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Polyethylene (PE) valves for gas distribution systems

Robinets en polyéthylène (PE) pour distribution de gaz

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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.

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.

International Standard ISO 10933 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 7, *Valves and auxiliary equipment of plastics materials*.

Annexes A to F form an integral part of this International Standard. Annex G is for information only.

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Polyethylene (PE) valves for gas distribution systems

1. Scope

This International Standard specifies the constructive and qualitative criteria, test methods and marking for valves having a polyethylene (PE) body and intended for use with PE pipes and fittings for the supply of gaseous fuels.

In addition, it specifies some general properties of the material from which these valves are made.

It is applicable to bi-directional valves with spigot ends or electrofusion sockets conforming to ISO 8085-3 intended to be used with pipes conforming to ISO 4437 and with spigot fittings conforming to ISO 8085-2.

This International Standard covers valves having a nominal outside diameter up to and including 225 mm and for which the service temperature lies between -20 °C and +40 °C.

Methods of test are given in normative annexes A to F inclusive.

2. Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 760:1978	*Determination of water - Karl Fischer method (General method).*
ISO 1133:1997	*Plastics - Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics.*
ISO 1167: 1996	*Thermoplastics pipes for the conveyance of fluids - Resistance to internal pressure - Test method.*
ISO 1183:1987	*Plastics - Methods for determining the density and relative density of non-cellular plastics.*
ISO 1872-1:1993	*Plastics - Polyethylene (PE) moulding and extrusion materials - Part 1: Designation system and basis for specifications.*
ISO 3126:1974	*Plastics pipes - Measurement of dimensions.*
ISO 4437:1997	*Plastics pipes and fittings - Buried polyethylene (PE) pipes for the supply of gaseous fuels - Metric series - Specifications.*
ISO 4440-1:1994	*Thermoplastic pipes and fittings - Determination of melt mass-flow rate - Part 1: Test method.*
ISO 5208:1993	*Industrial valves - Pressure testing of valves.*

ISO 6447:1983	*Rubber seals - Joint rings for gas supply pipes and fittings - Specification for material.*
ISO 6964: 1986	*Polyolefin pipes and fittings - Determination of carbon black content by calcination and pyrolysis - Test method and basic specification.*
ISO 8085-2:–[1)]	*Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels - Metric series - Specifications - Part 2: Spigot fittings for butt fusion jointing, for socket fusion using heated tools and for use with electrofusion fittings.*
ISO 8085-3:–[1)]	*Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels - Metric series - Specifications - Part 3: Electrofusion fittings.*
ISO 8233:1988	*Thermoplastic valves - Torque - Test method.*
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/TR 10837:1991	*Determination of the thermal stability of polyethylene (PE) for use in gas pipes and fittings.*
ISO/TR 10839-1	*Plastics piping systems for the supply of gaseous fuels - Recommended practice for design, handling and installation - Part 1: Main and service lines.*
ISO 11420:1996	*Method for the assessment of the degree of carbon black dispersion in polyethylene pipes and fittings.*
ISO 12162:1995	*Thermoplastics materials for pipes and fittings for pressure applications - Classification and designation - Overall service (design) coefficient.*
ISO 13479: –[1)]	*Polyolefin (PE) pipes for the conveyance of fluids - Determination of resistance to crack propagation - Test method for slow crack growth on notched pipes (notch test).*
ISO 13949:1997	*Method for the assessment of the degree of pigment dispersion in polyolefin pipes, fittings and compounds.*
ASTM D 4019:1994a	*Test method for moisture in plastics by coulometric regeneration of phosphorus pentoxide.*

3. Definitions

For the purposes of this International Standard, the following definitions apply:

3.1 **nominal outside diameter d_n:** A numerical designation of size which is common to all components in a thermoplastics piping system other than flanges and components designated by thread size. It is a convenient round number for reference purposes.

1) To be published.

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

3.2 **nominal wall thickness** e_n**:** The wall thickness, in millimetres, tabulated in ISO 4065, corresponding to the minimum wall thickness at any point, $e_{y,min}$.

3.3 **wall thickness at any point** e_y**:** The measured wall thickness at any point round the circumference of the pipe, rounded up to the nearest 0,1 mm.

3.4 **valve:** A device that permits the interruption and the restoration of a gas stream by operating its opening/closing mechanism.

3.5 **pressure:** The static overpressure with respect to the atmospheric pressure.

3.6 **maximum operating pressure, MOP:** The maximum effective pressure of the gas in a piping system, expressed in bars, which is allowed in continuous use. It takes into account the physical and the mechanical characteristics of the components of the piping system.

3.7 **external leaktightness:** The leaktightness of the body enveloping the space containing the gas, with respect to the atmosphere.

3.8 **internal leaktightness:** The leaktightness between the inlet and the outlet of the valve, obtained by closing the operating mechanism.

3.9 **leakage:** Emission of gas through the body, sealing membrane or any other component of the valve.

3.10 **compound:** The PE compound manufactured from the base PE polymer and all additives (UV stabilisers, anti-oxidants and pigments).

3.11 **hydrostatic stress:** The stress induced in the wall of a pipe when the pipe is filled with a fluid under pressure.

3.12 **shell test:** A test to determine the internal hydrostatic pressure resistance of the valve assembly.

The shell test is covered by the hydrostatic strength test (7.2).

3.13 **leaktightness test** (seat and packing test):

A combination of tests to determine:

- the internal leaktightness of the valve seat when closed (from one direction for unidirectional valves and from each direction for other valves);

- the external leaktightness of the valve when half-open.

3.14 **initiating torque:** The torque necessary to initiate movement of the obturator.

3.15 **running torque:** The torque necessary to achieve full opening or closing of the valve at maximum service pressure.

4. Material requirements

4.1 General

The technical data concerning the materials used shall be made available to the purchasers by the valve manufacturer.

When dissimilar metallic materials are used which may be in contact with moisture, the possibility of galvanic corrosion shall be prevented.

Note 1 - In the application of a quality plan for manufacturing or certifying valves conforming to this International Standard, any change in the choice of materials affecting the quality of the valve assembly should require a new type testing of the valve.

Note 2 - The following aspects should be taken into consideration pending inclusion of practicable and verifiable requirements for such purposes:
a) all parts of the valve in contact with the gas stream should be resistant to the gas, its condensates and other substances occurring, such as dust;
b) all metal parts should be resistant to both internal and external corrosion.

4.2 Valve body

4.2.1 The valve body shall be manufactured from PE80 or PE100 and shall contain only those additives (e.g. antioxidants, UV stabilisers, pigments) necessary for the manufacture and end use of valves conforming to this standard. The manufacturer shall demonstrate to the user the compatibility of his valves for any specified material, in accordance with 4.5.

4.2.2 The compound from which the valve is manufactured shall conform to the requirements given in table 1.

4.2.3 All additives shall be uniformly dispersed, in accordance with ISO 11420 for carbon black and ISO 13949 for pigments, for instance.

Note - A more precise specification is under study.

Table 1 - Characteristics of the PE compound [1)]

Characteristics	Units	Requirements	Test parameters	Test method
Density	kg/m³	≥ 930 (base polymer)	23 °C	ISO 1183/ISO 1872-1
Melt mass-flow rate		± 20 % of value nominated by compound producer	190 °C	ISO 1133
Thermal stability	minutes	> 20	200 °C	ISO/TR 10837
Volatile content at extrusion	mg/kg	≤ 350		ISO 4437:1997, Annex A
Water content [2]	mg/kg	≤ 300		ASTM D 4019
Carbon black content	% (m/m)	2,0 ≤ .. ≤ 2,5		ISO 6964
Carbon black dispersion [3]	grade	≤ 3		ISO 11420
Pigment dispersion [4]	grade	≤ 3		ISO 13949
Resistance to gas constituents	h	≥ 20	80 °C 2 MPa	ISO 4437:1997, Annex B
Resistance to slow crack growth, e_n > 5 mm	h	165	80 °C, 4,0 MPa [5] 80 °C, 4,6 MPa [6]	ISO 13479

[1] Non-black compounds shall conform to the weathering requirements of ISO 4437.
[2] Only applicable if the compound does not conform to the requirement for volatile content. In case of dispute the requirement for water content shall be acceptable.
[3] Carbon black dispersion for black compounds only.
[4] Pigment dispersion method for non-black compounds only.
[5] Test parameter for PE 80.
[6] Test parameter for PE 100.

4.2.4 Material qualification

The compound supplier shall make available regression data on the compound in the form of a graph plus individually determined points (hoop stress at failure versus failure time). The regression data shall be derived from long-term hydrostatic pressure testing at 20 °C, 60 °C and 80 °C on injection-moulded or extruded pipe, in accordance with ISO/TR 9080.

The PE compound shall be classified by MRS which shall be given and demonstrated by the compound supplier in accordance with ISO 12162.

4.3 Seals

Seals shall be homogeneous and free of internal cracks, inclusions, impurities and constituents which would adversely affect the properties of the materials with which they come into contact to an extent that would prevent conformity to this standard.

Additives shall be uniformly dispersed.

Rubber rings shall conform to ISO 6447.

Other seals shall conform to relevant ISO standards and shall be suitable for gas service. Alternative standards may be utilised in cases where suitable ISO Standards do not exist, provided a fitness for purpose can be demonstrated.

4.4 Lubricants

Lubricants shall not have a deleterious effect on valve components.

4.5 Compatibility

The manufacturer shall demonstrate compatibility of his valves to the user for any specified pipe material by subjecting the joints to the tests given in this specification. The fusion conditions and the fusion tooling to be used shall also be agreed between manufacturer and purchaser.

Note - The publication of an appropriate document relating to the classification of PE as a function of weldability is pending.

5. General requirements for valves

5.1 Appearance

The internal and external surfaces of the valve, when visually examined without magnification, shall be clean and free from defects which might impair its conformity to this standard.

5.2 Design

The valve shall be designed for a maximum service pressure corresponding to SDR 11 pipes conforming to ISO 4437. If applicable, Spigot ends may be adapted to fit SDR 17,6.

For the valve ends, the SDR series correspond to the SDR series of the pipe, in accordance with ISO 4437, with which the valve is intended to be used.

The valve shall not be a rising spindle type.

The full opening and closing positions shall be secured by stops.

5.3 Construction

5.3.1 Body

The body may be manufactured either from one piece or from pieces welded together.

The valve shall be so designed that it cannot be dismantled on site without the use of special tools.

5.3.2 Operating cap

The operating cap shall be integral or connected to the stem in such a way that disconnection is only possible with special equipment. The valve shall be closed by turning the operating cap clockwise.

On quarter turn valves the position of the obturator shall be clearly indicated on the topside of the operating cap.

5.3.3 Seals

The seals shall be so mounted as to be resistant to normally occurring mechanical loads. Creep and cold flow effects shall be taken into account. Any mechanism that puts a loading on any seal shall be permanently locked. Line pressure shall not be relied upon as the sole source of seal loading.

6. Dimensions

6.1 General

Each valve shall be characterised by its dimensions and associated tolerances. The technical data given by the manufacturer shall include assembly dimensions, such as spigot lengths and overall length.

Note - The manufacturer should provide on-site assembly instructions as part of the technical data.

6.2 Wall thickness at any point of the valve body

The wall thickness at any point of the valve body, corresponding to the wall thickness e_y as defined in 3.3, shall be at least equal to the nominal wall thickness of the corresponding SDR 11 pipe series. Any changes of wall thickness shall be sufficiently gradual to prevent stress concentrations.

6.3 Spigot-ended valves

The spigot dimensions shall conform to ISO 8085-2, when measured in accordance with 9.5 of this standard, if applicable.

6.4 Valves with electrofusion sockets

The socket dimensions shall conform to ISO 8085-3, when measured in accordance with 9.5 of this standard, if applicable.

6.5 Operating cap

The operating cap shall be so designed that it can be operated effectively with a 50 mm square socket, 40 mm deep.

The operating cap shall not be damaged by normal valve operation.

7. Mechanical requirements for assembled valves

7.1 General

Before testing, all valves shall be conditioned at 23 °C ± 2 °C for at least 4h.

All tests shall be carried out on valves assembled with straight lengths of pipe from the same series according to ISO 4437, in accordance with the technical instructions and the extreme installation conditions recommended by the manufacturers and with the limit conditions (geometry, ovality, dimensional tolerances of pipe and valve, temperature, fusion characteristics) requested by the purchaser.

The technical description of the manufacturer shall include:

a) field of application (pipe and valve temperature limits, SDR series and ovality);

b) assembly instructions.

For valves with electrofusion ends, this description shall include the fusion instructions (power requirements or fusion parameters with limit). In the event of modification of these welding parameters, the manufacturer shall ensure that the assembled valve conforms to this standard.

Note - The properties of an assembled valve depend on the properties of the pipes and the valve and on the conditions of their installation (geometry, temperature, type and method of conditioning, assembling and welding procedures).

7.2 Hydrostatic strength (shell test)

When tested in accordance with 9.6, the valve assembly shall withstand, at 20 °C and at 80 °C, the pressures and times given in ISO 4437 for hydrostatic testing.

7.3 Leaktightness tests (seat and packing test)

When tested in accordance with 9.7, the valve assembly shall not leak.

7.4 Pressure drop

When tested in accordance with 9.8, the pressure drop shall be determined for an operating pressure of 25 mbar.

The manufacturer shall state in his technical literature the air flow rate (Nm^3/h) corresponding to a pressure drop across the valve of 0,5 mbar for $d_n \leq 63$ and 0,1 mbar for larger diameters.

7.5 Operating torque

The combination of operating torque and obturator design shall prevent operation simply by hand, i.e. the use of some form of operating socket, with or without an ancillary handle, shall be necessary to apply torques conforming to table 2.

The cap shall not be damaged by a valve operated at the maximum applicable torque given in table 2.

When tested in accordance with 9.9, the initiating torque and the running torque shall conform to the applicable limits for the maximum operating torque measured as given in table 2 at a temperature of -20 °C and +40 °C. Measurements at 23 °C shall be permitted for quality control purposes where the requirements of table 2 also apply.

The resistance of the connection between the stem and the obturator shall be at least 1,5 times the maximum value of the maximum operating torque measured in 9.9.

Table 2 - Torque

Nominal outside diameter d_n mm	Minimum stop torque Nm	Maximum operating torque Nm
$d_n \leq 63$	2 times the value of the operating torque measured with minimum 150 Nm	35
$63 \leq d_n \leq 125$		70
$125 < d_n \leq 225$		150

7.6 Stop resistance

When tested in accordance with 9.10, the stops shall resist the minimum stop torque given in table 2 for 15 s, during and at the end of which time the valve shall not leak either externally or internally.

7.7 Leaktightness during and after applying a bending moment to the operating mechanism

When tested in accordance with 9.11, the valve shall not leak.

7.8 Leaktightness and ease of operation after temperature cycling under bending applied via the adjacent pipework for $d_n \leq 63$

When tested in accordance with 9.12, valves with $d_n \leq 63$ shall conform, at -20 °C and +40 °C, with the applicable maximum torque requirement given in 7.5 and with the leaktightness requirements given in 7.3 with bending still applied.

No external leakage under load shall occur.

No leakage shall occur before or after the test.

7.9 Leaktightness and ease of operation after tensile loading

When tested in accordance with 9.13, the valve shall conform, at -20 °C and +40 °C, with the applicable maximum torque requirement given in 7.5.

No external leakage shall occur before or after the test.

The pipe shall yield before the valve is damaged.

7.10 Ease of operation after an impact

When tested in accordance with 9.14, no part of the valve shall crack. The valve shall conform, at -20 °C and +40 °C, with the applicable stop resistance torque requirement given in 7.6.

7.11 Leaktightness and ease of operation after sustained internal hydrostatic pressure testing

When tested in accordance with 9.15, and within 1 h of being depressurised and removed from the test rig, the valves shall conform to 7.10 and 7.3.

8. Physical characteristics

When tested in accordance with the test methods as specified in table 3 using the parameters indicated, the valve shall have physical characteristics conforming to the requirements given in table 3.

Table 3 - Physical characteristics of valves

Property	Requirements	Test parameters		Test method
		Parameter	Value	
Density	≥ 930 kg/m³ (base polymer)	Test temperature	23 °C	9.1
Oxidation induction time (thermal stability)	> 20 min	Test temperature	200 °C (1)	9.2
Volatile content	≤ 350 mg/kg			9.3
Melt mass-flow rate (MFR)	0,2 ≤ MFR ≤ 1,4 g/10 min and after processing maximum deviation of ± 20 % of the value measured on the batch compound	Shall conform to	Condition 18	9.4
Water content (2)	≤ 300 mg/kg			ISO 760
Carbon black content	(2 - 2,5) % by mass			ISO 6964
Carbon black dispersion	≤ grade 3	preparation of test samples	free (3)	ISO 11420
Pigment dispersion	≤ grade 3	preparation of test samples	free (3)	ISO 13949

(1) Test may be carried out at 210 °C providing that there is a clear correlation with the results at 200 °C. In case of dispute the reference temperature shall be 200 °C.

(2) Only applicable if the requirement for volatile content is not conformed to. In case of dispute the requirement for water content shall apply.

(3) In case of dispute, the compression method for the preparation of test pieces shall apply.

9. Test methods

9.1 Density

The density shall be determined in accordance with ISO 1183, using a test sample prepared in accordance with 3.3.1 of ISO 1872-1:1993.

9.2 **Oxidation induction time** (thermal stability)

The thermal stability shall be determined in accordance with ISO/TR 10837, using a test temperature of 200 °C. See also table 3, footnote (1).

9.3 Volatile content

The volatile content shall be measured in accordance with annex A of ISO 4437:1997 or, in case of dispute, in accordance with ISO 760, as mentioned in table 3, footnote (2).

9.4 Melt mass-flow rate

The melt flow rate shall be measured in accordance with ISO 4440-1, applying test condition No.18.

9.5 Measurement of dimensions

The dimensions of the valve spigot/socket, as applicable, shall be measured in accordance with ISO 3126 at a temperature of 23 °C ± 2 °C after being conditioned for at least 4 h. The measurement shall be made not less than 24 h after manufacturing.

9.6 Resistance to internal hydraulic pressure

The test for the internal hydraulic pressure resistance shall be performed in accordance with figure 1a) of ISO 1167:1996 on a valve assembled in accordance with 7.1.

The test pressure shall be applied to each part of the valve which is subjected to line pressure under normal operation.

9.7 Leaktightness tests (seat and packing test)

9.7.1 24 h test

The test shall be performed in accordance with ISO 5208 using air or nitrogen at a pressure of 25 mbar for 24 h.

9.7.2 30 s test

The test shall be performed in accordance with ISO 5208 using air or nitrogen at a pressure of 6 bar for 30 s.

9.8 Pressure drop

The valve shall be tested in accordance with annex A using an air source at a pressure of 25 mbar ± 0,5 mbar.

9.9 Operating torque

The initiating and the running torque shall be measured in accordance with ISO 8233, subject to the following conditions:

a) the test shall be carried out at the maximum operating pressure;

b) the test shall be carried out at the temperatures specified in 7.5, unless otherwise specified by the purchaser.

9.10 Resistance of the stop mechanism

The valve shall be tested in accordance with ISO 8233, using the following conditions:

a) the test pressure, p, shall be the maximum service pressure for which the valve is intended;

b) the first test temperature, T_1, shall be +40 °C;

c) the test period, t, under pressure shall be 24 h;

d) the test torque shall be the minimum stop torque specified in table 2;

e) the second test temperature, T_2, shall be -20 °C.

9.11 Leaktightness during and after applying a bending moment to the operating mechanism

The valve shall be tested in accordance with annex B, using the following conditions:

a) the bending moment, M, shall be 55 Nm;