TECHNICAL REPORT

ISO TR 11647

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Fusion compatibility of polyethylene (PE) pipes and fittings

Compatibilité au soudage des tubes et des raccords en polyéthylène (PE)

Reference number
ISO/TR 11647:1996(E)

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.

The main task of technical committees is to prepare International Standards, but in exceptional circumstances a technical committee may propose the publication of a Technical Report of one of the following types:

— type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

— type 2, when the subject is still under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;

— type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art", for example).

Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/TR 11647, which is a Technical Report of type 2, 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*.

This document is being issued in the Technical Report (type 2) series of publications (according to subclause G.3.2.2 of part 1 of the ISO/IEC Directives, 1995) as a "prospective standard for provisional application" in the

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field of fusion-jointing of polyolefin pipes and fittings because there is an urgent need for guidance on how standards is this field should be used to meet an identified need.

This document is not to be regarded as an "International Standard". It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the ISO Central Secretariat.

A review of this Technical Report (type 2) will be carried out not later than three years after its publication with the options of: extension for another three years; conversion into an International Standard; or withdrawal.

Annexes A to D of this Technical Report are for information only.

Introduction

To fuse a PE pipe or fitting to another PE pipe, it is possible to use different fusion methods. For each one, it is necessary to know the values of the important parameters (temperature, pressure, time, etc.).

After consideration of the problem, the ISO working group responsible for studying the fusion compatibility of PE pipes and fittings came to the following conclusions:

a) the nature of the basic PE should be identified by a code marked on the component itself;

b) when selecting the fusion technique to be used, account should be taken of all the codes [see point a)], as well as the compatibility of the components;

c) a method or methods of evaluating the quality of the butt-fused joints should be defined, based upon the properties of the materials themselves.

A classification of the various commercially available materials would be difficult to develop. Classification of the materials by their melt flow rate (MFR) is not acceptable as this classification cannot guarantee good fusion.

However, butt fusion of materials with an MFR between 0,3 g/10 min and 1,3 g/10 min (load 5 kg) can be carried out satisfactorily.

It is difficult enough to assess the quality of jointed pipe/fitting systems manufactured from the same material, since long-term performance is not easily demonstrated without a great deal of testing. To accomplish this with different PE grades and differently designed fittings would be uneconomic and unrealistic.

This Technical Report therefore outlines the possibilities and defines a test procedure to determine compatibility; certain of the methods of test are as yet untried in some countries.

Fusion compatibility of polyethylene (PE) pipes and fittings

1 Scope

This Technical Report gives guidance on methods for the examination of the fusion compatibility of two PE materials when jointed. A basic "material" test using prepared specimens cut from fused pipes is included, plus a type test using static pressure.

This Technical Report applies to all fusion techniques for PE systems.

Compatibility is defined by means of the "material" test and the type tests relevant to each type of joint/application.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Technical Report. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Technical Report 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/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 11413:—[1], *Plastics pipes and fittings — Preparation of test piece assemblies between a polyethylene (PE) pipe and an electrofusion fitting.*

ISO 11414:1996, *Plastics pipes and fittings — Preparation of polyethylene (PE) pipe/pipe or pipe/fitting test piece assemblies by butt fusion.*

ISO 12176-1:—[1], *Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems — Part 1: Butt fusion.*

3 Material compatibility (butt-fusion jointing)

Pipes from the two materials X and Y are butt-fused in accordance with ISO 11414 or, for the purposes of research, using the conditions thought most appropriate. The weld beads may or may not be uniform or meet prescribed dimensions given in a product standard.

Test specimens cut from the pipes, with the joint in the centre of the specimen, are subjected to a static tensile test at 80 °C (e.g. ISO 13952 — see annex A). The two PE materials X and Y are compatible provided the failure time for X/Y specimens is at least that for X/X or Y/Y specimens, whichever is the lower.

The following tests are also recommended:

— ISO 13951 (see annex A);

— ISO 13953 (see annex A) (the ratio of the tensile strength of the joint to that of the weaker of the two pipes shall be $\geq 0{,}9$);

— short-term pressure tests (see annex B);

— long-term pressure tests (see annex B).

1) To be published.

4 Fusion compatibility of fittings

(see table 1)

4.1 Heated-tool fusion

If two materials X and Y are found to be compatible when butt-fused together, this does not necessarily mean they are compatible when pipes made from material X are fused to fittings made from material Y (or *vice versa*) using a different fusion-jointing technique, such as socket fusion, saddle fusion or electrofusion.

To confirm the compatibility of the two materials for all fusion-jointing techniques, the following tests are recommended:

— the mechanical tests (generally short-term) listed in annex A;

— the pressure tests (both short- and long-term) listed in annex B.

A particular type and size of fitting made from material Y is considered to be compatible for fusion with pipes made from material X if it satisfies the requirements of the short-term pressure tests (see annex B) and other tests specified in this Technical Report. Other requirements may also be specified in the relevant product standard, depending on the application.

4.1.1 Butt fusion

Pipes and fittings shall be jointed together in accordance with the procedure specified in ISO 11414, using fusion equipment as specified in ISO 12176-1.

The assembly is then subjected to:

— tensile tests (e.g. ISO 13953 — see annex A);

— static tensile tests (e.g. ISO 13952 — see annex A);

— short-term and long-term pressure tests (see annex B).

4.1.2 Socket fusion

Pipes and fittings shall be jointed together in accordance with a procedure agreed between the interested parties.

The assembly is then subjected to:

— short-term and long-term pressure tests (see annex B);

— cohesive-strength testing (e.g. ISO 13956 — see annex A);

— tensile testing (e.g. ISO 13951 — see annex A).

4.1.3 Saddle fusion

Pipes and fittings shall be jointed together in accordance with a procedure agreed between the interested parties.

The assembly is then subjected to:

— short-term and long-term pressure tests (see annex B);

— impact testing (e.g. ISO 13957 — see annex A);

— cohesive-strength testing (e.g. ISO 13956 — see annex A).

Table 1 — Summary of compatibility tests given in clauses 3 and 4

Tests	Mechanical (see annex A)							Pressure (see annex B)		
	Tensile			Impact	Cohesive strength					
	ISO 13953	ISO 13951	ISO 13952	ISO 13957	ISO 13954	ISO 13955	ISO 13956	Short-term	Long-term	AREL
Heated-tool fusion										
Butt fusion	★	—	★	—	—	—	—	★	★	—
Socket fusion	—	★	—	—	—	—	★	★	★	—
Saddle fusion	—	—	—	★	—	—	★	★	★	—
Electrofusion										
Electrofusion socket	—	★	—	—	★	★	★	★	★	★
Electrofusion saddle	—	—	—	★	—	★	★	★	★	—

NOTE — The table gives the preferred methods. For the cohesive-strength test, the choice of test method is made depending on the design and/or diameter of the fitting. Other tests may be specified in the relevant product standards and can be added to the table above.

4.2 Electrofusion

Evidence has been accumulated indicating that compatibility is more likely between widely different PE materials when electrofusion fittings are used.

Nevertheless, fusion compatibility can still be influenced by design and tolerances.

Confirmation of compatibility is thus recommended.

4.2.1 Electrofusion socket

Pipes and fittings shall be jointed together in accordance with the procedure specified in ISO 11413, using fusion equipment agreed between the interested parties.

The assembly is then subjected to:

— short-term and long-term pressure tests plus the AREL (see annex B);

— cohesive-strength testing (e.g. ISO 13954, ISO 13955 or ISO 13956 — see annex A);

— tensile testing (e.g. ISO 13951 — see annex A).

4.2.2 Electrofusion saddle

Pipes and fittings shall be jointed together in accordance with the procedure specified in ISO 11413, using fusion equipment agreed between the interested parties.

The assembly is then subjected to:

— short-term and long-term pressure tests (see annex B);

— cohesive-strength testing (e.g. ISO 13955 or ISO 13956 — see annex A);

— impact testing (e.g. ISO 13957 — see annex A).

5 Marking

Gas utilities require that their products are marked with a code which indicates the particular PE grade. Some general agreement has been obtained within the gas industry in Europe with respect to these codes (see annex C).

6 Test report

The test report shall include the following information:

a) a reference to this Technical Report;

b) details of the materials being assessed;

c) the type of joint tested;

d) the conditions under which the joint was made;

e) the tests carried out, and the results obtained;

f) details of the failure type, i.e. ductile, brittle or interface;

g) the date(s) of each test;

h) the name of the test laboratory.

Annex A
(informative)

Mechanical tests

The following documents give the preferred mechanical-test methods (some are still in course of preparation).

ISO 13951, *Test method for the resistance of polyolefin pipe assemblies to tensile loading.*

ISO 13952, *Butt-fused polyethylene (PE) pipe joints — Constant-load tensile test in surfactant solution.*

ISO 13953, *Plastics pipes and fittings —Tensile testing of specimens from butt-fused polyethylene (PE) pipe assemblies.*

ISO 13954, *Plastics pipes and fittings — Peel decohesion test for polyethylene electrofusion assemblies.*

ISO 13955, *Plastics pipes and fittings — Crushing decohesion test for polyethylene electrofusion assemblies.*

ISO 13956, *Plastics pipes and fittings — Determination of cohesive strength — Tear test for polyethylene (PE) assemblies.*

ISO 13957, *Plastics pipes and fittings — Polyethylene tapping tees — Determination of impact resistance.*

Annex B
(informative)

Pressure tests

B.1 Short-term pressure tests (100 h at 20 °C)

These tests are carried out in accordance with the relevant product standard. However, temperatures, stresses and times are chosen in accordance with the material classification criterion based on ISO/TR 9080.

B.2 Long-term pressure tests (1 000 h at 80 °C)

These tests are carried out in accordance with the relevant product standard. However, temperatures, stresses and times are chosen in accordance with the material classification criterion based on ISO/TR 9080.

B.3 AREL (accelerated relaxation and end load) test (500 h at 80 °C)

B.3.1 Test specimen

The test specimen shall be assembled in accordance with the manufacturer's instructions. The free pipe length between fittings shall be at least three times the nominal external diameter of the pipe.

B.3.2 Procedure

B.3.2.1 Mount the assembled test specimen in a fixture capable of applying a constant longitudinal tensile load to the assembly.

The assembly shall be held in such a way that distortion or support of any of the fitting components cannot occur.

B.3.2.2 Load the specimen along its longitudinal axis in accordance with table B.1 for 500 h at a temperature of 80 °C ± 2 °C.

B.3.2.3 Subsequently carry out a leak test at a pressure of 25 mbar for 24 h followed by a further 24 h at 6 bar.

For pipes of nominal external diameter 180 mm (SDR17), use a test pressure of 3 bar.

Carry out the test at a temperature of 23 °C ± 2 °C.

B.3.2.4 Finally, test the fitting in accordance with e.g. ISO 13951 (see annex A).

Table B.1 — End loads for SDR11 and SDR17,6

Nominal external diameter of pipe mm	End load for SDR17,6 N	End load for SDR11 N
16	350	430
20	450	560
25	570	730
32	750	960
40	950	1 480
50	1 500	2 300
63	2 350	3 650
75	3 500	5 000
90	5 000	7 500
110	7 000	11 500
125	9 000	14 000
140	11 500	18 000
160	15 500	24 000
180	19 000	29 500
200	24 000	37 000
225	31 000	47 000
250	37 000	57 000
280	48 000	72 000
315	58 500	90 000
355	74 000	115 000
400	94 000	146 000
450	124 000	186 000
500	147 000	227 000