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

Part 1: General

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

Partie 1: Généralités

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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 procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document 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.*

This first edition of ISO 16422-1, together with ISO 16422-2 and ISO 16422-5, cancels and replaces the second edition of ISO 16422:2014, which has been technically revised.

The main changes are as follows:

— ISO 16422:2014 has been split into several parts, under the general title "*Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure*". The information previously included in ISO 16422:2014 has been divided into ISO 16422-1 (this document), ISO 16422-2 and ISO 16422-5.

A list of all parts in the ISO 16422 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Molecular orientation of thermoplastics results in the 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.

In general, the following production process is common.

— A thick-wall tube is extruded (feedstock) and conditioned at the desired temperature.

— The orientation process is activated primarily in circumferential direction under controlled conditions. Axial orientation can also be activated in the product.

— After the orientation process, the pipe is cooled down quickly to ambient temperature.

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.

Improved hoop strength allows reduced wall thickness with material and energy savings. It also results in improved resistance to impact and fatigue.

The classification of the material depends on material compound/formulation and stretch ratios used. Therefore, with the classification, these characteristics may be specified or determined.

Regarding potential adverse effects on the quality of water intended for human consumption caused by the products covered by this document, this document provides no information as to whether or not the products can be used without restriction.

Requirements and test methods for PVC-O components are specified in this document, as well as in ISO 16422-2 and ISO/TS 16422-3.

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

Part 1: General

1 Scope

This document specifies the general characteristics of solid-wall pipes made of oriented unplasticized poly(vinyl chloride) (PVC-O) for piping systems intended to be used underground or above-ground (where protected from direct sunlight), for water supply, buried drainage, sewerage, treated waste water and irrigation under pressure.

In conjunction with ISO 16422-2, ISO/TS 16422-3, ISO 16422-5 and ISO 1452-4, this document is applicable to PVC-O pipes and PVC-O fittings, as well as to valves, their joints and to joints with components of other plastics and non-plastics materials intended to be used for the following:

a) water mains and services lines;

b) conveyance of water for both outside and inside buildings;

c) drainage, sewerage and treated wastewater under pressure;

d) irrigation under pressure.

This document is applicable to piping systems intended for the supply of water under pressure up to and including 25 °C (cold water), intended for human consumption and for general purposes as well as for wastewater under pressure.

This document is also applicable to components for the conveyance of water and wastewater up to and including 45 °C. For temperatures between 25 °C and 45 °C, see ISO 16422-2:2023, Figure C.1.

The piping system according to this document is intended for the conveyance of cold water up to pressures of 25 bar[1)] and especially in those applications where special performance requirements are needed, such as impact loads and pressure fluctuations, up to pressure of 25 bar.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 16422-2:2023, *Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure — Part 2: Pipes*

ISO/TS 16422-3:2023, *Pipes and joints made of oriented unplasticized poly(vinyl chloride) (PVC-O) for the conveyance of water under pressure — Part 3: Fittings*

ISO 472, *Plastics — Vocabulary*

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

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*

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

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.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1 Terms related to wall construction

3.1.1
solid-wall
having smooth internal and external surface and the same homogeneous compound/formulation throughout the wall

3.2 Terms related to geometrics

3.2.1
mean inside diameter of socket
d_{im}
arithmetical mean of two measured inside diameters perpendicular to each other at the midpoint of the socket length

3.2.2
mean outside diameter
d_{em}
value of the measurement of the outer circumference of a pipe or spigot end of a fitting in any cross-section, divided by π (≈ 3,142), rounded up to the nearest 0,1 mm

3.2.3
mean wall thickness
e_m
arithmetical mean of a number of measurements of the wall thickness, regularly spaced around the circumference and in the same cross-section of a component, including the measured minimum and the measured maximum values of the wall thickness in that cross-section

3.2.4
nominal diameter
d_n
specified diameter assigned to a nominal size

Note 1 to entry: According to ISO 1452-2, the nominal (outside) diameter of a thermoplastics pipe or a spigot, is equal to its minimum mean outside diameter, $d_{em,min}$.

Note 2 to entry: The nominal (inside) diameter of the socket of a fitting, pipe, valve or ancillary equipment is equal to the nominal (outside) diameter of the connecting pipe for which they are designed.

Note 3 to entry: The nominal diameter is expressed in millimetres.

3.2.5
nominal wall thickness
e_n
numerical designation of the wall thickness of a component which is identical to the minimum permissible wall thickness at any point

Note 1 to entry: The wall thickness is expressed in millimetres.

3.2.6
pipe series
S
dimensionless number for pipe designation

Note 1 to entry: The pipe series S is related to a given pipe geometry as given in Formula (1):

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

3.2.7
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 1 to entry: According to ISO 4065, the standard dimension ratio (SDR) and the pipe series (S) are related as given in Formula (2):

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

3.2.8
wall thickness at any point
e
value of the measurement of the wall thickness at any point around the circumference of a component

3.3 Terms related to material

3.3.1
feedstock
starting stock of PVC-U pipes before orientation-process

3.3.2
own reprocessed material
material prepared from rejected unused feedstock, pipes or fittings, including trimmings from the production of pipes or fittings, which 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 compound is known

3.3.3
virgin material
material in the form of granules or powder that has not been subjected to use or processing other than that required for its manufacture and to which no reprocessed or recycled material(s) has been added

3.4 Terms related to material characteristics

3.4.1
overall service (design) coefficient
C
overall 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 predictive limit

3.4.2
design stress
σ_s
allowable stress for a given application at 20 °C

Note 1 to entry: This is derived from the minimum required strength (MRS) by dividing it by the coefficient, *C*, using Formula (3):

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

Note 2 to entry: Design stress is expressed in megapascals (MPa).

3.4.3
lower prediction limit
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 to entry: $\sigma_{LPL} = \sigma(T,t,0{,}975)$.

Note 2 to entry: The value of this quantity is determined by the method given in ISO 9080.

3.4.4
minimum required strength
MRS
value of the lower prediction limit σ_{LPL}, rounded to the next lower value of the R10 series when σ_{LPL} is below 10 MPa, or to the next lower value of the R20 series when σ_{LPL} is 10 MPa or greater

Note 1 to entry: The R10 and R20 series are the basic series of preferred numbers conforming to ISO 3 and ISO 497.

3.4.5
orientation factor
λ
factor related to the stretching ratio used in orientation processing

3.5 Terms related to service conditions

3.5.1
allowable operating pressure
PFA
maximum hydrostatic pressure which a component is capable of withstanding continuously in service (excluding surge)

Note 1 to entry: For water temperatures up to and including 25 °C: *PFA* = *PN*.

Note 2 to entry: For water temperatures above 25 °C: $PFA = f_T \times PN$.

where

f_T is the derating factor depending on water temperature;

PN is the nominal pressure.

In cases where a further derating factor for application is required: $PFA = f_A \times f_T \times PN$, where f_A is the factor depending on the application.

3.5.2
hydrostatic pressure
p
internal pressure applied to a piping system

3.5.3
hydrostatic stress
σ
stress induced in the wall of a pipe when a pressure is applied using water as a medium

Note 1 to entry: Hydrostatic stress is related to the applied pressure, p, in bar, the wall thickness at any point, e, and the mean outside diameter, d_{em}, of a pipe and is calculated using approximation Formula (4):

$$\sigma = \frac{p(d_{em} - e)}{20e} \quad (4)$$

Note 2 to entry: Hydrostatic stress is expressed in megapascals (MPa).

3.5.4
nominal pressure
PN
numerical designation used for reference purposes related to the mechanical characteristics of a component of a piping system

Note 1 to entry: For plastics piping systems, this corresponds to the allowable operating pressure, in bar [2], conveying water at 20 °C during 50 years, as given in Formula (5):

$$PN = \frac{20MRS}{C \times (SDR - 1)} \quad (5)$$

4 Symbols and abbreviated terms

4.1 Symbols

C	overall service design coefficient
d_{em}	mean outside diameter
d_{im}	mean inside diameter of socket
d_n	nominal (outside or inside) diameter
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
p	hydrostatic pressure
T	temperature
t	time
λ	orientation factor
σ	hydrostatic stress
σ_{LPL}	lower predicted confidence limit

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

σ_s design stress

4.2 Abbreviated terms

DN nominal size

DN/ID nominal size, inside diameter related

DN/OD nominal size, outside diameter related

MRS minimum required strength

PFA allowable operating pressure

PN nominal pressure

PVC-O oriented unplasticized poly(vinyl chloride)

PVC-U unplasticized poly(vinyl chloride)

SDR standard dimension ratio

5 Material

5.1 General requirements for compounds or formulations

The material from which the pipes and fittings are made shall be an unplasticized poly(vinyl chloride) compound or formulation. The K-value of the PVC resin shall be at least 64.

This compound or formulation shall consist of PVC resin/powder, to which shall be added those additives which are needed to facilitate the manufacture of pipes and fittings conforming to ISO 16422-2 and ISO/TS 16422-3 as applicable.

None of these additives shall be used separately or together in quantities sufficient to constitute a toxic, organoleptic or microbiological hazard or to impair the fabrication or solvent cementing properties of the product or to impair the chemical and physical or mechanical properties (in particular long-term mechanical strength and impact strength) as specified in the ISO 16422 series.

5.2 Special requirements for compounds or formulations for components in contact with drinking water

All plastics and non-plastics materials for components of the PVC-O piping system (e.g. pipes, fittings, valves, elastomeric sealing rings, lubricants), when in permanent or in temporary contact with water which is intended for human consumption, shall take into consideration national requirements and regulations for drinking water if applicable.

5.3 Use of reworked material

The use of the manufacturer's own reprocessed material obtained during the production and production testing of products conforming to ISO 16422-2 and ISO/TS 16422-3 as applicable is permitted in addition to the use of virgin material. Own reprocessed material obtained during the production of feedstock or products conforming to ISO 1452-2 or ISO 1452-3 with the same formulation may be used.

Reprocessed material obtained from external sources and recycled material shall not be used.