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Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems —

Part 1:
Butt fusion

Tubes et raccords en matières plastiques — Appareillage pour l'assemblage par soudage des systèmes en polyéthylène —

Partie 1: Soudage bout à bout

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 committe 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 12176-1 was prepared by Technical Committee ISO/TC 138, *Plastics pipes, fittings and valves for the transport of fluids*, Subcommittee SC 4, *Plastics pipes and fittings for the supply of gaseous fuels.*

ISO 12176 consists of the following parts, under the general title *Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems*:

— *Part 1: Butt fusion*

— *Part 2: Electrofusion*

— *Part 3: Operator's badge*

Annex A forms an integral part of this part of ISO 12176.

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Plastics pipes and fittings — Equipment for fusion jointing polyethylene systems —

Part 1:
Butt fusion

1 Scope

This part of ISO 12176 specifies the performance requirements for equipment for butt fusion jointing of polyethylene (PE) piping systems, using electric heaters.

It is applicable to mechanical and pressure-activated equipment for butt fusion jointing PE pipes and fittings conforming to ISO 4437 and ISO 8085-2.

The normal ambient-temperature range in which the butt fusion machine is intended to operate is –10 °C to +40 °C. Use outside this temperature range will need to be agreed between the user and the supplier of the machine.

Butt fusion machines with an automatic controller are subject to additional requirements as given in annex A.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 12176. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 12176 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 161-1:1996, *Thermoplastics pipes for the conveyance of fluids — Nominal outside diameters and nominal pressures — Part 1: Metric series.*

ISO 4287:1997, *Geometrical Product Specifications (GPS) — Surface texture: Profile method — Terms, definitions and surface texture parameters.*

ISO 4437:1997, *Buried polyethylene (PE) pipes for the supply of gaseous fuels — Metric series — Specifications.*

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 and for use with electrofusion fittings.*

1) To be published.

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

EN 837-1:1996, *Pressure gauges — Part 1: Bourdon tube pressure gauges — Dimensions, metrology, requirements and testing.*

3 Definitions

For the purposes of this part of ISO 12176, the following definitions apply:

3.1 base framework: A self-supporting entity composed of two or more guides and pipe clamps.

It provides the mechanism for heating and fusing the pipes and/or fittings.

3.2 force transmission system: The complete equipment necessary for creating and controlling the movement and forces during planing, heating and fusion.

3.3 frictional resistance of the basic butt fusion machine: The force necessary to overcome friction in the whole mechanism (see 6.1).

3.4 frictional resistance during the fusion cycle: The sum of the frictional resistance of the basic butt fusion machine and the friction due to the weight of the length of pipe fixed in the moveable clamp at the point at which movement of the moveable clamp is initiated (peak drag).

3.5 peak drag: The friction at the point at which movement is initiated.

3.6 dynamic drag: The friction occurring during movement.

3.7 nominal outside diameter, d_n: The nominal outside diameter of the pipe as specified in ISO 161-1.

3.8 drag compensation: The ability of the butt fusion machine to overcome mechanical and frictional forces, as well as forces caused by operating on site, in order to achieve and maintain the fusion parameters specified for the pipe.

4 Basic concept

To conform to the requirements of this specification, butt fusion machines may have different design configurations, as follows :

— manual with a mechanical linkage system for force generation;

— a hydraulic hand-pump system for force generation;

— a semi-automatic externally powered system for force generation;

— a fully automatic system that controls and records fusion parameters.

Machines are generally designed for well defined ranges of diameters and SDR ratios.

Each component of the machine shall conform to relevant national safety regulations.

5 Chassis and clamps

5.1 General

The butt fusion equipment shall be as maintenance-free as possible.

The base framework of the butt fusion machine shall provide rigidity and stability without unnecessary weight.

The butt fusion machine shall be sufficiently robust to withstand normal field use.

The chassis shall provide facilities for the alignment of and relative movement between pipes and/or fittings.

The butt fusion machine shall incorporate a facility for supporting the heating plate and planing tool when in use. This support shall not affect transmission of interface forces across the heating plate and shall not prevent proper alignment of the heating plate during the heating operation.

The butt fusion machine shall be capable of making satisfactory joints at ambient temperature and under normal worksite conditions with pipes and fittings at extremes of dimensional tolerances.

With butt fusion machines designed for use in narrow trenches, the basic design and construction of the clamps shall enable the machine to be removed from the trench after fusion without damaging the PE pipe.

The base framework shall be fitted with a minimum of two clamps, one fixed and one moveable, to position the PE pipes during the fusion cycle. These clamps shall be designed to enable the pipes to be positioned or removed quickly.

The clamps shall grip the circumference of the pipes and fittings and shall be designed and dimensioned to avoid damage to the pipe or fitting surfaces. The leading faces of the clamps shall be flat and perpendicular to the clamp centreline, and no part of the clamping mechanism shall protrude beyond these faces. Clamps and clamp inserts shall be symmetrical in shape.

NOTE 1 For safety reasons, the clamp jaws should preferably be designed so that they cannot close to less than a certain minimum distance apart.

No adjustment of the centreline of either pipe shall be required after changing the relevant parts to accommodate different pipe sizes. The clamps, inserts and liners shall not damage the pipe or fitting.

NOTE 2 Clamps and/or liners for each pipe size should preferably be interchangeable between similar machines made by the same manufacturer.

The maximum number of removable clamping layers shall be two for machines for pipe diameters up to and including d_n = 400, and a maximum of three for machines for pipe diameters above d_n = 400.

Operating instructions shall be available.

5.2 Performance

5.2.1 The design of the butt fusion machine shall allow the heating plate to be removed and the pipe ends to be closed after heating, without damaging the heated surfaces, within a time of (3 + 0,01d_n) s, with a maximum of 6 s for diameters up to and including d_n = 250 and a maximum of 12 s for diameters above d_n = 250.

5.2.2 The clamp alignment system shall provide the necessary frictional resistance to resist the jointing forces at extreme temperatures and shall have a re-rounding action on the pipe such that any out-of-roundness at the pipe end does not exceed 5 % of the pipe wall thickness and any mismatch of the pipe ends does not exceed 10 % of the wall thickness, when the test for out-of-roundness is carried out in accordance with 10.1.1

5.2.3 The clamp support and bearing system shall be sufficiently rigid to maintain axial alignment to within 0,2 mm over its entire length of travel when tested in accordance with 10.1.2.1.

5.2.4 Misalignment of supported pipes shall not exceed 0,5 mm when tested in accordance with 10.1.2.2. With the pipe supports removed, additional bending of the butt fusion machine chassis and clamps shall not result in additional misalignment. An example of the additional misalignment for SDR 17,6 is given in table 1.

Table 1 — Pipe size versus additional misalignment for SDR 17,6 pipes

Nominal outside diameter of pipe, d_n	**Maximum additional misalignment** mm
$\leqslant 250$	1
315	2
400	3
500	4
630	5

5.2.5 Using two rigid metal cylinders in the machine instead of pipes, the maximum gap on closing the cylinder ends together, under the conditions specified in 10.1.3. and 10.2, shall not exceed:

0,3 mm for $d_n \leqslant 250$ mm;

0,5 mm for 250 mm $< d_n \leqslant 400$ mm;

1,0 mm for $d_n > 400$ mm.

5.2.6 The guide elements and work-holding fixtures shall be designed in such a way that, together, they ensure that the values given in table 2 (measured on cold jointing surfaces) are not exceeded under the stress of bending and flexure, in the respective working range of the machine at the maximum working pressure, with the widest part of the pipe in the most unfavourable place.

Table 2 — Maximum gap

Nominal outside diameter of pipe, d_n	**Maximum gap between pipe ends** (measured between Sp1 and Sp2) (see figure 4)
$d_n \leqslant 250$	0,25 mm
$250 < d_n \leqslant 630$	0,5 mm

The tests shall be carried out in accordance with 10.3.4.

6 Interface force transmission

6.1 General

All types of operating system are acceptable (e.g. manual, hydraulic, pneumatic, electric), provided they meet the requirements of this part of ISO 12176.

Pipe-to-pipe interface forces generated during the jointing cycle shall either be measured directly or, alternatively, means shall be provided to determine the interface force indirectly from the measurement of appropriate machine-operating parameters which take into account the force transfer efficiency and frictional resistance of the machine.

In the case of machines with fluid power rams, the force may be indicated in terms of the applied cylinder pressure.

For such machines, a specific calibration table shall be provided that gives the relationship between the real interface force and the pressure indicated by the manometer (pressure gauge). The pressure gauge shall be calibrated. The accuracy class of the pressure gauge shall be 1,0 as defined in EN 837-1.

6.2 Manual systems

Mechanically operated equipment shall have the following features:

— the moving clamp shall be capable of continuous and steady displacement;

— a system for verifying the forces applied during the fusion cycle;

— a locking system to maintain the fusion force.

6.3 Hydraulic and pneumatic systems

The butt fusion machine shall be capable of maintaining the required interface pressure throughout each stage of the jointing cycle. Where the fluid pressure is generated by a manually operated pump, the pump shall be capable of single person operation to meet all force and time requirements of the jointing cycle for the range of pipe sizes for which the butt fusion machine is designed.

The hydraulic system shall be capable of exerting the required force on the pipe or fitting ends as long as necessary.

The pressure indication display shall be clear and easily readable from a normal working distance.

The hydraulic system shall be protected against overpressure.

National standards shall apply for the construction of pressure vessels.

6.4 Electric systems

The butt fusion machine shall be capable of maintaining the required interface force throughout each stage of the jointing cycle.

The electric system shall be capable of exerting the required force on the pipe or fitting ends as long as necessary.

The force indication display shall be clear and easily readable from a normal working distance.

National standards shall apply for the construction and safety of electric systems.

6.5 Performance

The butt fusion machine shall be capable of drag compensation such that the net force applied to the pipe ends will be within 20 % of the specified fusion force.

For diameters up to and including d_n = 250, the frictional resistance of the basic butt fusion machine shall not exceed 20 % of the calculated fusion force for the maximum pipe diameter and wall thickness, with a maximum of 800 N.

For diameters above d_n = 250 and up to and including d_n = 630, the frictional resistance of the basic butt fusion machine shall not exceed 20 % of the calculated fusion force for the maximum pipe diameter and wall thickness, with a maximum of 1 200 N.

The maximum permitted variation, with the moving clamp in any position, shall be less than 10 % of the frictional resistance of the basic butt fusion machine.

The chassis, clamps and planing tool design shall ensure sufficient fusion force and travel after planing the pipe and/or fitting ends to assure proper fusion, taking into account the simultaneous action of the various external forces, e.g. drag compensation, frictional resistance, clamp motion.

7 Planing tool

7.1 General

The planing tool shall be a double-sided surface planer, powered by hand or by electrical, hydraulic or pneumatic power, and shall establish clean, flat, parallel mating surfaces of the pipe and fitting ends in preparation for heating.

The design of the planing tool shall ensure that cut material is deflected away from the cut face, the planing tool and the bore of the pipe or fittng. The swarf produced shall be visible to the operator, so that completion of planing can be recognized.

Planing tools shall be interchangeable between any butt fusion machines of the size and type for which they were designed. They shall be suitable for planing the complete range of pipe sizes and materials for which the butt fusion machine is designed.

The planing tool shall operate at right angles to the axis of the pipe.

The cutting blades shall be removable.

Provision shall be made to prevent the planing of the pipe/fitting end beyond the limit needed for a good fusion joint.

7.2 Performance

The planing tool shall operate on both sides and produce a smooth cut on each fusion face so that the maximum gap between fusion faces, when measured in accordance with 10.2, shall not exceed that permitted in 5.2.5.

8 Heating plate

8.1 General

The heating plate shall establish a satisfactory melt or molten condition of the pipes and/or fittings ends in preparation for fusion. The heating plate shall be equipped with a temperature control system.

Heating plates shall be interchangeable between any butt fusion machines of the size and type for which they were designed.

If the heating plate cannot be easily removed during operation by one person for reasons of its weight or other factors, then hydraulic, pneumatic or other mechanical assistance shall be provided as part of the butt fusion machine.

The total heat capacity of the tool shall be such that, if the electrical power supply is accidentally disconnected from the heating plate at the operating temperature, it can still complete a satisfactory joint. If the heating plate is not capable of meeting this requirement, then a foolproof alarm indicating accidental disconnection shall be provided on the butt fusion machine.

The heater system shall be designed to ensure that, under normal ambient conditions, the pipe and/or fitting ends are heated up correctly to the operating temperature and stable fusion conditions are maintained.

8.2 Dimensions

The heating plate shall be of adequate size to ensure good heat transfer to the two fusion ends.

The width *x* of the inside and outside parts of the heating plate (see figure 1) shall be at least 10 mm for pipe diameters up to and including d_n = 250 mm and at least 15 mm for pipe diameters above d_n = 250.

The heating plate shall be flat on both sides to ±0,1 mm/100 mm.

The thickness shall not vary by more than 0,2 mm up to d_n = 250 or by more than 0,5 mm above this size, and the plate shall have no holes or screws within the area of pipe contact.

8.3 Material and surface finish

Heating plates shall be made of materials having good thermal conductivity and shall resist normal site handling.

The surfaces which contact the pipe or fittings shall be such that molten material does not stick to them, and they will allow damage-free cleaning and resist normal site handling. This can be attained, for example, by coating the surface with coloured PTFE (polytetrafluoroethylene) or by other surface treatments. The colour of the PTFE coating shall be such that, after the tool has been used for jointing operations, the presence of any surplus of PE on the plate will be readily visible, regardless of any degradation of the PE or PTFE coating.

No release spray of any type, such as PTFE, shall be used at any time during the jointing cycle. Such a spray coating can be transferred to the fusion interface during the jointing procedure.

Alternatively, the heating plate may be made of hard-chromed or stainless steel.