Guide to the Selection of Jointing Methods for Polyethylene Pressure Pipes

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1. Introduction

In the trench we face different situations, conditions, or tasks that can be managed in different ways. At times we want to install a new pipe, while in others we just want to repair an existing one. However, we have to bear in mind that not all pipes have the same characteristics and that the available space to work on the trench is usually limited. Therefore, there is always a jointing technique that will be more appropriate or will make the installation easier.

Just to give an example, the two pictures below, show two pipelines with different working conditions. In each case and depending on the application, a different jointing technology will be more suitable.

Fig. 1 - Different Working Conditions

This document aims to provide a general overview of the different jointing techniques and their advantages.

2. Butt Fusion

This welding process is generally applied to PE pipes within the range 40mm to 1'600mm but can be done up to 2'500mm.

A heating plate is used to rise the temperature of the two planed ends of pipes or fittings which are to be joined, until the fusion temperature is reached. Once the PE of the end surfaces is melted, the heating plate is quickly removed and the two surfaces are brought together under controlled pressure for a determined period of time. After the cooling time, a homogeneous and resistant joint is formed (an example of the welding machine is showed on figure 6).

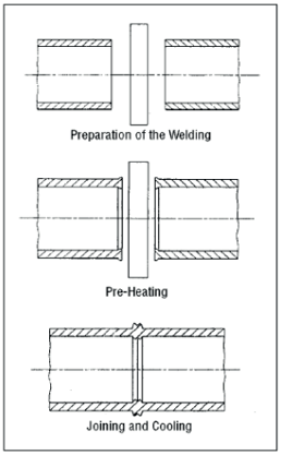


Fig. 2 - Sketch of the Butt Fusion process

Fig. 3 - Section of a Butt Fusion welded joint

Advantages

- Material bonded connection.
- Efficient jointing technology, especially for big diameters.
- No need of extra fittings to connect straight pipes.
- Can be used to joint PE80, PE100 and a combination of both materials, however the use of an electro fusion coupler is recommended for this joint.
- The welding machine facilitates the axial alignment and re-rounding of pipes.
- Fusion bead allows visual quality control (see figure 3).
- No elastomeric sealing needed.

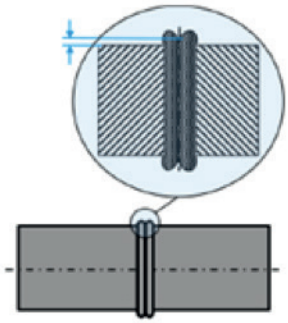


Fig. 4 - Visual quality control of the butt fusion welded joint

Disadvantages

- Pipes/fittings to be joined must have the same SDR (wall thickness).
- Fusion joint has to be protected from adverse weather conditions during installation.
- Time of the whole jointing process.
- Heavy and bulky equipment.
- Various machines are needed to cover different dimensions.
- Cost of the welding machines, especially for big dimensions.

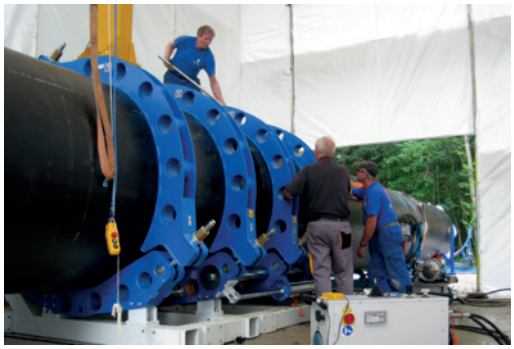


Fig. 5 Big dimension butt fusion welding

Main Applications

- Transmission lines.
- Jointing PE pipes with big diameters.
- Pre-fabrication.
- Installation of pipes over long distances without working space restriction.
- No-dig installations e.g. directional drilling

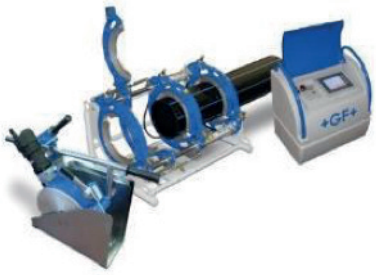
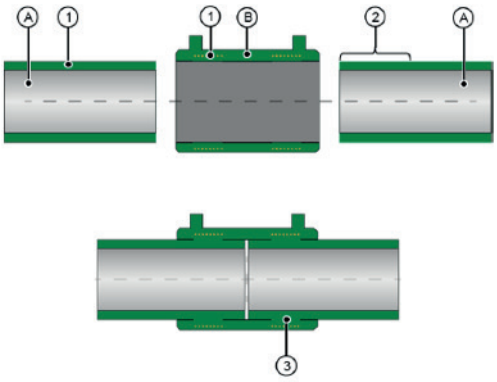


Fig. 6 Butt fusion welding machine

3. Electro Fusion

The method to join PE plastic pipes using electro fusion fittings can be used within the range 20mm to 2000mm. These fittings have an electrical heating element that provides enough heat to melt the PE surface of the fitting and pipe, creating a homogeneous and resistant joint after the cooling time.

The whole welding process is automatically managed through the welding machine with the parameters provided on the bar code of each individual fitting. For more information about electro fusion, please see the TEPPFA Technical Guidance Document – AGU/2014/01: "A Good Practice Guide for the Electrofusion Jointing of Larger Diameter Polyethylene Pressure Pipes".



Nr.	Description
A	Pipe
B	Fitting
1	Jointing area
2	Insertion depth
3	Welded area

Fig. 7 Sketch of electro fusion with a coupler

Fig. 8 Section of two pipes jointed with Electro Fusion

Advantages

- Material connection.
- Does not require large working space in the trench.
- Full-automatic welding process.
- Different wall thickness and PE types can be jointed together.
- Saddle connection can be installed when the main line is in full operation and under pressure.

- No bead at the inner surface of the pipe.
- Light weight and easy to handle machinery.
- Visual welding control through welding indicators (see figure 9).
- Low investment, as one machine can weld various dimensions.
- Slide over version for repair applications.

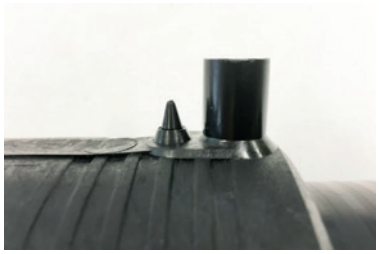


Fig. 9 Welding indicator showing that pressure was applied during the welding process

Fig. 10 Range of electro fusion fittings

Disadvantages

- Fusion joint has to be protected from adverse weather conditions during installation.
- Tooling for pipe preparation is needed.
- The centering of pipes and fittings can be difficult, especially for bigger dimensions.
- The control of the gap between pipe/spigot end and the electro fusion fitting can be challenging, especially for bigger dimensions.

Main Applications

- Transport lines.
- Distribution lines.
- Utilities, pressure discharge sewage systems.
- House connection installations.

Fig. 11. Electro fusion machine welding a big dimension coupler

4. Mechanical connection - Flange joint

The flange connection is the most important mechanical joint. It is used to joint pipes or components such as valves or fittings in a range between 6mm to 2000mm.

The connection is normally assembled with two flange adapters which are joined to the pipes, two backing rings and a flange gasket. The bolts and nuts with washers on both sides, keep the components together and tight.

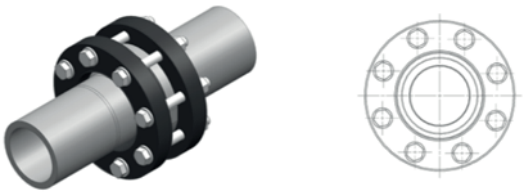


Fig. 12 Flange Adapter

Fig. 13 Components of a Flange Joint

When making a flange joint, it is important to take into consideration the following points:

- The type of seals and flanges should be selected according to the material, pressure, temperature and medium.
- Torque of the bolt tightening.
- Orientation of bolts.

Advantages

- Can be installed under wet conditions.
- No electrical current is needed.
- Disassemble is possible.
- Low tooling investment.

Disadvantages

- Installation time.
- Torque measurement for proper installation.
- Space required for the flange.
- Heavy weight.
- Possible national restrictions in gas applications.
- Metal parts.
- Gasket, not bounded.

Main Applications

- Utility and industry.
- Material transition.
- Connection to fittings.

Fig. 14 Flange connections in the field

5. Mechanical connection - Compression jointing

The mechanical compression jointing technology for pipes uses fittings which have integrated a sealing ring and grip elements.

Fig. 15 Compression Fittings

Before installing a compression fitting, it is important to choose the correct seal and fixing ring according to the application. It varies on the material, temperature, pressure and medium.

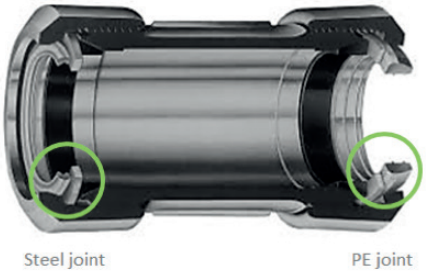


Fig. 16 : Compression fitting that joints a PE with a steel pipe

Advantages

- Fast and easy installation.
- Low cost.
- No threading is necessary.
- Transition from PE to steel pipes is possible.
- Limited pipe preparation.

Disadvantages

- Not as robust as a welded jointing.
- Gasket, not bounded.
- Possible national restrictions in gas applications.

Main Applications

- Water (cold-water, heating) and gas.
- Oil, compressed air.
- Temporary use.
- Bypass, repair.

6. Mechanical connection – wide range (restraint) coupling

Wide range (restraint) couplings joint mechanically two pipes by tightening bolts and compressing a gasket on the pipe surface. The biggest advantage of this product is that it allows connecting all pipe material which have different diameters (for example PVC, Cast iron, (stainless) steel, PE, GRP, AC).

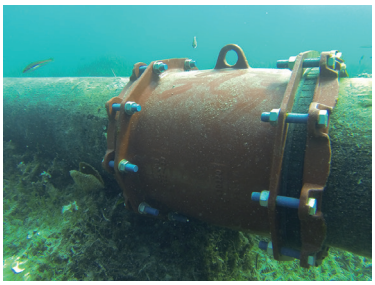


Fig. 17 Wide range restraint coupling connecting two pipes

The most important element of the coupling is the segmented plastic ring which consists of a rubber gasket and grip elements (if required).

When tightening the bolts, the clamp ring presses the plastic segmented ring on the pipe and the body of the fitting. The plastic segmented ring transfers the torque forces on the rubber sealing and gripping segments, assuring leak tightness and a restraint connection.

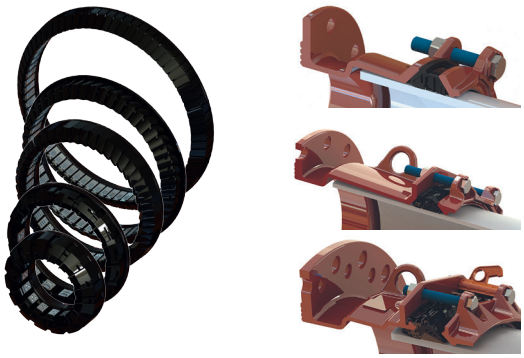


Fig. 18 Sealing System

Advantages

- The quick, safe and simple repair solution.
- Wide range couplings can take a nominal angular deflection of up to 8° per coupling side.
- One coupling DN size connects various pipe diameters and materials (plastic with metal).
- Reusable.
- Applicable for under and above ground use.

Disadvantages

- Weight.
- Possible national restriction in gas applications.

Fig. 19 Wide range restraint coupling used for a pressure test on a branch connection.

Main Applications

- Repair & maintenance, extension, renovation.
- Pressure testing.
- Water, gas, sewage and industrial applications.

Fig. 20 Wide range restraint end caps

7. Mechanical connection - Push fit

The Push fit jointing connects mechanically two pipes just by pushing them into the fitting.

The mechanism of this jointing technology works similar to the one used in a compression fitting but the push fit connection uses a resilient O-ring for sealing and a grip ring to hold the pipe.

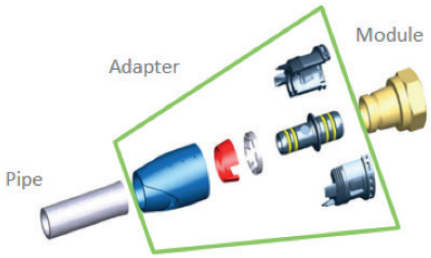


Fig. 21 Components of a Push fit fitting

Advantages

- Easy and fast installation.
- Low investment tooling.
- Disassemble is possible.
- No electrical current needed.

Disadvantages

- Possible national restrictions in gas applications .
- Size limitation.

Main Applications

- Small diameter pipes for drinkable water.
- Irrigation.

8. Overview

On the following table we can find an analysis of some parameters that must be taken into consideration while choosing a jointing technology.

	Butt fusion	Electro fusion	Mechanical connection
Dimension range [1.)]	40mm to 2'500mm	20mm to 2'000mm	6mm to 2'000mm
Investment [2.)]	- -	-	0
Required space [3.)]	- -	+	+
Effect of the environmental conditions [4.)]	-	-	+
Water applications [5.)]	++	++	++
Gas applications [6.)]	++	++	++
Jointing time [7.)]	- -	-	0
Reliability of the joint [8.)]	++	++	0

(Scale: --, -, 0, +, ++. Being "++" the optimal situation and "--" the less advantageous)

1.) Dimension range available for the jointing technology. 2.) Investment required for the use of the jointing technology (includes machines, tools, fittings and spare parts). 3.) Space required to apply the jointing technology. 4.) Effect of the environmental conditions on the joint during the installation (temperature, rain, moisture...). Precautions might be taken. 5.) Jointing technology that can be applied for water applications. 6.) Jointing technology that can be applied for gas applications. 7.) Time needed to do the joint. 8.) Long-term reliability of the joint.