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Plastics pipes and fittings — Butt fusion jointing procedures for polyethylene (PE) pipes and fittings used in the construction of gas and water distribution systems

Tubes et raccords en matières plastiques — Modes opératoires d'assemblage par soudage bout à bout de tubes et raccords en polyéthylène (PE) utilisés pour la construction de systèmes de distribution de gaz et d'eau

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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 21307 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*.

Introduction

With the increasing use of bimodal polyethylene (PE) materials such as PE 80 and PE 100, more and more PE compounds are appearing on the pipe market accompanied by proposals for butt fusion procedures that often differ for the same materials. The aim of standardization is to encourage the use of similar procedures for similar materials. There is a need to examine on a global scale current practice and then establish the best procedure(s) for the highest quality, most reliable and efficient construction of PE butt fusion systems for gas and water distribution.

Plastics pipes and fittings — Butt fusion jointing procedures for polyethylene (PE) pipes and fittings used in the construction of gas and water distribution systems

1 Scope

This International Standard establishes general principles regarding the process used in the construction and quality assessment of butt fusion joints incorporating fittings (ISO 8085-2) and pipes used in the construction of gas (ISO 4437) and water (ISO 4427) distribution systems, made from PE 80 and PE 100 materials having a melt flow rate at 190 °C/5 kg of between 0,3 g/10 min and 1,7 g/10 min, with equipment which complies with ISO 12176-1 and installed in accordance with ISO/TS 10839. Specifically, this International Standard specifies a number of proven butt fusion jointing procedures for pipes and fittings with a wall thickness up to and including 70 mm. This International Standard takes into consideration the materials and components used, the fusion jointing procedure and equipment and the quality assessment of the completed joint. This International Standard can be applied in conjunction with appropriate national regulations and standards.

NOTE It is important for pipe or fitting and equipment manufacturers to be consulted when undertaking butt fusion jointing of pipes with wall thickness greater than 70 mm.

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 1167-3, *Thermoplastics pipes, fittings and assemblies for the conveyance of fluids — Determination of the resistance to internal pressure — Part 3: Preparation of components*

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 4065:1996, *Thermoplastics pipes — Universal wall thickness table*

ISO 4427 (all parts), *Plastics piping systems — Polyethylene (PE) pipes and fittings for water supply*

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

ISO 8085-2, *Polyethylene fittings for use with polyethylene pipes for the supply of gaseous fuels — Metric series — Specifications — Part 2: Spigot fittings for butt fusion, for socket fusion using heated tools and for use with electrofusion fittings*

ISO/TS 10839, *Polyethylene pipes and fittings for the supply of gaseous fuels — Code of practice for design, handling and installation*

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

ISO 13953, *Polyethylene (PE) pipes and fittings — Determination of the tensile strength and failure mode of test pieces from a butt-fused joint*

3 Terms and definitions

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

3.1
cooling cycle reduced pressure (dual pressure)
reduced pressure, used in the cooling cycle or the dual pressure procedure, after the jointing time has expired

3.2
cooling time in the machine under pressure
time period that the butt fusion joint remains under pressure when still clamped in the machine

3.3
cooling time in the machine without pressure
time period the butt fusion joint remains without pressure when still clamped in the machine and before rough handling or installation

3.4
drag pressure
gauge pressure required to overcome, on a given machine, the sliding frictional drag force of the machine and pipe

NOTE This drag pressure must be added to the bead-up, heating and bead roll-over pressures.

3.5
fusion jointing pressure
actual pressure, including drag pressure, exerted on the pipe or fitting ends during jointing

3.6
gauge pressure
actual pressure read by the gauge of the butt fusion jointing machine

3.7
heater plate removal (dwell) time
time taken for the separation of the pipe or fitting ends from the heater plate, removal of the heater plate and closure of the carriage to bring the molten pipe or fitting ends together

3.8
heater plate temperature
measured temperature on the surface of the heater plate where the pipe or fitting wall cross section makes contact

3.9
heat soak pressure
pressure required to positively maintain the pipe or fitting in contact with the heater plate

3.10
heat soak time
time that the heater plate is in contact with the pipe or fitting ends at the heat soak pressure

3.11
minimum bead size after heating
minimum value of bead size to be attained after achieving the heat soak time

3.12
initial bead-up pressure
pressure exerted on the heater plate by the pipe or fitting ends during the bead-up phase of the jointing cycle, including drag pressure exerted on the pipe or fitting ends during jointing

3.13
initial bead-up time
time taken to generate a continuous bead, of a specified dimension, around the circumference of the ends of the pipes or fittings

3.14
initial bead-up size
bead size formed on the pipe or fitting ends during the bead-up phase

NOTE Initial bead-up size is expressed in millimetres.

3.15
fusion jointing time (dual pressure)
time period allotted for bead roll-over before cooling cycle reduced pressure

3.16
nominal wall thickness
e_n
wall thickness tabulated in ISO 4065, corresponding to the minimum wall thickness at any point e_y

NOTE Nominal wall thickness is expressed in millimetres.

3.17
operator
person authorized to build polyethylene (PE) systems from pipes and/or fittings, based on a written procedure agreed by the pipeline operator

3.18
pipeline operator
private or public organization authorized to design, construct and/or operate and maintain a gas supply system

4 Butt fusion jointing process

4.1 General

PE pipes for the production of butt fusion joints according to this International Standard shall conform to ISO 4437 (alternatively ISO 4427). Fittings shall conform to ISO 8085-2.

Butt fusion joints according to this International Standard shall be produced on equipment for fusion jointing PE systems conforming to ISO 12176-1.

4.2 Principle

The principle of butt fusion jointing is to heat two pipe or fitting ends by means of a heater plate to a designated temperature, then fuse them together by application of pressure and cool them under pressure for a designated time.

Butt fusion joints shall be made by qualified operators using butt fusion jointing machines that secure and precisely align the pipe ends. The training and the level of skill of the operator shall be in accordance with the requirements of the jointing procedure. A written jointing procedure, authorized by the pipeline operator, shall be available prior to the construction of a pipeline. The jointing procedure shall include specification of the

jointing method, the fusion parameters, the fusion equipment, the jointing conditions, the level of skill of the operator, and the quality control methods to be used. Guidelines for quality control are given in Clause 6.

Key elements of the jointing process shall include:

1) cleaning the pipe or fitting ends, planing unit and heater surfaces;

2) clamping the components to be joined; Pipe support may be needed to ensure proper alignment;

3) planing the pipe or fitting ends;

4) aligning the pipes or fittings;

5) measuring the drag and compensating pressure accordingly;

6) melting the pipe or fitting ends;

7) jointing the pipe or fitting ends;

8) holding the pipe or fitting ends under pressure for the cooling time in the machine;

9) completing the cooling time out of the machine.

In 4.3 to 4.10 these key elements are explained in more detail.

4.3 Cleaning the pipe or fitting ends, planing unit and heater surfaces

Clean the inside and outside of the pipe or fitting to be joined by wiping the joint area with a clean lint-free cloth. All foreign matter shall be removed.

If the pipe has a protective outer layer, it shall be peeled back far enough so that the pipe can be properly clamped in the fusion machine, unless the pipe manufacturer has personal specific instructions.

Clean the planing unit and the heater plate surfaces with a clean lint-free cloth.

4.4 Clamping the components

Clamp the components in the butt fusion jointing machine and adjust as necessary to achieve proper alignment. Pipe support may be needed to achieve proper alignment and reduce drag.

4.5 Planing the pipe or fitting ends

Plane the pipe or fitting ends to establish clean, parallel mating surfaces.

4.6 Aligning the pipes or fittings

Remove any shavings from the pipe or fitting ends. Clean the pipe or fitting ends with an alcohol wipe or dry cloth only if required by company, state or national standards.

Inspect the pipe or fitting ends for incomplete planing, voids, or other imperfections, and then bring them together to check for proper alignment. The pipe or fitting ends shall be rounded and aligned to ensure compliance with ISO/TS 10839.

4.7 Measuring drag pressure

Measure the gauge pressure required to overcome the frictional drag force of the machine and the pipe. This pressure shall be added to the calculated bead-up and fusion jointing pressures.

4.8 Melting the pipe or fitting ends

The surface of the heater plate that comes into contact with the pipe or fitting ends shall be clean, oil free and coated with a non-stick coating to prevent molten plastic from adhering to the heater plate surface. The heater plate temperature shall be in the range of 200 °C to 245 °C.

Install the heater plate in the butt fusion machine and bring both pipe or fitting ends simultaneously into full contact with the heater plate to produce molten surfaces for fusion jointing. To ensure that full contact is made between the pipe or fitting ends and the heater plate, the initial contact shall be under a bead-up pressure. After holding the pressure for a specified bead-up time, or until a specified bead-up size has formed, the pressure shall be adjusted to the heat soak interface pressure without breaking contact between the heater plate and the pipe or fitting ends for a period equal to the heat soak time.

4.9 Jointing the pipe or fitting ends

At the completion of the heat soak time, pull the pipe or fitting ends from the heater plate. Then remove the heater plate and bring the molten pipe or fitting ends together in a controlled manner. The joint shall be held at the jointing pressure(s) for the prescribed fusion jointing time(s).

4.10 Cooling the pipe or fitting ends

The molten joint shall be held immobile under pressure in the butt fusion jointing machine for the period of time defined as the cooling time in the machine under pressure. Allowing adequate time under pressure for cooling prior to removal from the machine clamps is important to develop strength and to achieve joint integrity. The jointing pressure shall be maintained until the interface temperature has dropped below the re-crystalline melting temperature of the PE.

Further cooling may take place in the machine without applying fusion jointing pressure or out of the machine.

5 Butt fusion jointing procedures

The following three butt fusion procedures are described in detail in 5.1 to 5.3:

— single pressure and low fusion jointing pressure;

— dual pressure and low fusion jointing pressure;

— single pressure and high fusion jointing pressure.

The dual pressure and low fusion jointing pressure procedure is only applicable for pipes with a wall thickness greater than 20 mm. The choice between a single and dual pressure fusion procedure shall be determined by the pipeline operator. Examples of single and dual pressure and low and high fusion jointing pressure procedures are given in Annex A.

5.1 Single pressure and low fusion jointing pressure

Butt fusion jointing conforming to the single pressure and low fusion jointing pressure procedure shall be performed as specified in Table 1.