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Plastics piping systems for water supply and drainage and sewerage under pressure — Modified poly(vinyl chloride)(PVC-M) pipe

Systèmes de canalisations en plastique pour l'alimentation en eau et pour les branchements et collecteurs d'assainissement sous pression — Tube en poly(chlorure de vinyle) modifié (PVC-M)

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Foreword

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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*.

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.

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Introduction

This document defines the requirements for modified poly(vinyl chloride) (PVC-M) pipes.

PVC-M pipe is similar in composition to unplasticized PVC (PVC-U) pipe except that an impact modifier has been added to alter the fracture mechanism, so that the material behaves in a more predictable, ductile manner. The combination of material formulation and processing conditions are such that the required strength and ductility is achieved.

The more predictable, ductile fracture mechanism allows for reduced wall thickness with material and energy savings. It also results in improved resistance to crack propagation.

Similar products have been specified in various national standards and have been referred to as PVC-A, PVC-HI, PVC-CPE, PVC-EPR and HIVP. This product is different to the product specified in the ISO 6993 series (PVC-HI).

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Plastics piping systems for water supply and drainage and sewerage under pressure — Modified poly(vinyl chloride) (PVC-M) pipe

1 Scope

This document specifies requirements for pipe and integral joints of higher level of impact resistant PVC-M for the conveyance of water and waste water under pressure. The pipes are intended for installation below and above ground where they are not exposed to direct sunlight.

This document also specifies the test parameters for the test methods in this document.

This document is applicable to extruded PVC-M pipes without a socket and pipes with a socket (integral or not), intended to be used for the following purposes:

a) water mains and services buried in the ground;

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

c) buried and above-ground drainage and sewerage 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 waste water under pressure.

This document specifies pipes for the conveyance of water and waste water up to and including 45 °C. For temperatures between 25 °C and 45 °C, Figure A.1 applies.

NOTE 1 The producer and the end-user can come to agreement on the possibilities of use for temperatures above 45 °C on a case-by-case basis

This document specifies a range of pipe sizes and pressure classes, and gives requirements concerning colours.

NOTE 2 It is the responsibility of the purchaser or specifier to make the appropriate selections concerning pipe sizes, pressure classes and colours, taking into account their particular requirements and any relevant national regulations and installation practices or codes.

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 472, *Plastics — Vocabulary*

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

ISO 1167-2, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 2: Preparation of pipe test pieces*

ISO 1452-1, *Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U) — Part 1: General*

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ISO 1452-2, *Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U) — Part 2: Pipes*

ISO 1452-5, *Plastics piping systems for water supply and for buried and above-ground drainage and sewerage under pressure — Unplasticized poly(vinyl chloride) (PVC-U) — Part 5: Fitness for purpose of the system*

ISO 2505, *Thermoplastics pipes — Longitudinal reversion — Test method and parameters*

ISO 2507, *Thermoplastics pipes and fittings — Vicat softening temperature — General test method and test conditions for vinyl chloride-based (PVC-U, PVC-C, PVC-HI) and acrylonitrile-based (ABS, ASA) pipes and fittings*

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

ISO 6259-1, *Thermoplastics pipes — Determination of tensile properties — Part 1: General test method*

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

ISO 7387-1, *Adhesives with solvents for assembly of PVC-U pipe elements — Characterization — Part 1: Basic test methods*

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

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

ISO 9311-1, *Adhesives for thermoplastic piping systems — Part 1: Determination of film properties*

ISO 9852, *Unplasticized poly(vinyl chloride) (PVC-U) pipes — Dichloromethane resistance at specified temperature (DCMT) — Test method*

ISO 11673, *Unplasticized poly(vinyl chloride) (PVC-U) pressure pipes — Determination of the fracture toughness properties*

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

ISO 18373-1, *Rigid PVC pipes — Differential scanning calorimetry (DSC) method — Part 1: Measurement of the processing temperature*

EN 681-1, *Elastomeric seals — Materials requirements for pipe joint seals used in water and drainage applications — Part 1: Vulcanized rubber*

3 Terms, definitions, symbols and abbreviated terms

3.1 Terms and definition

For the purposes of this document, the terms and definitions given in ISO 472, ISO 1452-1, ISO 1452-2 and the following apply.

ISO and IEC maintain terminology 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/

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3.1.1 Terms related to geometrical definitions

3.1.1.1
nominal size
DN
numerical designation of the size of a component, other than a component designated by thread size, which is a convenient round number approximately equal to the manufacturing dimension in millimetres (mm)

3.1.1.2
nominal diameter
d_n
specified diameter assigned to a nominal size

Note 1 to entry: According to the ISO 1452 series, 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 of 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 (mm).

3.1.1.3
outside diameter at any point
d_e
value of the measurement of the outside diameter through its cross-section at any point of a pipe or spigot, rounded up to the nearest 0,1 mm

3.1.1.4
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

3.1.1.5
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

3.1.1.6
out-of-roundness
ovality
difference between the measured maximum and the measured minimum outside diameter in the same cross-section of a pipe or spigot, or the difference between the measured maximum and the measured minimum inside diameter in the same cross-section of a socket

Note 1 to entry: The out-of-roundness tolerance on the outside diameters is applicable to pressure classes PN 10 and above. No such tolerance is placed on classes PN 8 and below because the thinner walled pipes can be easily re-rounded when inserted into sockets.

3.1.1.7
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 (mm).

3.1.1.8
wall thickness at any point
e
value of the measurement of the wall thickness at any point around the circumference of a component

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3.1.1.9
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

3.1.1.10
tolerance
permitted variation of the specified value of a quantity, expressed as the difference between the permitted maximum and the permitted minimum value

3.1.1.11
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):

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

3.1.1.12
standard dimension ratio
SDR
numerical designation of 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,[4] the standard dimension ratio, SDR, and the pipe series, S, are related as given in Formula (2):

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

3.1.2 Terms related to material

3.1.2.1
virgin material
plastics material in the form of pellets, granules, powder, flake, etc. that has not been subjected to use or processing other than that required for its initial manufacture and to which no reworked or recyclate material(s) has been added

3.1.2.2
own reworked material
material prepared from rejected unused pipes including trimmings from the production of pipes, which will be reworked in a manufacturer's plant after having been previously processed by the same manufacturer and for which the complete formulation or compound is known

3.1.2.3
recyclate
plastics material resulting from the recycling or reworking of material from any external source including pre-consumer and post-consumer plastics products

3.1.2.4
resin
non-crystalline powder or pellets consisting of organic compound or organic derivatives or both

3.1.2.5
impact modifier
substance added into an unplasticized poly(vinyl chloride) (PVC-U) composition in order to alter the fracture mechanism so that the material behaves in a more predictable and ductile manner

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3.1.2.6
compound
polymer composition that is based on unplasticized poly(vinyl chloride) (PVC-U) resin and that further incorporated only the modifiers and additives that are required for the manufacture of pipes and fittings

3.1.3 Terms related to material characteristics

3.1.3.1
lower prediction limit
σ_{LPL}
quantity which can be considered as a material property, representing the 97,5 % lower confidence limit of the predicted long-term hydrostatic strength at 20 °C for 50 years with internal water pressure

Note 1 to entry: Lower prediction limit is expressed in megapascals (MPa).

3.1.3.2
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.

3.1.3.3
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

3.1.3.4
design stress
σ_s
allowable stress for a given application at 20 °C

Note 1 to entry: Design stress 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).

3.1.4 Terms related to service conditions

3.1.4.1
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, nominal pressure corresponds to the allowable operating pressure, in bar (1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2), conveying water at 20 °C during 50 years, as given in Formula (4):

$$PN = \frac{20\ MRS}{C \times (SDR - 1)} \tag{4}$$

Note 2 to entry: Research on long-term performance prediction of existing poly(vinyl chloride) (PVC) water distribution systems shows possible service life of at least 100 years[8],[9].

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3.1.4.2
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*, where *PN* is the nominal pressure.

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.

Note 3 to entry: In cases where a further derating factor for application is required: $PFA = f_A \times f_T \times PN$, where f_A is the derating factor depending on the application.

3.1.4.3
allowable site test pressure
PEA
maximum hydrostatic pressure which a newly installed component is capable of withstanding for a relatively short duration, in order to ensure the integrity and leaktightness of the pipeline

Note 1 to entry: For ISO 12051 or PEA equals PFA+5 bar whichever is the lowest (1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2).

3.1.4.4
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: The hydrostatic stress is related to the applied pressure, p, in bar (1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2), the wall thickness at any point, e, and the mean outside diameter, d_{em}, of a pipe and is calculated using Formula (5):

$$\sigma = \frac{p\left(d_{em} - e\right)}{20e} \tag{5}$$

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

3.2 Symbols

C	design coefficient
d_e	outside diameter at any point
d_{em}	mean outside diameter
$d_{e,test}$	outside diameter of the test piece
d_i	inside diameter at any point
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
E	Young's modulus

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