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Buried, high-impact poly(vinyl chloride) (PVC-HI) pipes for the supply of gaseous fuels — Specifications

Tubes enterrés en poly(chlorure de vinyle) à résistance au choc améliorée (PVC-HI) pour réseaux de combustibles gazeux — 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 3.

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 International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6993 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastics pipes and fittings for the supply of gaseous fuels*.

This second edition cancels and replaces the first edition (ISO 6993:1990), which has been technically revised. Substantial changes have been made to the specifications for the PVC-HI material and to those for the mechanical properties of the PVC-HI pipe. In addition, references have been added to ISO test methods which were not published at the time the first edition was issued.

Annexes A to F form a normative part of this International Standard.

Buried, high-impact poly(vinyl chloride) (PVC-HI) pipes for the supply of gaseous fuels — Specifications

1 Scope

This International Standard specifies the requirements for pipes made of high-impact poly(vinyl chloride) (PVC-HI) intended to be used for the supply of gaseous fuels through buried pipelines with an operating temperature range of 0 °C to 30 °C and a maximum operating pressure of 1 bar.

Such pipes are only suitable for those gases which do not contain potentially damaging components in such concentrations as to impair the properties of the pipe material.

NOTE 1 bar = 10^5 N/m^2 = 100 kPa

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 3, *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 877:1994, *Plastics — Methods of exposure to direct weathering, to weathering using glass-filtered daylight, and to intensified weathering by daylight using Fresnel mirrors*

EN 922, *Plastics piping and ducting systems — Pipes and fittings of unplasticized poly(vinyl chloride) (PVC-U) — Specimen preparation for determination of the viscosity number and calculation of the K-value*

ISO 1167, *Thermoplastics pipes for the conveyance of fluids — Resistance to internal pressure — Test 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 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 3127, *Thermoplastics pipes — Determination of resistance to external blows — Round-the-clock method*

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

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

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

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

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1 Geometrical definitions

3.1.1
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, and is a convenient round number for reference purposes

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

3.1.2
mean outside diameter
d_{em}
measured length of the outer circumference of the pipe divided by π and rounded up to the nearest 0,1 mm

NOTE The value of π is taken to be 3,142.

3.1.3
minimum mean outside diameter
$d_{em,min}$
minimum value of the mean outside diameter specified in this International Standard

NOTE It is equal to the nominal outside diameter d_n, expressed in millimetres.

3.1.4
maximum mean outside diameter
$d_{em,max}$
maximum value of the mean outside diameter specified in this International Standard

3.1.5
outside diameter at any point
d_{ey}
outside diameter measured through the cross-section at any point along the pipe, rounded up to the nearest 0,1 mm

3.1.6
out-of-roundness
difference between the measured maximum outside diameter and the measured minimum outside diameter in the same cross-sectional plane of the pipe

3.1.7
nominal wall thickness
e_n
wall thickness, in millimetres, tabulated in ISO 4065, corresponding to the minimum wall thickness at any point $e_{y,min}$

3.1.8
mean wall thickness
e_m
arithmetic mean of at least four measurements regularly spaced around the same cross-sectional plane of the pipe, including the measured minimum and maximum values obtained, rounded up to the nearest 0,1 mm

3.1.9
wall thickness at any point
e_y
wall thickness measured at any point around the circumference of the pipe, rounded up to the nearest 0,1 mm

3.1.10
minimum wall thickness
$e_{y,min}$
minimum wall thickness specified for the pipe in this International Standard

3.1.11
maximum wall thickness
$e_{y,max}$
maximum wall thickness of the pipe, not specified in this International Standard but which can be determined from the tolerance on $e_{y,min}$ given in ISO 11922-1

3.1.12
standard dimension ratio
SDR
numerical designation of a pipe series, which is equal to the ratio of the nominal outside diameter d_n to the nominal wall thickness e_n

$$\text{SDR} = \frac{d_n}{e_n}$$

3.2 Material definitions

3.2.1
high-impact PVC
mixture of unplasticized PVC and an impact-resistance modifier

3.2.2
lower confidence limit
σ_{lcl}
quantity with the dimensions of stress, in megapascals, which can be considered as a property of the material and represents the 97,5 % lower confidence limit of the mean long-term hydrostatic strength at 20 °C for 50 years determined by pressurizing internally with water

[ISO 8085-1]

3.2.3
minimum required strength
MRS
value of σ_{lcl} rounded down to the next value in the R 10 series when σ_{lcl} is less than 10 MPa, or to the next lower value in the R 20 series when σ_{lcl} is greater than or equal to 10 MPa

NOTE The R 10 and R 20 series are the Renard number series as defined in ISO 3 and ISO 497.

[ISO 8085-1]

3.2.4
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 confidence limit

NOTE For gas applications, C can have any value $\geqslant$ 2,0.

3.3 Definitions related to service conditions

3.3.1
natural gas
gaseous fuel containing a mixture of hydrocarbons, primarily methane, but generally also including ethane, propane and higher hydrocarbons in much smaller amounts

NOTE 1 Natural gas generally also includes some inert gases, such as nitrogen and carbon dioxide, plus minor amounts of trace constituents.

NOTE 2 Natural gas remains in the gaseous state under the temperature and pressure conditions normally found in service.

3.3.2
pressure
overpressure relative to atmospheric pressure

3.3.3
maximum operating pressure
MOP
maximum effective pressure of the gas in a piping system, expressed in bars, which is allowed in continuous use

NOTE It takes into account the physical and the mechanical characteristics of the components of the piping system and is given by the equation:

$$\text{MOP} = \frac{20 \times \text{MRS}}{C \times (\text{SDR} - 1)}$$

[ISO 8085-1]

4 Symbols and abbreviated terms

4.1 Symbols

C overall service (design) coefficient

ΔD indentation, in millimetres

d_{ey} outside diameter at any point

d_{em} mean outside diameter

$d_{em,max}$ maximum mean outside diameter

$d_{em,min}$ minimum mean outside diameter

d_m mean diameter (= $d_{em} - e_m$)

d_n nominal outside diameter

E_{mod} initial modulus of elasticity

e_m mean wall thickness

e_n nominal wall thickness

e_y wall thickness at any point

$e_{y,max}$ maximum wall thickness

$e_{y,min}$ minimum wall thickness

I moment of inertia

p_b internal hydraulic pressure

ε strain, in percent

σ hoop stress

σ_{lcl} lower confidence limit

4.2 Abbreviated terms

PVC-AK acrylate-modified PVC

PVC-CPE chlorinated polyethylene modified PVC

PVC-EPR ethylene propylene rubber modified PVC

MOP maximum operating pressure

MRS minimum required strength

PVC-HI high-impact PVC

PVC-U unplasticized PVC

SDR standard dimension ratio

STIS specific tangential initial stiffness

THT tetrahydrothiophene

5 Operating conditions

When considering the use of PVC-HI pipes, the impact strength and the environmental conditions may have more influence on performance than the internal pressure.

The most commonly used SDR values are 41 and 33. For specific applications, other SDR values can be taken from all series given in ISO 4065 and ISO 161-1. SDR 41 series pipes are suitable for use under a maximum service pressure of 0,2 bar. SDR 33 series pipes are suitable for use under a maximum service pressure of 1,0 bar.

Transport, handling and storage, climatic conditions and the buried environment (notably soil loading) will vary in different countries. It will therefore be necessary to refer to the codes of practice and the local regulations within each country.

6 Product requirements

6.1 Pipe appearance and finish

Pipes shall be conditioned for at least 4 h and then examined visually without magnification.

The internal and external pipe surfaces shall be free from grooves, pits, blisters, indications of burning and other defects. The pipe ends shall be cut cleanly and square to the axis of the pipe. The cut end shall not show any voids.

6.2 Pipe material

6.2.1 Composition

The pipes shall be made of high-impact PVC, to which shall be added only those additives that are necessary to facilitate conformity of the pipes to this International Standard.

The impact-resistance modifier shall be one of the following:

a) a mixture based on PVC;

b) a blend based on PVC;

c) a copolymer based on PVC;

d) a combination of these types.

The proportion of PVC in the material shall be at least 80 % by mass.

NOTE Only materials such as PVC-CPE, PVC-EPR and PVC-AK, for which studies have been completed by ISO/TC 138, are included in this International Standard.

6.2.2 Long-term strength

The MRS value of the material shall be at least 18 MPa. Conformity to this requirement shall be demonstrated using a long-term evaluation in accordance with ISO/TR 9080:1992, method I. Testing shall be carried out at 20 °C, 40 °C and 60 °C, for periods up to 10 000 h. The knee at 60 °C shall occur beyond 5 000 h.

6.2.3 Vicat softening temperature

The Vicat softening temperature of the high-impact PVC shall be not less than 76 °C, when measured in accordance with ISO 2507-1 and ISO 2507-2.

6.2.4 Degree of gelation

When tested in accordance with ISO 9852, the material shall not show any visual deterioration at 15 °C.

6.2.5 *K*-value

The *K*-value of the unplasticized poly(vinyl chloride) (PVC-U) shall exceed 65, when measured in accordance with EN 922.

6.2.6 Initial modulus of elasticity

The initial modulus of elasticity E_{mod} calculated from the specific tangential initial stiffness (STIS) measured in accordance with ISO 9969 shall be at least 2 150 MPa.

$$\text{STIS} = \frac{E_{mod} \times I}{(d_m)^3}$$

$$E_{mod} = \text{STIS} \times \left(\frac{(d_m)^3}{I} \right)$$

$$E_{mod} = \text{STIS} \times \left(\frac{(d_{em} - e_m)^3}{I} \right)$$

where

$$I = \frac{(e_m)^3}{12}$$

6.2.7 Contaminants

When tested in accordance with clause 8 and annex A, the pipe material shall not show any contaminant particles, such as inorganic particles or agglomerations thereof, exceeding 50 µm in size.

6.2.8 UV stability

Test specimens with a d_n of 63 mm shall be exposed for weathering in accordance with clause 8 and annex B. After exposure, the impact resistance of the weathered side shall be determined in accordance with 7.3, using a falling weight of $(750 \, ^{+5}_{0})$ g and a drop height of $(2\,000 \, ^{+10}_{0})$ mm.

6.2.9 Resistance to gas constituents

The resistance to gas constituents shall be determined in accordance with clause 8 and annex D.

6.3 Pipe dimensions and tolerances

6.3.1 Nominal outside diameter d_n

The nominal outside diameter d_n shall be selected from those given in Table 1.

6.3.2 Mean outside diameter d_{em}

The mean outside diameter at any point shall conform to Table 1.

6.3.3 Out-of-roundness $(d_{em,max} - d_{em,min})$

The out-of-roundness at any cross-section shall conform to Table 1.

6.3.4 Wall thickness e_y

The wall thickness at any point shall conform to Table 1. The measured value of e_m shall not be less than e_n.

NOTE In order to meet the requirements for handling and resistance to soil loads, a minimum wall thickness of 2,0 mm is specified for all series.

