Butt Fusion Principles and Jointing

Polyethylene is a thermoplastic, which can be fusion welded. Butt Fusion undertaken correctly using the correct well maintained equipment and with trained operators will result in producing fully end load resistant pipe joints, which when tested will display the same properties as the parent pipe material.
Butt Fusion welding involves simultaneously heating the two pipe ends by means of an electrically heated plate until a sufficient heat reservoir has been created on the ends of the pipe. The two pipe sections are brought together under a controlled fusion pressure for a cooling period (dependent on the pipe size).

Butt Fusion is a suitable process for the jointing of both PE80 and PE100materials, though only similar materials and wall thicknesses should be welded to each other unlike electrofusion which may be used for jointing dissimilar materials as shown in Figure One.

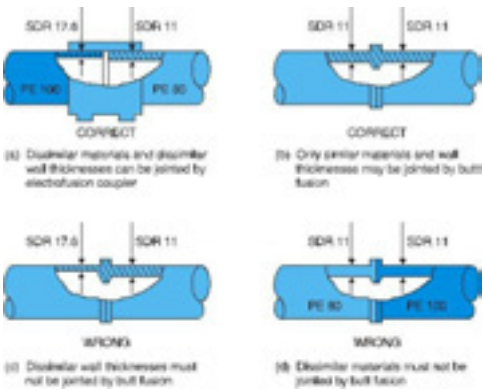

Figure 1

Most of the Butt Fusion welding undertaken in the UK on small and medium pipe sizes is now undertaken using fully automatic Butt Fusion equipment. This negates the need for site operatives to calculate or interpret welding parameters.
Automatic Butt Fusion machines should be programmed with the welding parameters detailed in the current issue of Water Industry Specification 4-32-08 which is the water industry's specification for site fusion jointing of both PE100 and PE80 Blue and Black materials.

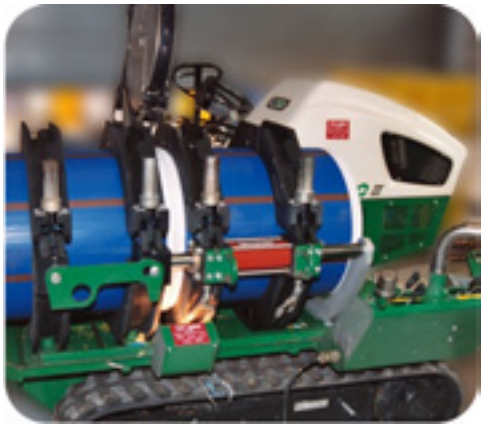

Figure 2

Fusion machines and ancillary equipment may be bought or hired from several manufacturers and agents suitable for welding up to 1200mm pipe diameters. Larger diameter jointing equipment has been produced but is less common.

All reputable manufacturers issue comprehensive literature on the operation procedures of their products.

Pre-Production Checks

Ensure that the welding equipment has been sited on a suitable hard standing which can easily be kept clean.

Check the generator has sufficient fuel for the operation.

Check that the heater plate is free from surface debris, prior to connecting the heater plate to the power source.

The heater plate should be washed thoroughly with copious amounts of water. Only clean lint-free materials shall be used when cleaning and drying the surface heater.

Once connected and the heater plate has reached operating temperature, check the heater plate is within the operating range of 230ºC (+10-5ºC). The heater plate should be checked with a calibrated surface probe.

When the heater is within the operating range dummy or cleaning welds can be produced. Although washing the heater plate removes heavy concentrations of debris, very fine particles may still be present within the hollows of the textured plate surface.

To remove the fine concentrations of surface contaminants from the plate surface, either go through the motions of welding without bring the melted pipe ends together, when cooled re-trim the pipe ends. Alternatively produce welds of short pipe sections of the same size and diameter. For pipes up to and including 180mm diameter one dummy joint should be undertaken. For pipes greater than 180mm two dummy joints / cleaning welds should be undertaken prior to the production welding.

Production Welding

Clean the pipe ends to be welded. Also if welding Profuse pipes then remove 25mm of the protective blue polypropylene skin from the pipe ends.

Position the pipes within the butt fusion machine leaving a suitable gap between the two pipes to allow the trimmer to be inserted. When the pipes are in the correct position the clamps can be secured in place and the trimmer can be inserted.

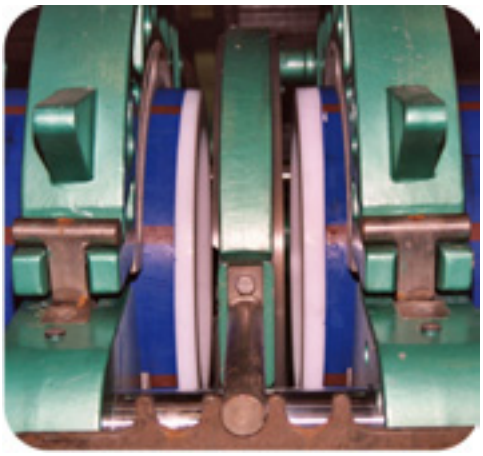

Figure 3

Switch the trimmer tool on and close the pipes together. Pressure should be maintained onto the trimmer blades until a continuous ribbon of material has been planed from the pipe ends as shown below.

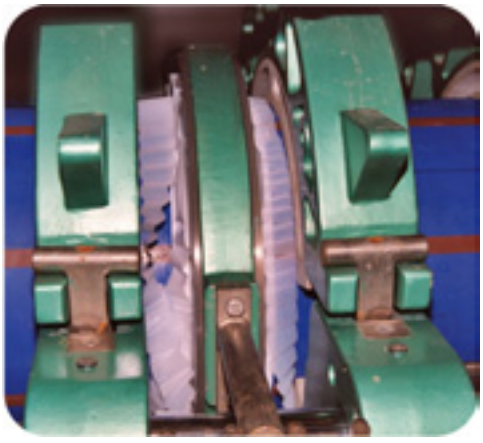

Figure 4

Remove the shavings (this operation is normally best undertaken from the bottom of the machine). **Do not touch the pipe ends.**

Remove the trimmer and bring the pipes together under full welding pressure and check for mismatch, pipe slippage and that there is no

visible gap between the pipe ends. If there is a visible gap between the pipe ends, or if there is excessive mismatch or the pipes have slipped then the pipe ends should be repositioned and re-trimmed.

Mismatch

WIS 4-32-08 issue 3 states that there should be no discernable mismatch on pipe sizes up to and including 180mm.
For pipes above 180mm the amount of allowable mismatch should be less than 10% of the pipe wall thickness.

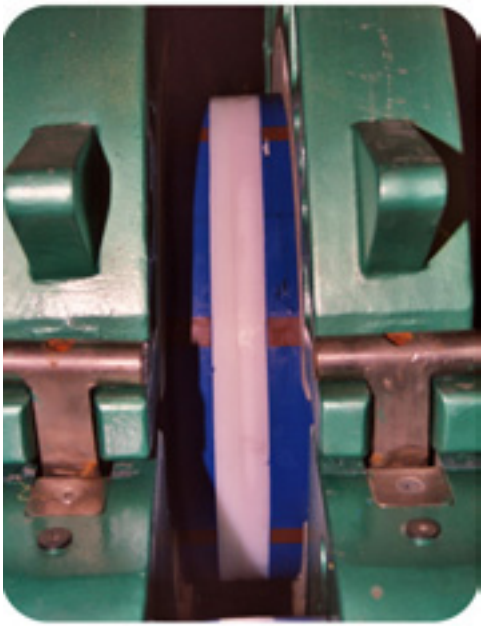

Figure 5

Butt Fusion Check Cycle

The correct welding parameters are detailed in the attached tables and also documented in WIS 4-32-08. The times and pressures stated should not be modified or deviated from in any way as this may result in production of welds which do not meet the required standards of Water Industry Specification
4-32-17.

When the pipes have been trimmed and checked for mismatch they are separated and the heater plate is positioned between the two pipe ends.

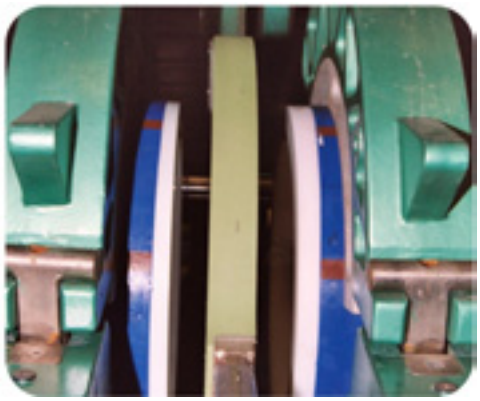

Figure 6

The pipe ends are brought up to the heater plate at a pressure of 0.15MPa until the initial bead has formed.

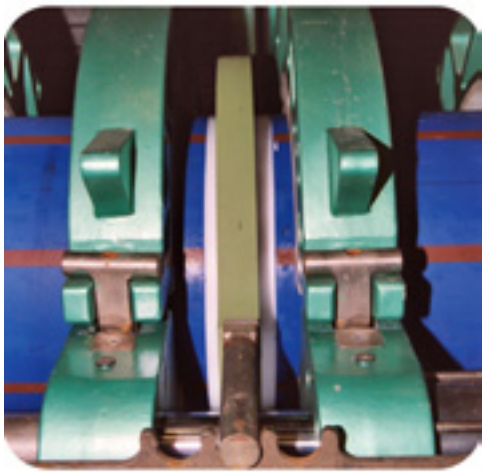

Figure 7

Once the initial bead has formed, the pressure is dropped to between zero and drag pressure (drag pressure is the hydraulic pressure needed to overcome friction). The reason for dropping the pressure is to create a stress free environment, which will result in establishing a reservoir of molten polymer on the pipe ends to be jointed.

The correct soak time for any given diameter can be established by

consulting the data tables contained within this document.

A point of interest when welding ProFuse pipes is that the pipe material in contact with the heater plate becomes clear when the material reaches a molten state. When the material cools it reverts to its normal white appearance.

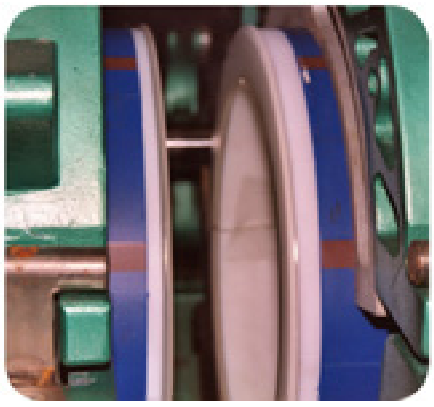

Figure 8

At the point when the soak time has been completed the machine is opened, separating the pipe from the heater plate.

The heater plate is removed from between the two pipes as quickly as possible.

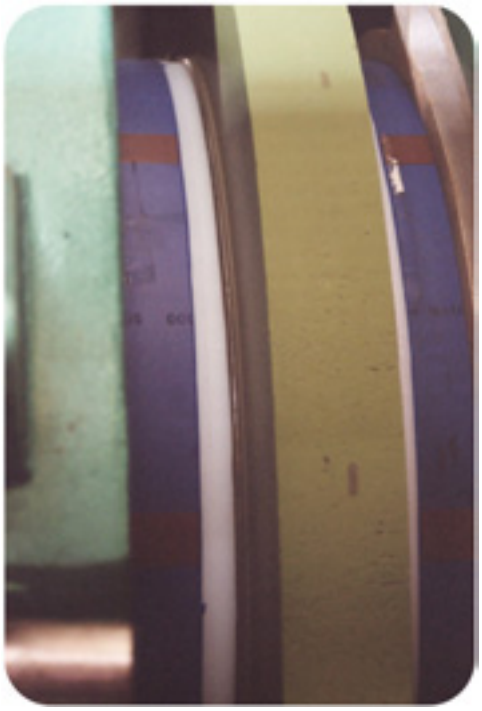

Figure 9

The two pipe ends are brought back together in a smooth action up to an interface stress of 0.15MPa.

Figure 10

The process of removing the heater plate and moving the two pipe lengths back together should take no longer than ten seconds, from the point the pipe separates from the heater plate to the point the two pipe ends are brought together at an interface stress of 0.15 MPa.

For single pressure welding this interface stress is maintained for the full cooling time. For dual pressure welding the interface stress of 0.15 MPa is dropped after ten seconds to a stress of 0.025 MPa.
The tables included highlight the pipe sixes which need to be welded using the dual and single pressure welding cycles, through as a general rule, pipes having a wall thickness of above 21mm will require jointing with dual pressure parameters.

When the weld has been allowed to cool for the recommended cooling time it can be removed from the machine and the next weld can be prepared.

During the cooling time of any further welds it is an ideal opportunity to remove external weld bead from the previous weld. Beads can be removed at any point following the cooling time of the weld. The weld beads are removed using specific tooling as shown below.

Figure 11

The de-beading tool can remove the outer bead in one-piece, which may then be used as an on-site quality inspection of the weld.

Figure 12

Twisting the bead as shown along its total length gives a very good indication of the quality of the weld. Should faults be noted then the weld should be cut from the pipe string and re-welded.

It is good practice to mark the beads and welds with a unique number which would help with identification should it be necessary.