6 Welding

6.1 Welding

6.1.1 Welding PE-HD, PP and PVDF pipes and fittings

PE 80, PE 100, PE 100 RC, PE-EL

According to the Technical Code DVS 2207, Part 1 the suitability requirement for welding is Melt Flow Rate MFR 190/5 (Previously called MFI = Melt Flow Index), i. e. 0.3–1.7 g/10 min.

PP-H, PP-R

With Melt Flow Rate within MFR 190/5, i. e. 0.4 – 1.0 g/10 min., these are suitable for welding. Please refer to Technical Code DVS 2207, Part 11.

Fundamentally the same welding suitability holds for PP-H or PP-R with the same parameters.

PVDF

With Melt Flow Rate within MFR 230/5, i. e. 1,0 – 25 g/10 min. Please refer to Technical Code DVS 2207, Part 15.

General requirements

The welding area is to be protected from harmful weather, e. g. moisture, wind, intense sunlight, and temperatures below 5 °C.

When an even, appropriate welding temperature can be maintained for the pipe walls, then welding is possible at any outside temperature. This may involve:

- Preheating
- Protective shelter
- Heating up.

In direct sunlight, cover the weld area in advance, to allow temperature differences in unevenly warmed pipe to equalize. In strong wind, close off the extreme ends of the pipe segments to prevent cooling the weld during the welding process.

Welding methods

To achieve a permanent bond with SIMONA® pipes and fittings, we recommend the processes that have proven themselves in practice:

- butt welding
- socket welding
- electro fusion welding.

6.1.2 Butt welding

Before butt welding, the two surfaces to be welded are heated to welding temperature by a heating plate. It is then removed and the two plasticized surfaces are pressed together to form a weld.

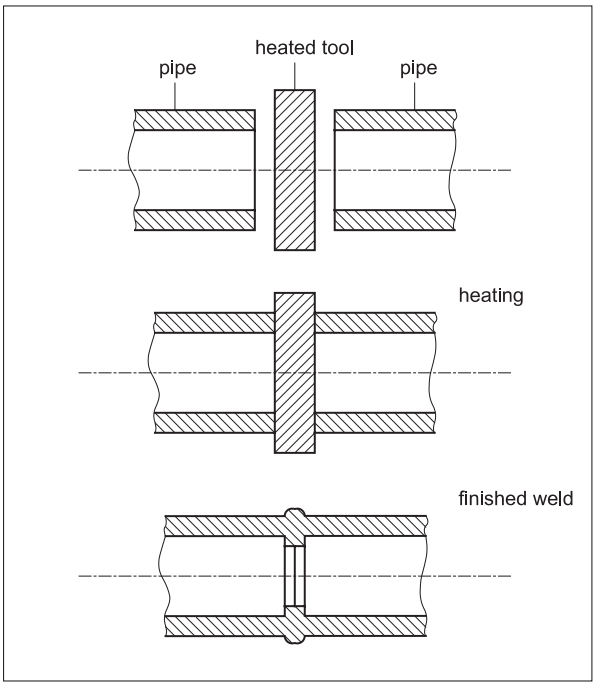

Fig. 2: Heated tool butt welding

Weld preparation

The pipeline components are laid out axially before being clamped into the welding machine. The part to be welded on must be free to move along the axis, with the help of e.g. adjustable pulleys if necessary.

With a planer, machine off the surfaces to be bonded, after they have been clamped into place. If swarf happens to fall into the pipe, use a clean tool to remove them. A hand must never touch the surfaces planed for welding.

After planning, check that the surfaces are parallel. Any gap remaining must be no greater than the maximum in Table 9. As well, check that any mismatch of the pipe ends is smaller than 10% of the pipe wall thickness. If not, the wall thicknesses are to be matched around the weld by machining.

Table 9: Maximum gap before welding

Pipe d	Max. gap
≤ 355	0.5
400 to < 630	1.0
630 to < 800	1.3
800 to ≤ 1000	1.5

Welding process

The heating plate is heated to welding temperature and placed between the surfaces to be welded. They are pressed against the heated tool with the correct matching pressure. The temperature is monitored with a rapidly registering surface thermometer.

The force for matching or welding can be calculated from the weld surface and the specific pressure. Usually the welding machine manufacturers give pressure values in table form, since most machines work with hydraulics, not with measured forces. To this pressure value, add the drag pressure from the movement of the work piece. The latter is influenced by friction of machine parts and the weight of the pipes and fittings to be welded.

Bead-up time is completed only after a bead (according to Tables 10–12) has formed completely around both ends to be welded. The heating time begins at this point, and the pressure is reduced to nearly zero.

After heating, the fusion surfaces are detached from the heating plate without damage or contamination. The time for detaching the fusion surfaces, removing the heating plate, and bringing the fusion surfaces

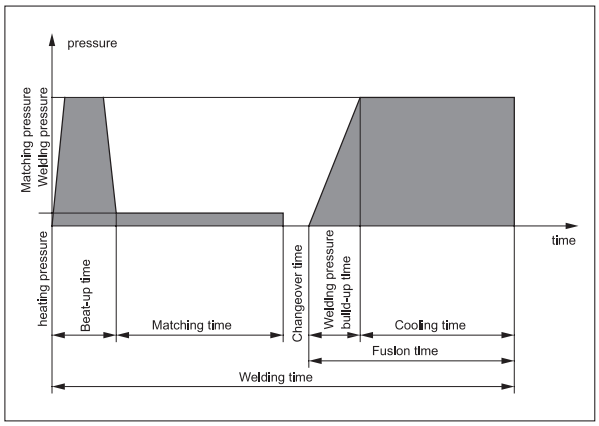

Fig. 3: Steps in heated tool butt welding

into contact with each other is called the changeover time. It should be kept as short as possible.

The weld surfaces should be brought into contact gently, at extremely low speed. Then pressure is slowly increased (for times see Tables 10–12), then maintained until cooling is complete.

Never accelerate weld cooling or apply coolant to the area. For pipe walls 20 mm or more in thickness, an even cooling for a better weld can be achieved by covering the weld area during the cooling phase. After welding a double bead must go completely around the weld, as in Fig. 4.

If the bead is to be removed, it should be done before the weld is entirely cooled down. Machining the bead off the cold weld runs the risk of causing dents. With brittle materials like PVDF it can cause chipping.

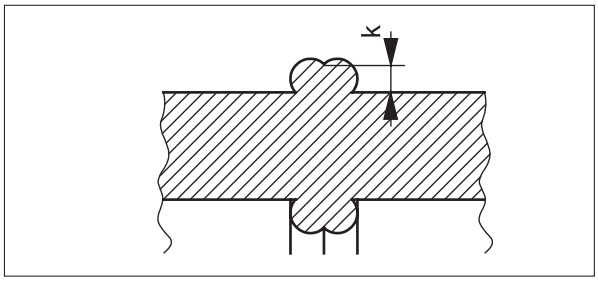

Fig. 4: Bead from butt welding

Table 10: Recommended values for butt welding, PE 80/PE 100/PE 100 RC/PE-EL pipes and fittings ①

	Matching ②	Heat up ③	Changeover	Welding ④	
Wall thickness	**Heat up time starts**	**Heat up time**	**Changeover time**	**Weld pressure build-up time**	**Cooling time**
mm	mm	s	s (max. time)	s	min (min. time)
up to 4.5	0.5	45	5	5	6
4.5–7	1.0	45–70	5–6	5–6	6–10
7–12	1.5	70–120	6–8	6–8	10–16
12–19	2.0	120–190	8–10	8–11	16–24
19–26	2.5	190–260	10–12	11–14	24–32
26–37	3.0	260–370	12–16	14–19	32–45
37–50	3.5	370–500	16–20	19–25	45–60
50–70	4.0	500–700	20–25	25–35	60–80

① For outdoors temperature about 20 °C and moderate air movement
② Height of bead on the heated tool at the end of the matching time (matching at < 0.15 N/mm²)
③ Heated tool temperature is 210 ± 10 °C, heat up time = 10 x wall thickness (heat soak at ≤ 0.02 N/mm²)
④ Cooling time at welding pressure (p = 0.15 ± 0.01 N/mm²)

Table 11: Recommended values for butt welding, PP-H/PP-R pipes and fittings ①

	Matching ②	Heat up ③	Changeover	Welding ④	
Wall thickness	**Heat up time starts**	**Heat up time**	**Changeover time**	**Weld pressure build-up time**	**Cooling time**
mm	mm	s	s (max. time)	s	min (min. time)
up to 4.5	0.5	up to 135	5	6	6
4.5–7	0.5	135–175	5–6	6–7	6–12
7–12	1.0	175–245	6–7	7–11	12–20
12–19	1.0	245–330	7–9	11–17	20–30
19–26	1.5	330–400	9–11	17–22	30–40
26–37	2.0	400–485	11–14	22–32	40–55
37–50	2.5	485–560	14–17	32–43	55–70

① The particular machine and working conditions may make it impossible to use these recommended values, especially the heat up time. If so, test samples should be made and tested.
② Heated tool temperature is 210 ±10 °C. Height of bead on the heated tool at the end of the bead-up time (matching at 0.10 N/mm²)
③ Heat up at ≤ 0.02 N/mm²
④ Cooling time at welding pressure (p = 0.10 ±0.01 N/mm²)

Table 12: Recommended values for butt welding, PVDF pipes and fittings ①

	Matching ②	Heat up ③	Changeover	Welding ④	
Wall thickness	**Heat up time starts**	**Heat up time**	**Changeover time**	**Weld pressure build-up time**	**Cooling time**
mm	mm	s	s (max. time)	s	min (min. time)
1.9–3.5	0.5	59–75	3	3–4	5–6
3.5–5.5	0.5	75–95	3	4–5	6–8.5
5.5–10.0	0.5–1.0	95–140	4	5–7	8.5–14
10.0–15.0	1.0–1.3	140–190	4	7–9	14–19
15.0–20.0	1.3–1.7	190–240	5	9–11	19–25
20.0–25.0	1.7–2.0	240–290	5	11–13	25–32

① The particular machine and working conditions may make it impossible to use these recommended values, especially the heat up time. If so, test samples should be made and tested.
② Height of bead on the heated tool at the end of the matching time (matching at 0.10 N/mm²)
③ Heat up time = 10 x wall thickness +40 s (heat up at = 0.01 N/mm²)
④ Cooling time at welding pressure (p = 0.10 N/mm² ±0.01), cooling time = 1.2 x wall thickness + 2 min.

6.1.3 Socket welding (HD)

In heated tool socket welding, pipe and fittings are welded with an overlap. A heating tool (or tools) with socket and plug-shaped faces is used to heat the two pieces to be welded; they are then brought together and fused. The pipe end, heating tool, and fitting socket are matched so that fusion pressure is built up during fusion.

When the pipe diameter is:

- > 63 mm for PE 80, PE 100, and PP
- > 50 mm for PVDF

a suitable welding equipment should be used.

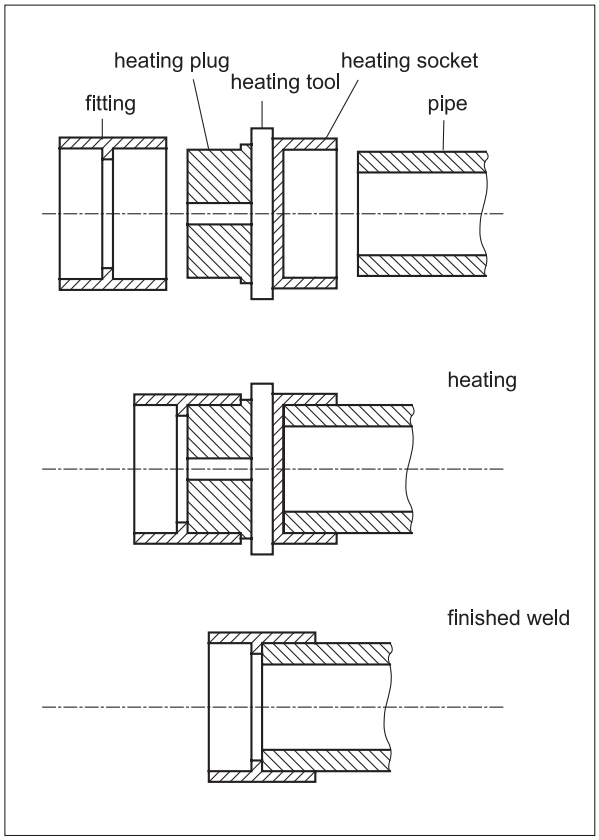

Fig. 5: Socket welding

Weld surface preparation

The surfaces to be bonded are rough-turned or scraped. The fitting is thoroughly cleaned with a cleaning solution, e.g. with alcohol and absorbent lint-free paper.

The pipe end is machined down on the outside to a 15° slant on the last:

- 2 mm for diameters up to 50 mm
- 3 mm for larger diameters

Then it is marked to show how far it will be inserted into the heating tool.

Welding process

The tools are heated to 260 ±10 °C. The temperature is monitored with a rapidly registering surface thermometer. For heating, the fitting is slid onto the heating tool as far as it goes, and the pipe is inserted up to the mark. The parts are heated according to the times given in Tables 13 and 14.

At the end of the heating time, the fitting and pipe are removed from the heated tool with a jerk, and the pipe inserted straight into the fitting, without twisting, up to the pipe marking or a stop in the fitting. The fused parts must cool undisturbed for the same time as recommended for heating.

Table 13: Recommended values for socket welding, PE-HD and PP pipes and fittings ①

Pipe	Heating time		Changeover time	Cooling time	
d mm	Pipe PN 10 ② s	Pipe PN 6 ③ s	max. permissible s	clamped s	total min
16	5		4	6	2
20	5		4	6	2
25	7	②	4	10	2
32	8	②	6	10	4
40	12	②	6	20	4
50	12	②	6	20	4
63	24	12 ②	8	30	6
75	30	15	8	30	6
90	40	22	8	40	6
110	50	30	10	50	8
125	60	35	10	60	8

① For outdoor temperature about 20 °C and moderate air movement

② For PP. Not advisable for PE-HD.

③ Not advisable at this wall thickness

Table 14: Recommended values for heated tool socket welding, PVDF pipes and fittings

Pipe	Heating time	Changeover time	Cooling time	
d mm	 s	max. permissible s	clamped s	total min
16	4	4	6	2
20	6	4	6	2
25	8	4	6	2
32	10	4	12	4
40	12	4	12	4
50	18	4	12	4
63	20	6	18	6
75	22	6	18	6
90	25	6	18	6
110	30	6	24	8

6.1.4 Electro fusion welding (HM)

The surfaces to be welded, i.e. the pipe outer surface and the socket inside surface, are heated to welding temperature and fused by electric current, through the resistance of wires within the socket.

Weld surface preparation

For a good electro fusion weld, clean surfaces are an important factor. The pipe surfaces must be shaved in the weld area. Then the burr on the inner edge must be removed and the outer edge rounded, see Fig. 7. The fitting is thoroughly cleaned inside with an appropriate cleaning solution and absorbent lint-free paper. In the weld area, the pipe may be out of the round by no more than 1.5%. Otherwise clamps for this purpose can be used to force roundness.

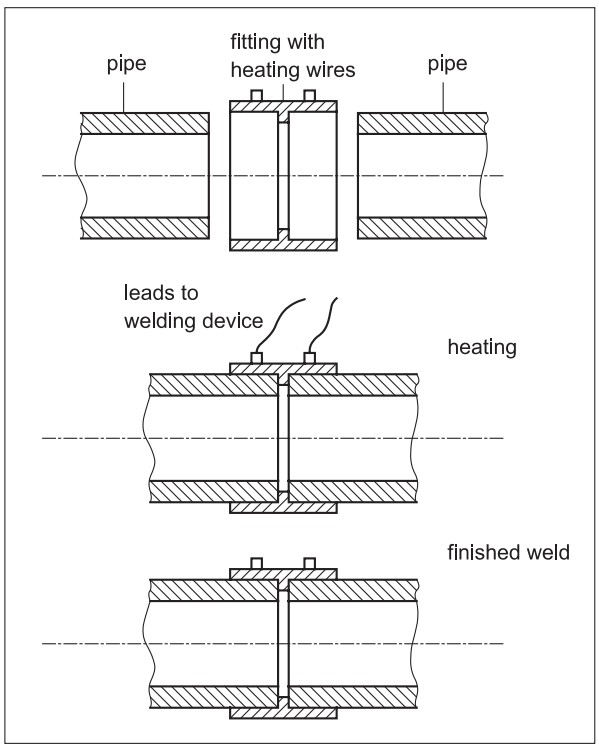

Fig. 6: Electro fusion welding

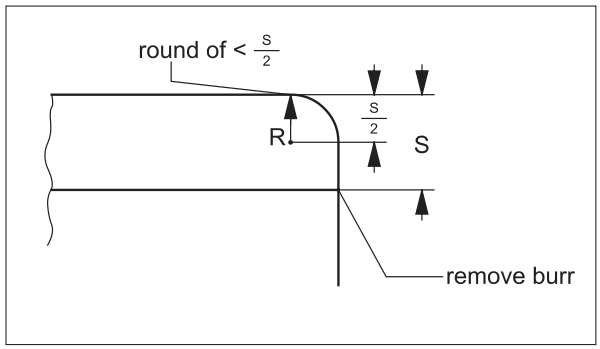

Fig. 7: Preparing pipe ends

When the fitting goes on to the pipe ends, keep it straight along the axis and avoid forcing. This prevents displacing and damaging the resistance wire.

Welding process

The welding device must match the fitting used. Settings on the device are selected before welding, according to the pipe diameter and nominal pressure. Welding cables connect device and fitting. Fusion is carried out automatically, and the weld is left at rest until thoroughly cooled.

For all welding processes, the applicable DVS Guidelines are to be followed.