term hydrostatic strength for the resistance to internal pressure as determined in accordance with ISO 9080. This σ_{LPL} value shall be converted into a minimum required strength (MRS) in accordance with ISO 12162. The MRS shall be divided by an overall service (design) coefficient C to give the design stress σ_s, which is expressed by the following equation.

$$\sigma_s = \frac{\text{MRS}}{C}$$

Table 1 — Material classification

Pipe material classification number	315		355		400		450			500		
MRS MPa[a]	31,5		35,5		40		45			50		
C	1,6	2	1,6	2	1,6	2	1,4	1,6	2	1,4	1,6	2
σ_s MPa	20	16	22	18	25	20	32	28	23	36	32	25

[a] Higher MRS classes may be chosen, provided they fall in the R20 range of ISO 3:1973.

