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Plastics piping systems — Polyolefin pipes and mechanical fitting assemblies — Test method for the resistance to end load (AREL test)

Systèmes de canalisations en matières plastiques — Assemblages de tubes en polyoléfines et raccords mécaniques — Méthode d'essai de résistance en fin de charge (essai AREL)

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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.

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The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 19899 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 5, *General properties of pipes, fittings and valves of plastic materials and their accessories — Test methods and basic specifications*.

Introduction

The Accelerated Relaxation and End Load test (AREL) was introduced initially in the gas industry product standard for full end-load-bearing mechanical fittings designed for connection to PE gas pipes. Its introduction as a stand-alone test method covering polyolefin pipes provides the opportunity for the method to be used in other application areas.

Plastics piping systems — Polyolefin pipes and mechanical fitting assemblies — Test method for the resistance to end load (AREL test)

1 Scope

This International Standard specifies a method to determine, for mechanically jointed polyolefin pipe and fitting assemblies in sizes of $d_n \leqslant 63$ mm, the effect of component relaxation and creep on the resistance of the assembly to pipe pull out under the long-term application of a constant and longitudinally applied force.

The susceptibility of the polyolefin pipe to stress crack failure initiated by the joint assembly is also examined.

NOTE For sizes $d_n > 63$ mm, the method is under development.

2 Normative references

The following referenced documents are indispensable for the application 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 1167-1, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 1: General method*

ISO 1167-4, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 4: Preparation of assemblies*

ISO 3458, *Assembled joints between fittings and polyethylene (PE) pressure pipes — Test of leakproofness under internal pressure*

3 Terms and definitions

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

3.1
lower confidence limit of the predicted hydrostatic strength
σ_{LPL}
quantity, with the dimensions of stress, which represents the 97,5 % lower confidence limit of the predicted hydrostatic strength at a temperature θ and time t

NOTE 1 The quantity is expressed in megapascals.

NOTE 2 Temperature, θ, is expressed in degrees Celsius and time, t, is expressed in years.

3.2
minimum required strength
MRS
value of σ_{LPL} at 20 °C and 50 years, rounded down to the next smaller value of the R10 series or the R20 series

NOTE The R10 series conforms to ISO 3[1], the R20 series conforms to ISO 497[2].

3.3
standard dimension ratio
SDR
ratio of the nominal outside diameter, d_n, of a pipe to its nominal wall thickness, e_n

4 Principle

A test piece assembly of a polyolefin pipe(s) and a mechanical fitting, suspended in a bath of water or in air at 80 °C is subjected to a constant tensile force, F, applied along the longitudinal axis of the pipe for a defined period of time. The force, F, is then removed and the assembly conditioned to 23 °C before testing for leakage.

NOTE 1 The magnitude of the applied force is intended to simulate the combined effect of internal pressure, thermal contraction and secondary bending effects arising from loss of soil support around the pipe close to the fitting. For sizes $d_n \geqslant 355$ mm, experience has suggested loss of localized soil support is less likely to result in significant longitudinal bending stresses and consequently the applied force has been determined taking into account internal pressure and thermal contraction only.

NOTE 2 The elevated test temperature for fittings containing non-metallic non-polyolefin components can be less than 80 °C in order to avoid transitions in material properties that are non-representative of the in-service application and possible degradation effects.

Any reduction in test temperature should be undertaken in conjunction with an extension in the test period to take account of the time dependent properties of the component parts of the joint.

5 Apparatus

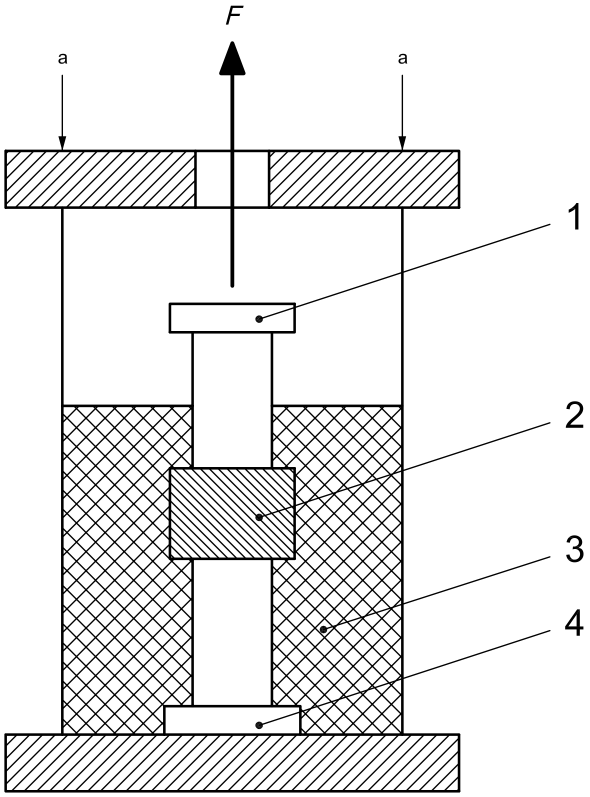
5.1 Tensile loading equipment, capable of applying a constant tensile force along the longitudinal axis of the pipe(s) connected to the mechanical fitting being tested. The force on the pipe shall be accurate to within ±1 % of the indicated force. The tensile force may be applied directly or via a lever arm, using dead weights or a fluid-activated loading cylinder. The test framework, as diagrammatically illustrated in Figure 1, shall be designed to permit the transmission of the applied force from the pipe to the joint and fitting assembly without reduction by frictional losses generated by the supporting structure.

5.2 External environment

5.2.1 Water, contained in a tank, and kept at a constant temperature, as specified by the referring standard, normally 80 °C, with a permissible variation of ±1 °C from the specified temperature. The water shall not contain impurities which could affect the results.

5.2.2 Air, in an enclosure, kept at a constant temperature, as specified by the referring standard, normally 80 °C, with a permissible variation of $^{+2}_{-1}$ °C from the specified temperature.

5.2.3 Circulation, forced. As the results are strongly influenced by temperature, the variation in temperature shall be kept as small as possible within the limits specified in 5.2.1 and 5.2.2, e.g. by using forced circulation of the test fluid. When testing with air, it is recommended that the surface temperature be checked in addition to the air temperature.



Key

F applied longitudinal end load force

1 end load bearing type A end cap

2 fitting to be tested

3 test fluid — water or air

4 end load bearing type A end cap

a End load reaction forces generated within the loading framework.

Figure 1 — Schematic illustration of tensile loading equipment

5.3 Leak test apparatus, to enable the conduct of leakage tests on fitting to pipe assemblies in accordance with ISO 3458, using air, inert gas or water as the pressurizing medium at an ambient temperature of (23 ± 2) °C and pressures of 25 mbar[1)] and 1,5 times nominal pressure (see Clause 7).

NOTE Nominal pressure for gas applications is MOP and for water, P_N.

6 Test piece

The test piece shall comprise a polyolefin pipe or pipes connected to a mechanical fitting conforming to ISO 1167-4. Type A end caps, as specified in ISO 1167-1, shall be attached to the pipe(s). The free length of pipe between the fitting and the terminating end caps shall be at least 100 mm or twice the nominal pipe diameter, d_n, in millimetres, whichever is the greater value, with a maximum of 250 mm. The end caps shall be capable of withstanding the applied tensile force and maintaining pressure during the leak test.

1) 1 mbar = 100 Pa.

7 Procedure

Assemble the fitting and end caps to the test pipe(s) in accordance with the manufacturer's assembly instructions. Mount the assembled test piece in the loading frame taking care to avoid distortion or frame-induced loading of any of the fitting components.

Place the test piece assembly in the external environment operating under the conditions specified in 5.2 and condition the test piece at the test temperature in accordance with the requirements for conditioning given in ISO 1167-1. In cases of dispute, the external environment shall be water.

After the test piece has been held for the required conditioning time at the test temperature, apply the end load force within ±2 % of the values specified in Annex A for $d_n \leqslant 250$ mm and ±5 % for $d_n > 250$ mm. Apply the force gradually within a time period of (5 ± 1) min and avoid shock loading of the test piece. Maintain the applied force for a minimum of 500 h. In cases where the referring standard specifies performance requirements at temperatures other than 80 °C, the tolerances on temperature, applied load and test duration contained in this International Standard shall apply.

Unload the test piece and immediately implement the following consecutive procedure, avoiding delays between each procedural element:

a) condition the test piece for 24 h at (23 ± 2) °C;

b) conduct a leaktightness test in accordance with ISO 3458 at a test pressure of 25 mbar;

c) conduct a second leaktightness test at 1,5 times nominal pressure (see 5.3).

Air or inert gas shall be used as the test medium for fittings intended for gas applications up to a leak test pressure of 8 bar subject to national safety regulations. The test medium for pressures greater than 8 bar shall be water.

At the end of each stage of the leaktightness test before depressurising, inspect the test piece and record the position of any leakage.

Test times less than 500 h are permitted in conjunction with appropriate changes to the applied load, provided correlation with the 500 h performance is demonstrated.

8 Test report

The test report shall include the following information:

a) a reference to this International Standard, i.e. ISO 19899:2010;

b) a complete identification of the fitting and pipe tested including

   1) the test temperature, and

   2) the end load test force;

c) the duration of the test and, if applicable, a description of the failure mode;

d) details of position and mode of any leakage and the associated test pressure;

e) any factors that could have affected the results, such as deviations from temperature limits, any incidents or any operating details not specified in this International Standard;

f) the date of the test.

Annex A
(normative)

End load forces for PE 80 pipes and PE 100 pipes

End load forces for PE 80 pipes and PE 100 pipes shall conform to Table A.1 or Table A.2, as applicable.

NOTE For sizes $d_n \leqslant 315$ mm, the applied force is selected to simulate the combined effect of internal pressure, thermal contraction and secondary bending loads. For sizes $315 < d_n \leqslant 630$ mm, the applied force is determined on the basis of internal pressure and thermal contraction only.

The end load force, F, for SDR values other than those given shall be determined by calculation using Equation (A.1):

$$F = K \times \frac{[\text{MRS}] \times d_n^2}{[\text{SDR}]^2} \times ([\text{SDR}] - 1) \tag{A.1}$$

where K is a mathematical constant equal to $4\pi/10^4$ for $d_n \leqslant 315$ mm and $3\pi/10^4$ for $315 < d_n \leqslant 630$ mm.

Table A.1 — PE 80 pipes — End load forces for SDR 11, SDR 17, SDR 17,6 and SDR 26

Nominal diameter d_n mm	**End load force**, F, **for PE 80 pipes** kN			
	SDR26	SDR 17,6	SDR 17	SDR 11
16	—	0,14	0,14	0,21
20	—	0,22	0,22	0,33
25	—	0,34	0,35	0,52
32	—	0,55	0,57	0,85
40	—	0,86	0,89	1,33
50	—	1,35	1,39	2,08
63	—	2,14	2,21	3,30
75	—	3,03	3,13	4,67
90	—	4,36	4,51	6,73
110	—	6,52	6,73	10,1
125	—	8,42	8,70	13,0
140	—	10,6	10,9	16,3
160	—	13,8	14,3	21,3
180	—	17,5	18,0	26,9
200	—	21,6	22,3	33,2
225	18,8	27,3	28,2	42,1
250	23,2	33,7	34,8	51,9
280	29,2	42,2	43,6	65,2
315	36,9	53,5	55,2	82,5
355	35,2	50,9	52,6	78,5
400	44,6	64,7	66,8	99,7
450	56,5	81,8	84,5	126
500	69,7	101	104	155
560	87,5	127	131	195
630	110	160	166	247

NOTE 1 The values given in this table are calculated using Equation (A.1). Note the change of value of K for 355 mm and above.

NOTE 2 For sizes $d_n > 63$ mm, the values are given for information, as the method is under development for these sizes.

Table A.2 — PE 100 pipes — End load forces for SDR 11, SDR 17, SDR 17,6 and SDR 26

Nominal diameter d_n mm	End load force, F, for PE 100 pipes kN			
	SDR26	SDR 17,6	SDR 17	SDR 11
16	—	0,17	0,18	0,27
20	—	0,27	0,28	0,42
25	—	0,42	0,43	0,65
32	—	0,69	0,71	1,06
40	—	1,08	1,11	1,66
50	—	1,68	1,74	2,60
63	—	2,67	2,76	4,12
75	—	3,79	3,91	5,84
90	—	5,46	5,64	8,41
110	—	8,15	8,42	12,6
125	—	10,5	10,9	16,2
140	—	13,2	13,6	20,4
160	—	17,2	17,8	26,6
180	—	21,8	22,5	33,7
200	—	26,9	27,8	41,6
225	23,5	34,1	35,2	52,6
250	29,1	42,1	43,5	64,9
280	36,4	52,8	54,5	81,4
315	46,1	66,8	69,0	103
355	43,9	63,7	65,8	98,2
400	55,8	80,8	83,5	124
450	70,6	102	106	157
500	87,2	126	130	194
560	109	158	164	244
630	138	200	207	309

NOTE 1 The values given in this table are calculated using Equation (A.1). Note the change of value of K for 355 mm and above.

NOTE 2 For sizes $d_n > 63$ mm, the values are given for information, as the method is under development for these sizes.

Bibliography

[1] ISO 3, *Preferred numbers — Series of preferred numbers*

[2] ISO 497, *Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers*

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