



HDPE Buttwelding Principles

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General

Butt-fusion jointing is a thermofusion process which involves the simultaneous heating of the ends of two components which are to be joined until a melt state is attained on each contact surface. The two surfaces are then brought together under controlled pressure for a specific cooling time and homogeneous fusion is formed upon cooling. The resultant joint is resistant to end thrust and has comparable performance under pressure to the pipe.



Refer to SABS 0269 code of practice.

This method of jointing requires an electrically heated plate to raise the temperature of the pipe ends to the required fusion temperature and is used for PE63, PE80 and PE100 grades of material for pipe of size 32mm and above of the same Standard Dimension Ratio (SDR). When joining pipes using butt-fusion techniques, the heater plate temperatures are the same for PE63, PE80 and PE100, 195°C to 200°C.



The Site Fusion Jointing Specification WIS 4-32-08 Issue 2, 1994 emphasises the importance for the butt-fusion machine to be able to control the reduced secondary ram pressures that are now required for dual pressure butt-fusion jointing. For SDR11 pipes of sizes 250mm, 280mm and 315mm and for all pipe (SDRs 11, 17.6, 26) of size 355mm and above the butt fusion pressures should be reduced after 10 seconds and therefore the use of an automatic butt fusion machine is required. (These conditions are tabulated on page 9)

The Marley System

Depending on the design and make, butt-fusion machines may or may not be capable of accepting fittings as moulded for direct welding to pipes. Marley therefore offers two ranges of fittings for butt-fusion systems to provide the greatest flexibility in this regard :

- long spigot fittings
- 'pupped' fittings

Pupped fittings are fabricated by butt-fusing, (in the factory), 0.5m lengths of pipe to each leg of a spigot fitting, thereby allowing the straight length of pipe to be gripped by clamps of the butt-fusion machine.

The Marley butt-fusion system comprises, therefore:

- Straight polyethylene pipe
- Long spigot fittings
- Pupped fittings
- Accessories

Equipment

- Generator to supply the heater plate, trimmer and hydraulic pump
- Butt-fusion machine fitted with the correct size clamp shells, trimmer, heater plate, hydraulic pump and timer
- Pipe support rollers
- Welding tent
- Cleaning material, lint free cotton cloth or paper towel
- External/Internal debanding tool
- Bead gauge
- Digital thermometer with surface probe to check heater plate.
- Pipe end covers
- Baseboard
- Pipe cutters
- Air temperature thermometer
- Indelible marker pen
- Timer

Jointing Method

Pre-Welding Checks

Before commencing a welding operation check that:

- There is sufficient fuel for the generator to complete the joint and that it is functioning correctly before it is connected to the machine.
- The trimming tool and hydraulic pump are in working order.
- The heater plate is clean and residues from previous welds have been removed.
- A tent is available to provide shelter during welding.
- The machine is complete and undamaged.
- You know the correct welding parameters for the machine and pipe being welded.
- The heater plate is at the correct temperature. (Connect the heater plate to the power supply and retain for at least 20 minutes inside the thermally insulated guard). To remove dirt deposits the heater plate may be washed, when cold,

with copious quantities of clean water at the start of the jointing session. Only clean, lint free materials must be used to clean the plate. To remove grease and oily films the plate may be wiped with lint free material dampened by a suitable solvent, eg. Isopropanol.

- Check that the pipes and/or fittings to be jointed are of the same size, SDR and material.

Dummy Welds

Even though washing may remove large deposits of dirt, very fine particles of dust may still remain on the heater plate. To remove such dust it is necessary to make a dummy joint at the start of each jointing session, whenever the plate has been allowed to cool below 180°C, or at a change of pipe size. Two dummy joints will be made if the pipe size is greater than 180mm.

A dummy joint can be made using pipe off cuts of the same size, SDR and material as the pipe being installed, It is not necessary to actually make a joint. The procedure can be discontinued after the full heat cycle.

Manual Welding

Procedure

- Place the pipes in the clamps with the ends against the trimming tool and with the pipe markings aligned.
- Align and level the components using the support rollers.
- Tighten the pipe clamps to grip and re-round the pipes.
- Cover the free ends of the pipes to prevent cooling of the plate by internal draughts.
- Switch on the trimming tool and close the clamps slowly so that the pipe ends are moved against the trimming tool until continuous shavings are cut from each surface.
- Keep the trimming tool turning whilst opening the clamps to avoid steps on the trimmed surfaces.
- Remove the trimming tool taking care not to touch the trimmed ends.
- Remove loose shavings from the machine and component ends.



Do not touch the prepared surfaces.

- Check that both surfaces are completely planed. If they are not then repeat the trimming process.
- Close the clamps and check that there is no visible gap between the trimmed faces.
- The maximum permitted outsider diameter mismatch is:
- 1.0mm for pipe sizes 90mm to 315mm
- 2,0mm for pipe sizes 316mm to 800mm,
- If the mismatch is greater than these values then the pipe must be realigned and re-trimmed.
- Open and then close the clamps and note the drag pressure needed to move the pipes together using the hydraulic system.

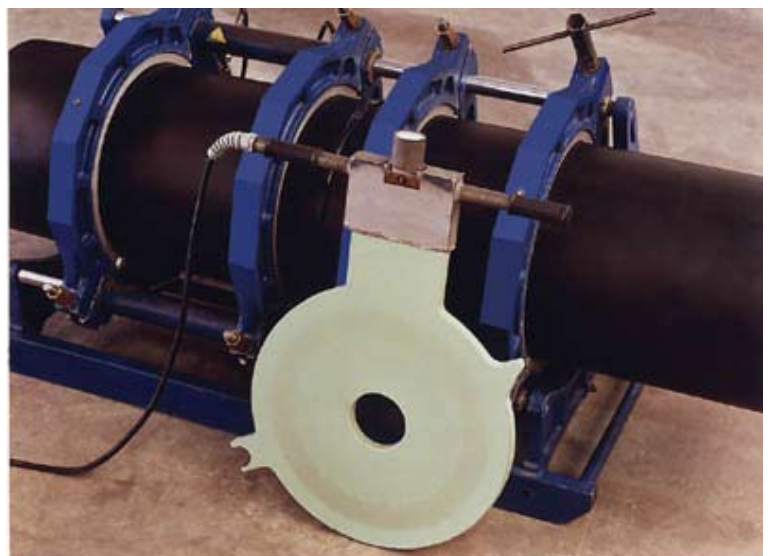


Drag pressure is the minimum gauge pressure required to overcome the sliding frictional drag on the rams due to the operation of the machine and the weight of the pipes/fittings being jointed,

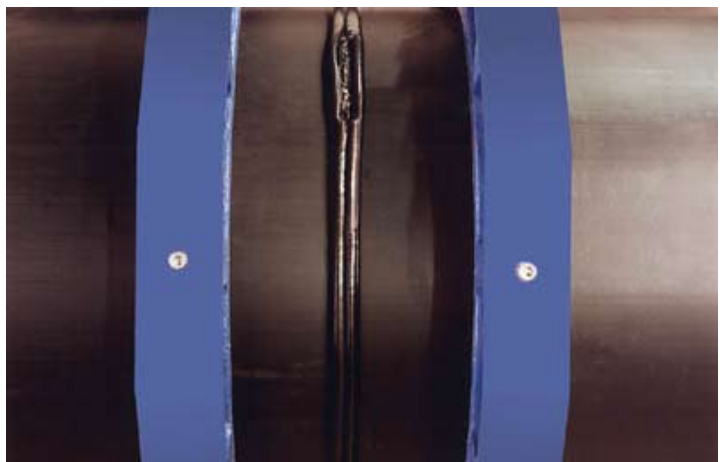
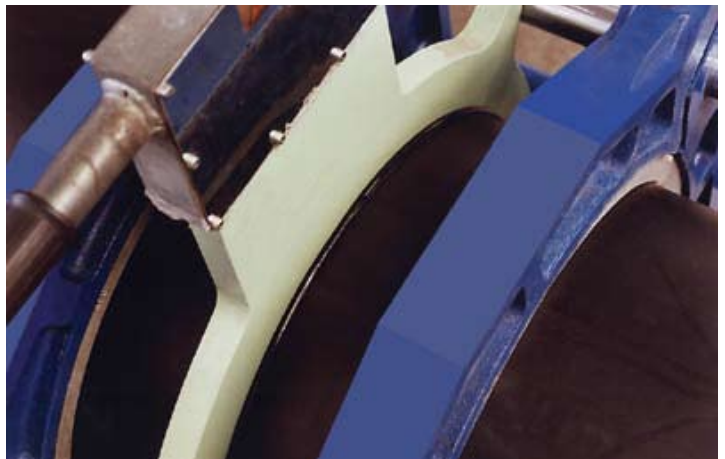
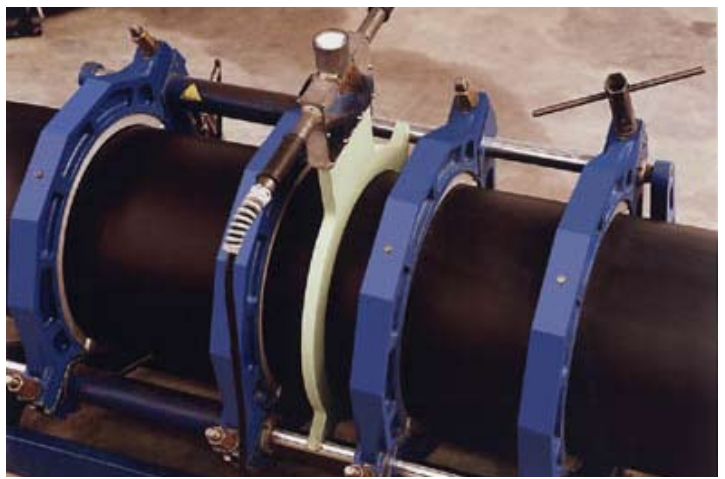


The drag pressure (in bar) must be assessed accurately prior to making each fusion joint and must be added to the basic ram pressure values shown on the machine. (When fully automatic machines are used this operation will normally be carried out automatically.)

- Remove the heater plate from its protective cover. Check that it is clean and up to temperature.



- Place the heater plate in the machine and close the clamps so that the surfaces to be joined are touching the plate. Using the hydraulic system apply the pressure previously determined.
- Maintain the applied pressure until the pipe begins to melt and a uniform bead of 2-3mm is formed on each end.
- After the initial bead up, the pressure in the hydraulic system shall be released so that the pressure gauge registers between zero and the drag pressure so as to control the bead growth during the heat soak time. Check that the pipe does not slip in the clamps. The pipe ends must maintain contact with the heater plates.
- When the heat soak time is completed, open the clamps and remove the heater plate ensuring that the plate does not touch the melted surfaces.
- Immediately close the clamps (within 8 to 10 seconds of removing the plate) and bring the melted surfaces together at the previously determined pressure.
- Maintain the required pressure for the minimum cooling time as indicated in the table.
- After this time the assembly can be removed from the machine but should not be handled for a further period equal to the cooling times given on page 9.
- Examine the joint for cleanliness and uniformity and check that the bead width is within the specified limits.
- Remove the external bead and if required the internal beads using suitable debanding tools.
- The beads and joint shall be numbered/coded using an indelible marker pen.
- Twist the beads at several positions. If the bead is seen to split at any point then the joint must be cut out from the pipeline and remade. If a similar defect re-occurs, cease all further jointing until the equipment has been thoroughly cleaned, examined and new trial joints were made and shown to be satisfactory.



Rules for Butt-Fusion

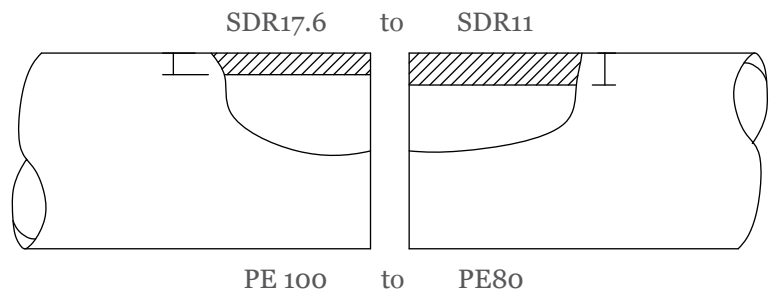
NEVER

- Attempt to weld together pipes of different SDR (wall thickness).
- Touch trimmed pipe ends.
- Leave trimming swarf inside pipe or on welding machine.
- Allow equipment to get wet or dusty.
- Use non-approved machinery.
- Remove a weld from the machine before cooling time has elapsed.
- Allow untrained personnel to use welding equipment.
- Cut corners in any part of the welding procedure.
- Weld pipes of different material on site (In factory controlled conditions it may be possible to do this).
- Use a generator of inadequate capacity.

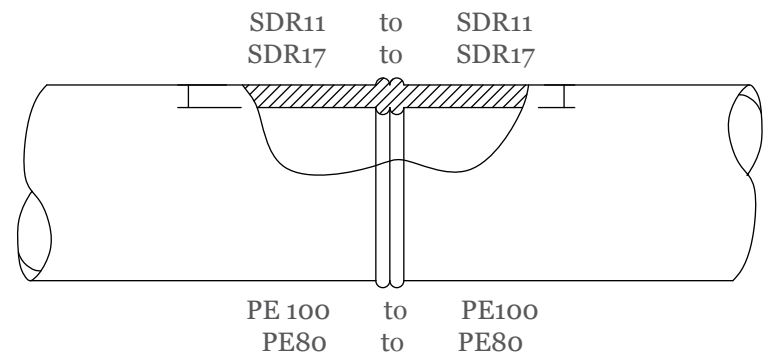
Summary

(a) Dissimilar materials and dissimilar wall thicknesses can be joined by **electrofusion**.

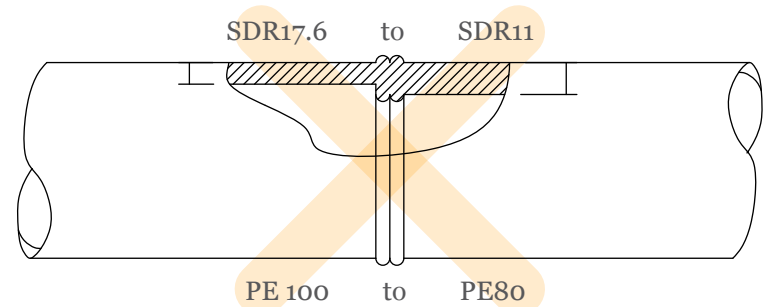
(Please note that the maximum working pressure should not exceed the lower of the two pipes.)



(b) Similar materials and/or wall thicknesses may be joined by butt fusion or electrofusion. (Please note that SDR17 can be butt fused to SDR17.6.)



c) Dissimilar wall thicknesses must not be joined by butt fusion. (PE80 can be butt fused to PE100 under closely controlled factory conditions.)



Buttweld Time and Pressure Tables

Outside diameter	SDR	Wall Thickness (min)	Bead up interface stress	Initial bead size (approx)	Soak time	Min soak interface stress	Max plate removal time	Fusion and cooling interface stress	Cooling time in clamps	Cooling time out of clamps	Cooling time for coiled pipe in clamps	Typical final overall beaded width	
mm		mm	Mpa	mm	sec	Mpa	sec	Mpa	min	min	min	min mm	max mm
90	26	3.5	0.15	2	95	0	10	0.15	10	5	15	8	15
90	17.6	5.1	0.15	2	110	0	10	0.15	10	5	15	8	15
90	11	8.2	0.15	2	140	0	10	0.15	10	5	15	9	16
110	26	4.2	0.15	2	100	0	10	0.15	10	5	15	8	15
110	17.6	6.3	0.15	2	125	0	10	0.15	10	5	15	9	16
110	11	10	0.15	2	160	0	10	0.15	10	5	15	10	17
125	26	4.8	0.15	2	110	0	10	0.15	10	5	15	8	15
125	17.6	7.1	0.15	2	130	0	10	0.15	10	5	15	9	16
125	11	11.4	0.15	2	175	0	10	0.15	10	5	15	10	17
160	26	6.2	0.15	2	120	0	10	0.15	10	5	15	9	16
160	17.6	9.1	0.15	2	150	0	10	0.15	10	5	15	9	16
160	11	14.6	0.15	2	205	0	10	0.15	10	5	15	11	18
180	26	6.9	0.15	2	130	0	10	0.15	10	5	15	9	16
180	17.6	10.2	0.15	2	160	0	10	0.15	10	5	15	10	17
180	11	16.4	0.15	2	225	0	10	0.15	10	5	15	11	18
225	26	8.6	0.15	2	145	0	10	0.15	10	5		9	16
225	17.6	12.8	0.15	2	190	0	10	0.15	10	5		10	17
225	11	20.5	0.15	2	265	0	10	0.15	10	5		12	19
250	26	9.6	0.15	2	155	0	10	0.15	10	5		9	16
250	17.6	14.2	0.15	2	200	0	10	0.15	10	5		10	17
280	26	10.7	0.15	3	170	0	10	0.15	10	5		13	22
280	17.6	15.9	0.15	3	220	0	10	0.15	10	5		14	23
315	26	12.1	0.15	3	180	0	10	0.15	10	5		13	22
315	17.6	17.9	0.15	3	240	0	10	0.15	10	5		14	23
	Tolerance		±0.02		±3			±0.02					

**Table 1 — Single pressure Butt-fusion jointing conditions for PE63, PE80 and PE100
Heater Plate Surface Temperature: 195 °C to 200 °C**

Outside diameter	SDR	Wall Thickness (min)	Bead up interface stress	Initial bead size (approx)	Soak time	Min soak interface stress	Max plate removal time	Fusion interface stress (after 10 sec)	Cooling interface stress (after 10 sec)	Cooling time in clamps	Cooling time out of clamps	Typical final overall bead width	
												min mm	max mm
250	11	22.7	0.15	2	285	0	10	0.15	0.025	15	7.5	15	24
280	11	25.4	0.15	3	315	0	10	0.15	0.025	15	7.5	16	25
315	11	28.6	0.15	3	345	0	10	0.15	0.025	15	7.5	17	26
355	26	13.6	0.15	3	195	0	10	0.15	0.025	10	5	13	22
355	17.6	20.1	0.15	3	260	0	10	0.15	0.025	15	7.5	15	24
355	11	32.3	0.15	3	385	0	10	0.15	0.025	15	7.5	18	27
400	26	15.3	0.15	3	215	0	10	0.15	0.025	10	5	14	23
400	17.6	22.7	0.15	3	285	0	10	0.15	0.025	15	7.5	15	24
400	11	36.4	0.15	3	425	0	10	0.15	0.025	20	10	18	27
450	26	17.2	0.15	3	235	0	10	0.15	0.025	10	5	14	23
450	17.6	25.6	0.15	3	315	0	10	0.15	0.025	15	7.5	16	25
450	11	41	0.15	3	470	0	10	0.15	0.025	20	10	19	28
500	26	19.1	0.15	3	250	0	10	0.15	0.025	10	5	15	24
500	17.6	28.3	0.15	3	345	0	10	0.15	0.025	15	7.5	16	25
500	11	45.5	0.15	3	515	0	10	0.15	0.025	20	10	20	29
560	26	21.4	0.15	3	275	0	10	0.15	0.025	15	7.5	15	24
560	17.6	31.7	0.15	3	380	0	10	0.15	0.025	15	7.5	17	26
560	11	50.8	0.15	3	570	0	10	0.15	0.025	20	10	22	31
630	26	24.1	0.15	3	300	0	10	0.15	0.025	15	7.5	16	25
630	17.6	35.7	0.15	3	420	0	10	0.15	0.025	15	7.5	18	27
630	11	57.2	0.15	3	635	0	10	0.15	0.025	25	12.5	23	32
710	26	27.2	0.15	3	335	0	10	0.15	0.025	15	7.5	16	25
710	17.6	40.2	0.15	3	465	0	10	0.15	0.025	20	10	19	28
800	26	30.6	0.15	3	370	0	10	0.15	0.025	15	7.5	17	26
800	17.6	45.3	0.15	3	515	0	10	0.15	0.025	20	10	20	29
900	26	34.6	0.15	3	405	0	10	0.15	0.025	20	10	18	27
900	17.6	50.9	0.15	3	570	0	10	0.15	0.025	20	10	22	31
1000	26	38.4	0.15	3	445	0	10	0.15	0.025	20	10	19	28
1000	17.6	56.6	0.15	3	630	0	10	0.15	0.025	25	12.5	23	32
	Tolerance		±0.02		±3			±0.02	±0.01				

**Table 2 — Duelpressure butt-fusion jointing conditions for PE63, PE80 and PE100
Heater Plate Surface Temperature: 195 °C to 200 °C**



All jointing pressure must be calculated by using the effective ram area of the machine in relation to the cross sectional area of the pipe wall. Effective ram area should be marked on each model.



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