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Polyethylene (PE) valves for gas distribution systems

Robinets en polyéthylène (PE) pour distribution de gaz

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Foreword

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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 13479:1997	*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:–[1]	*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/m^3	≥ 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
$d_n \leq 63$ $63 \leq d_n \leq 125$ $125 < d_n \leq 225$	2 times the value of the operating torque measured with minimum 150 Nm	35 70 150

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;

b) the first test pressure, p_1, shall be 25 mbar;

c) the second test pressure, p_2, shall be 6 bar;

d) the minimum periods under sustained pressure, before or after removal of the bending moment, whenever otherwise testing in accordance with 9.7.1, shall be 1 h.

9.12 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 annex C, using at least two valves where relative to the plane of bending, one is tested in accordance with C.3.1 (radiating spindle) and the other in accordance with C.3.5 (perpendicular spindle), using the following conditions:

a) the radius of bending at the centreline of the pipes in the test piece assembly shall be 25 times the mean outside diameter of the pipe;

b) the upper temperature, T_1, shall be +40 °C ± 5 °C;

c) the lower temperature, T_2, shall be -20 °C ± 5 °C;

d) the test periods, t_1 and t_2, at constant temperature shall each be 10 h;

e) the total number of thermal cycles each in accordance with C.3.2 shall be 50.

9.13 Leaktightness and ease of operation after tensile loading

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

a) the longitudinal tensile stress, σ_x, in the connected pipe wall shall be 12 MPa;

b) the internal pressure, p, shall be 25 mbar;

c) the period, t, for which the tensile force is maintained steady shall be 1 h;

d) the rate of extension between the grips (D.1.2) shall be 25 mm/min ± 1 mm/min.

9.14 Ease of operation after an impact

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

a) the total mass, m, of the striker shall be 3,0 kg;

b) the height of fall of the striker shall be 1 m;

c) the valve shall be supported rigidly at equal distances from the point of impact, but the maximum distance shall be equal to the length of the shorter outlet, so that the point of impact on the valve is the least supported point on the valve cap;

d) the conditioning temperature, T_c, shall be -20 °C ± 2 °C;

e) the conditioning time, t_c, shall be 2 h minimum;

f) the test temperatures shall be as follows:

   1) for testing in accordance with E.4.2, see E.4.2;

   2) for torque testing in accordance with 9.9 and 9.10, the test temperatures in each case shall be

   -20 °C and +40 °C (see 7.10).

9.15 Leaktightness and ease of operation after sustained internal hydrostatic pressure testing and impact

An even number of valves shall be tested in accordance with annex F, whereby half the valves shall be tested in the closed position and the remainder in the open position, using in each case the following conditions:

a) the pressurising medium and the surrounding liquid shall both be water (water-in-water test);

b) the test temperature, T, under hydrostatic pressure shall be +20 °C ± 1 °C;

c) the hydrostatic pressure, p, shall be calculated from the σ value. The value to be considered is the nominal σ for the MRS class of the final compound used to manufacture the valve body;

d) the test period, t, under hydrostatic pressure shall be 1000 h minimum.

10. Marking

At least the following details shall be permanently and durably affixed to or moulded into the valve:

a) the name or trademark of the manufacturer;

b) the code of the PE (compound) for the composition or grade;

c) the nominal outside diameter d_n (see 3.1);

d) the SDR series (see 3.4);

e) the traceability code for the valve and its components;

f) a reference to this ISO standard.

The information in item f) may be marked directly on the valve, on a plate/label attached to the valve or on the packaging.

All marking shall remain legible under normal handling, storage and installation procedures as specified in ISO/TR 10839-1. The method of marking shall not prevent the valve from complying with this standard. There shall be no marking on the minimum spigot length.

11. Protection

The valves shall be packaged in bulk or individually protected where necessary in order to prevent deterioration. Whenever possible, they shall be placed in plastic bags, in cardboard boxes or in cartons.

The cartons and/or plastic bags shall bear at least one label with the manufacturer's name, the type and dimensions of the part, the number of units in the box, and any special storage conditions and storage time limits.

Annex A (normative)

Determination of gas flow rate/pressure drop relationships

A.1 Principle

This annex specifies a method for determining the flow rate/pressure drop relationship for valves when tested using air at 25 mbar.

The data obtained may be used to calculate the flow rate of gases for a specified pressure drop.

Utilising a constant pressure, the flow rate through the valve is varied between specific limits to assess the pressure drop. The average value of the pressure drop/air flow rate, appropriate to the size of the valve, is then determined for the gas used. The value for other gases may be calculated on the basis of density differences.

A.2 Apparatus

A typical layout of the test rig is shown in figure A.1, with the positions of the pressure tappings. The main components are the following:

a) a source of air sufficient to sustain the specified test system pressures and flow rates;

b) a pressure controller (A) capable of maintaining an output pressure of 25 mbar ± 0,5 mbar;

c) a flow meter (B) accurate to ± 2 % and of the positive displacement or turbine type;

d) a manometer (C) for measuring the air pressure in the main line, and capable of checking conformity with the requirements of this annex and with an accuracy of class 0,6 or better;

e) a manometer (G) for measuring pressure differences, Δp, conforming to class 0,2;

f) an outlet valve (E) located at the downstream end of the pipe and capable of controlling the flow rate.

A.3 Test piece

The valve to be tested shall be fused or connected between two pieces of PE pipe of the same SDR as the valve and provided with connectors appropriate to the pressure drop apparatus.

The free lengths of the PE pipe and the geometry of the test arrangement shall conform to figure A.1.

Pressure tapping points, upstream (p_1) and downstream (p_2) of the valve under test, shall be flush with the pipe bore and free from burrs.

A.4 Procedure

Carry out the following procedure at an ambient temperature of 23 °C ± 2 °C:

a) Partially open the outlet valve (E).

b) Open the inlet valve to the pressure controller (A) so that air starts to flow, and ensure that the air flows from the outlet valve only.

c) By means of the pressure controller (A), regulate the line pressure, p_1, in the main line at manometer C to 25 mbar ± 0,5 mbar.

d) Measure and record the flow rate, Q, on flow meter B and the pressure drop, Δp, on manometer G, where Δp equals p_1 minus p_2.

e) Open the outlet valve (E) such that the air pressure, p_1, in the main line is reduced at manometer C by approximately 5 mbar.

f) Increase the flow until the air pressure in the main line at C returns to 25 mbar ± 0,5 mbar.

g) Measure and record the flow rate, Q, and the pressure drop, Δp.

h) Repeat operations e), f) and g) until the outlet valve (E) is fully open, and ensure that pressure drop readings for velocities between and including 2,5 m/s and 7,5 m/s have been measured and recorded. At least 5 measurements between the specified limits shall be recorded.

A.5 Calculation of results

Using each of the sets of pressure drop values and the corresponding flow rates obtained in accordance with clause A.4 (at least 5 values), calculate the following:

The velocity, V, of the flow, in m/s, through the outlet pipe component of the test piece, using the following equation:

$$V = \frac{Q}{A}$$

where

Q is the air flow rate, in cubic metres per second (m^3/s);

A is the area of the outlet pipe bore, in square metres.

If the following conditions are fulfilled:

1. at least five sets of data and hence differing values for V have been obtained;
2. at least one value of V is $\leq$ 2,5 m/s;
3. at least one value of V is $\geq$ 7,5 m/s;

consider the data acceptable.

Otherwise:

4. adjust the inlet valve opening and repeat c) and d) as necessary to obtain the missing value(s);
5. if it is not possible for V to be $\geq$ 7,5 m/s using a pressure of 25 mbar ± 0,5 mbar, stop the test and report this observation.

Calculate the factor F for each set of readings, using the following equation:

$$F = \frac{\Delta p}{Q^2}$$

where

Δp is the measured pressure drop, in millibars;

Q is the air flow rate, in cubic metres per hour (m^3/h).

Calculate the average value of *F*.

Using the average value of *F* and the specified pressure drop, Δp, calculate the average air flow rate, Q_a, at that pressure drop.

Calculate the equivalent flow rate for any other gas (e.g. natural gas) in cubic metres per hour. Correct each flow rate using the following relationship:

$$Q_{gas} = Q_a \frac{\rho_{air}}{\rho_{gas}}$$

where

Q_a is the average air flow rate at the relevant pressure drop, in cubic metres per hour;

ρ_{air} is the density of air at 23 °C and 1000 mbar;

ρ_{gas} is the density of any other gas at 23 °C and 1000 mbar.

A.6 Test report

The test report shall include the following information:

a) a reference to this method of test, i.e. annex A of ISO 10933:1997;

b) full identification of the valve, including manufacturer, production date and size(s);

c) the ambient temperature;

d) the pressure drop and flow rate and corresponding velocity for each set of data measured;

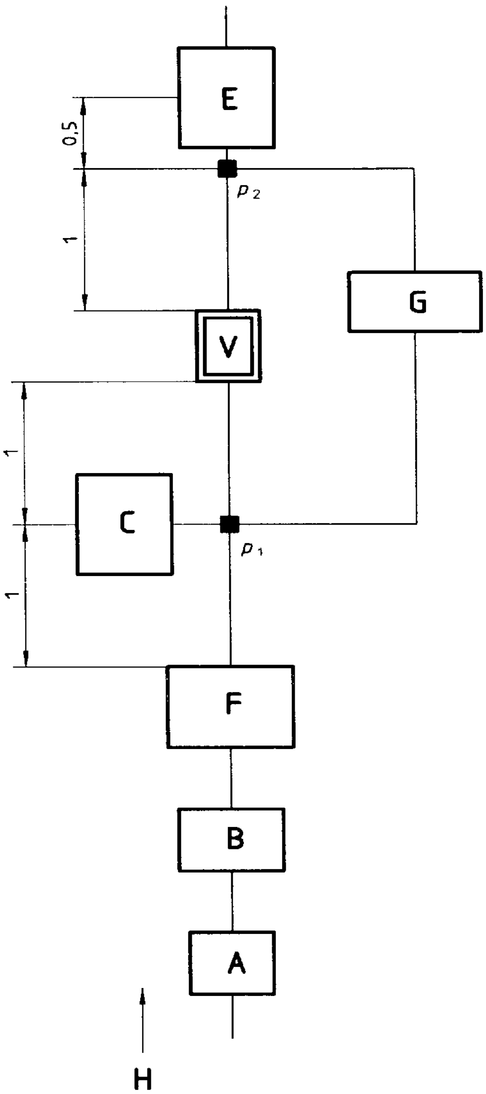
e) the average value of *F*, i.e. the relationship between pressure drop and flow rate;

f) the calculated flow rate(s) at the specified pressure drop(s) for air and gas;

g) any factors which may have affected the results, such as any incidents or any operating details not specified in this standard;

h) the date of the test.

Dimensions in metres



Key:

A Pressure controller
B Flow meter
C Pressure manometer
E Outlet valve
F Reservoir
G Differential pressure manometer
V Valve under test
H Flow

Figure A.1 - Typical pressure loss test rig

Annex B (normative)

Test method for leaktightness during and after applying a bending moment to the operating mechanism

B.1 Apparatus

The apparatus shall provide means for holding the valve body still while connected to a pressure source suitable for leaktightness testing in accordance with 9.7 and while the apparatus applies a sustained specified bending moment, M, at the most demanding position on the valve operating mechanism, with that mechanism in the half-open position.

Note - It is necessary to be able to pressurise the valve from each end in turn (see B.3.4).

B.2 Test piece preparation

Provision shall be made to pressurise any bonnet or body cavity which is not pressurised with the valve in the half-open position. If necessary, such provision shall be reversible on completion of the test.

B.3 Procedure

B.3.1 Mount the test piece in the apparatus (B.1), set the operating mechanism to the half-open position and apply the specified bending moment, M (55 Nm; see 9.11), at the most demanding position on the mechanism. Apply the specified test pressure, p_1 (25 mbar; see 9.7.1), and test for leaktightness in accordance with 9.7.1 except that the test period, t_1, shall be reduced to 1 h. Record any observations of leakage and otherwise maintain the pressure and proceed to B.3.2.

B.3.2 Remove the bending moment and maintain the internal pressure for a further 1 h, while checking the valve for leakage. Record any observations of leakage and otherwise maintain the test pressure and proceed to B.3.3.

B.3.3 Adjust the operating mechanism to the fully closed position and test for leaktightness in accordance with 9.7.1 except that the test periods shall be 1 h.

B.3.4 Keeping the operating mechanism closed, vent the valve and reapply the specified test pressure via the opposite end of the valve. Test for leaktightness in accordance with 9.7.1 except that the test period shall be 1 h. Record any observations of leakage and otherwise proceed to B.3.5.

B.3.5 Repeat once the procedures of B.3.1 to B.3.4 except that the leaktightness tests shall be conducted using test pressures, p_2, and test periods, t_2, in accordance with 9.7.2 (i.e. using a test pressure of 6 bar and a test period of 30 s in place of 25 mbar and 1 h, respectively).

B.4 Test report

The test report shall include the following information:

a) full identification of the valve under test;

b) a reference to this test method, i.e. annex B of ISO 10933: 1997;

c) any observations of leakage and the corresponding operating mechanism position(s) (half-open or closed) and test pressure(s);

d) any conditions or incidents not detailed by this test method and which may have affected the results;

e) the date of the test.

Annex C (normative)

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

C.1 Apparatus

C.1.1 A frame capable of inducing a bend of a constant specified radius in a test piece assembly by applying forces, and supports to induce three-point bending, as indicated in figure C.1.

C.1.2 A temperature-controlled air space capable of varying the temperature between specified limits, T_1 and T_2, and maintaining the limiting temperatures within ±5 °C for specified periods, the point of temperature sensing being within the valve under test.

C.1.3 The arrangements for C.1.1 and C.1.2 shall permit the use of torque application tools and allow pressurised system connections to be applied to the test piece for testing in accordance with 9.9 and 9.7.

C.2 Preparation of test pieces

The valve under test shall be assembled in accordance with 7.1 using two pipes of sufficient length to enable the test piece to be mounted in a frame in accordance with C.1.1 and figure C.1. Set the valve in the appropriate operating position (i.e. fully closed: see 9.12).

C.3 Procedure

C.3.1 Mount the test piece in the frame (C.1.1) so that the test piece is subjected to three-point bending, as shown in figure C.1, with the specified bending radius and with the valve spindle lying along the radius, i.e. in the plane of bending with the operating mechanism at the outer circumference.

C.3.2 Raise the temperature of the air space to the upper limit, T_1, and maintain the temperature for a specified period, t_1, then reduce the temperature of the air space to the lower limit, T_2, and maintain that temperature for a specified period, t_2.

C.3.3 Repeat the temperature cycle specified in C.3.2 until a total of 50 such cycles has been completed.

C.3.4. With the bending still applied and with no intervening operation of the valve, submit the valve to torque testing in accordance with 9.9 and leaktightness testing in accordance with 9.7.1 and 9.7.2 and record the results obtained.

C.3.5 Repeat the procedure in C.3.1 to C.3.4, but using a fresh test piece arranged so that the valve spindle is perpendicular to the plane of bending.

C.4 Test report

The test report shall include the following information:

a) full identification of the valve under test;

b) a reference to this method of test, i.e. annex C of ISO 10933:1997;

c) the bending radius used;

d) the limits, T_1 and T_2, of the temperature cycle;

e) the period(s), t_1, and, if different, t_2, for which the temperature was maintained at each limit of the temperature cycle;

f) for each test piece, the spindle orientation relative to the plane of bending (along the radius or perpendicular) and the associated measured torque values and any observations of leakage;

g) any conditions or incidents not detailed by this test method and which may have affected the results;

h) the dates between which the test was conducted.

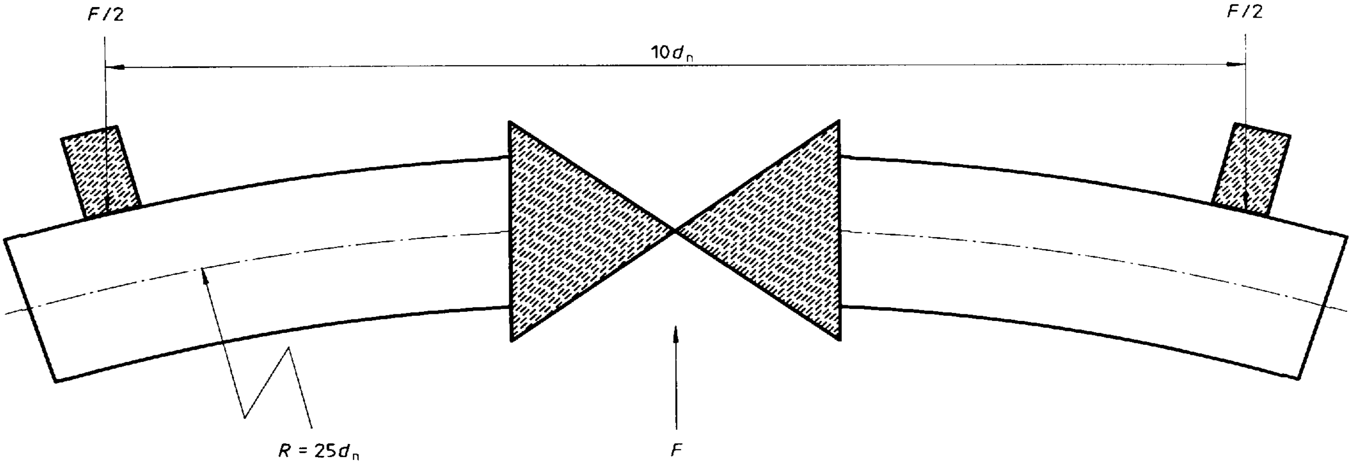


Figure C.1 - Schematic test arrangement for bending moment test

Annex D (normative)

Test method for leaktightness and ease of operation after tensile loading

D.1 Apparatus

D.1.1 A tensile test machine, capable of applying to a test piece, and maintaining for a specified period, *t*, a tensile force corresponding to a specified longitudinal tensile stress, σ_x, in the walls of pipes joined to the valve, and then producing a specified rate of extension until the test piece yields or breaks.

D.1.2 Grips or couplings, to enable the test machine (D.1.1) to apply the appropriate force, directly or via intermediate fittings.

D.1.3 Pressurising equipment, to enable a specified internal pressure, *p*, to be applied via suitable connections to the test piece while it is subject to the tensile force.

D.2 Test piece

The test piece shall comprise the valve under test assembled in accordance with 7.1 between two PE pipes, each of the nominal outside diameter, d_n, and the SDR series with which the valve is designed to be used, and each pipe having a length of either $2d_n$ mm or 250 mm, whichever is the shorter.

D.3 Procedure

D.3.1 While maintaining an ambient test temperature of 23 °C ± 2 °C, mount the test piece in the tensile testing machine and apply the specified internal pressure, *p*, for leaktightness assessment before testing.

D.3.2 Apply an increasing force smoothly until the applicable longitudinal stress, σ_x, is induced in the walls of the pipes in the test assembly.

D.3.3 Maintain the force for the specified length of time, *t*, and then apply the specified rate of extension until the test piece yields or breaks.

D.3.4 Remove the tensile load and, without any intervening operation of the valve, submit the valve to torque testing in accordance with 9.9 and leaktightness testing in accordance with 9.7.1 and 9.7.2 and record the results obtained.

D.4 Test report

The test report shall include the following information:

a) full identification of the valve under test;

b) a reference to this method of test, i.e. annex D of ISO 10933:1997;

c) the dimensions of the pipes used in the test piece;

d) the longitudinal tensile stress, σ_x;

e) the tensile force applied to the test piece;

f) the internal pressure, *p*, applied to the test piece;

g) the period, *t*, for which the tensile force was maintained;

h) any observations of signs of leakage;

i) the results of torque testing in accordance with 9.10;

j) the results of leaktightness testing in accordance with 9.7.1 and 9.7.2;

k) any conditions or incidents not detailed by this test method and which may have affected the results;

l) the date of testing.

Annex E (normative)

Test method for ease of operation and torque resistance after an impact

E.1 Apparatus

E.1.1 A falling-weight impact-testing machine, with means for releasing a striker through a vertical fall of 1 m relative to the point of impact on a valve clamped rigidly to a solid base and aligned in accordance with E.2.

E.1.2 A striker, having a hard hemispherical striking face of 50 mm diameter beneath a tup and/or weight carriage such that the striker has a specified total mass, m.

E.1.3 Clamps, to fit the valve outlets and enable orientation and clamping of the valve rigidly on to the base of the testing machine, in accordance with E.2, and which, if necessary, enable the valve to be moved from the conditioning environment (see E.1.4 and E.3) and struck in accordance with E.4.2.

E.1.4 A temperature-controlled environment, capable of accommodating a valve and its clamps for conditioning and/or access adjacent to or beneath the testing machine (see E.1.1 and E.4).

E.2 Test piece

The test piece shall comprise a complete valve, rigidly secured by both outlets to the clamps (E.1.3) and aligned between the clamps so that, when mounted on the test machine base, the point of impact of the falling striker will comply with 9.14 (i.e. the least supported point on the valve operating cap will be struck).

E.3 Conditioning

Immediately prior to testing, condition the test piece (valve with clamps) at the specified temperature, T_C, for the specified time, t_C.

E.4 Procedure

E.4.1 Set the height of the striker release mechanism relative to the base of the test machine or clamping system thereon so that the height of fall of the striker to impact at the specified position on the valve (see E.2) is $1^{+0{,}005}_{0}$ m.

E.4.2 Within 30 s of removal of the test piece (valve and clamps) from the conditioning environment, if necessary (see E.1.4), or while otherwise maintaining the temperature of the test piece environment at T_C, clamp the test piece onto the base of the machine (E.1.1), release the striker and subject the valve to a single blow.

E.4.3 Without any intervening operation of the valve, and in each case using test temperatures in accordance with 9.14, proceed as follows. Test the valve for operating torque in accordance with 9.9 and record the results. If these fail to comply with 7.5, proceed to E.5, otherwise continue by testing for the torque resistance of the stop mechanism, in accordance with 9.10, and record those results.

E.5 Test report

The test report shall include the following information:

a) full identification of the valve under test;

b) a reference to this method of test, i.e. annex E of ISO 10933:1997;

c) the mass and height of fall of the striker;

d) the position of impact on the valve (cap);

e) the conditioning temperature;

f) observations of any signs of fracture;

g) the results of torque testing in accordance with 9.9;

h) the results of stop mechanism testing in accordance with 9.10;

i) any conditions or incidents not detailed by this test method and which may have affected the results;

j) the date of testing.

Annex F (normative)
Test method for leaktightness and ease of operation after sustained internal hydrostatic pressure testing and impact

F.1 Apparatus

F.1.1 Pressurising equipment, enabling the required pressure to be applied gradually and evenly in 60 s and then to be kept constant between +2 % and -1 % for a specified period.

Notes:

1 - The pressure should preferably be applied individually to each test piece. However, the use of equipment enabling the pressure to be applied simultaneously to several test pieces is also permitted if there is no danger of interference when failure occurs (e.g. by the use of an isolation valve or a test based on the first failure in a batch).

2 - It is recommended that a system be introduced which automatically resets the pressure to the specified value when it drops slightly (owing, for example, to swelling of the test piece).

F.1.2 Pressure gauges, capable of checking that the pressure in the test pieces is within the specified limits.

The pressure gauges shall be oil-free to prevent contamination of the test fluid.

F.1.3 Timer, enabling the duration of the pressure application to be recorded up to the moment of failure or the first decrease in pressure, if within the specified test period.

Note - It is recommended that equipment be used which is sensitive to pressure variations due to leaks or a failure and which is capable of stopping the timer and, if necessary, closing the pressure circuit.

F.1.4 Tank, filled with water kept at a specified test temperature, T (see 9.15), to within ±1 °C throughout its working volume.

F.1.5 Supports or hangers, enabling the test pieces to be immersed in the tank (F.1.4) in such a way that there is no contact between them or with the walls of the tank.

F.2 Test pieces

F.2.1 Assembly of test pieces

Each test piece shall comprise a valve assembled with straight lengths of pipe, in accordance with 7.1, such that, if more than one valve is tested simultaneously, the free length of pipe between valves of any type is not less than three times the nominal outside diameter of the pipe (i.e. $3d_n$).

F.2.2 Number of test pieces

At least one valve shall be tested in the open position and the same number in the closed position.

The number to be tested in either position shall be specified by the referring standard and shall be at least sufficient for the tests to be carried out after the applicable period under pressure (see F.3.2).

F.3 Procedure

F.3.1 Application of internal hydrostatic pressure

F.3.1.1 In any convenient sequence, assemble the test pieces, fill each with water, connect them to the pressurising equipment (F.1.1) and immerse them in the water tank (F.1.4) long enough for them to reach the specified temperature, *T*.

F.3.1.2 Apply an increasing pressure smoothly and evenly to achieve the specified pressure, *p*, in 60 s ± 5 s, and maintain that pressure to within +2 % and -1 % for the specified test period, *t*, or until failure of the test piece by leakage or damage (see F.3.1.3). Then depressurise and proceed to F.3.2.

F.3.1.3 If failure occurs in a connecting pipe at a distance of more than one pipe outside diameter, d_n, from any valve under test, disregard the result and repeat the test.

F.3.2 Assessment of ease of operation and leaktightness after impact.

Within 1 h of depressurising, commence testing each valve in accordance with 9.14. Record the results. If these fail to comply with 7.10, 7.5 or 7.6, as applicable, proceed to F.4. Otherwise continue by testing each valve in accordance with 9.7. Record the results and whether or not the valves comply with 7.3.

F.4 Test report

The test report shall include the following information:

a) full identification of each of the valves under test;

b) a reference to this method of test, i.e. annex F of ISO 10933:1997;

c) the test pressure, test temperature and period of application of internal hydrostatic pressure;

d) any incidence of leakage of damage while under hydrostatic pressure, including failures causing repeat testing (see F.3.1.3);

e) any incidence of cracking or other damage caused by impact testing in accordance with 9.14;

f) the test conditions and results of testing for operating torque in accordance with 9.9, and compliance or otherwise with 7.10 and 7.5;

g) the test conditions and results of testing for stop resistance in accordance with 9.10, and compliance or otherwise with 7.10 and 7.6;

h) the test conditions and results of testing for leaktightness in accordance with 9.7, and compliance or otherwise with 7.3;

i) any conditions or incidents not detailed by this test method and which may have affected the results;

j) the dates between which testing was conducted.

Annex G
(informative)

Bibliography

[1] ISO 161-1:1996, *Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series.*

[2] ISO 4065:1996, *Thermoplastics pipes — Universal wall thickness table.*

ICS 75.200; 83.140.30

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