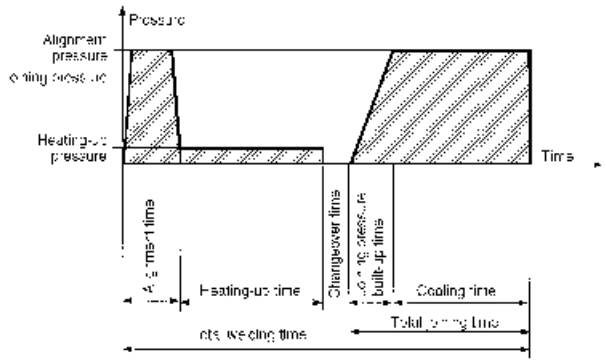

Figure 4. Process stages of heated tool butt welding.

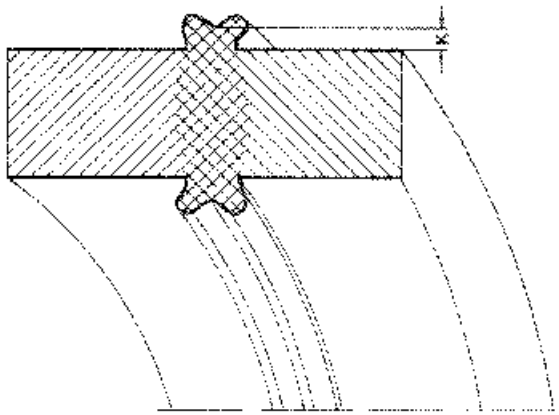

Figure 5. Bead design at heated tool butt welding (principle on example pipe).

Alignment

The joining areas of the welding components are aligned to the heated tool until all areas are plane-parallel on the heated tool. This fact is visible on the kind of beads. The alignment is finished when the bead heights have reached the mentioned values in table 2, column 2 on the total pipe circumference resp. the total sheet surface. The bead sizes are an index for a complete contact of the joining areas on the heated tool. At larger pipe diameters (> 630 mm) the sufficient bead size also on the pipe´s inside has to be controlled at the beginning of the welding works, possibly by a test joint. The alignment pressure of 0.15 N/mm² effects during the total alignment process.

Heating-up

For heating-up, the joining areas must contact the heated tool with low pressure. The pressure is reduced to nearly zero (≤ 0.02 N/mm²). During heating-up, the heat penetrates the joining areas and the welding temperature is reached. Heating-up times are mentioned in table 2, column 3.

Removal of heated tool

After heating-up, the joining areas are to be detached from the heated tool. The heated tool should be withdrawn in such a way that the heated joining areas are neither damaged nor contaminated. The joining areas should be joined together quickly until directly before the contact. The changeover time should be as short as possible (see table 2, column 4), as otherwise the plastified areas will cool down. The welding joint quality would be influenced negatively.

Joining

The areas to be welded should meet with a speed of nearly zero. The demanded joining pressure is built possibly linear. The required times are shown in table 2, column 5. The joining pressure is 0.15 ± 0.01 N/mm.

The joining pressure has to be kept during the cooling time (see table 2, column 5). Raised mechanical loads during or directly after the declamping are allowed only after elongated cooling.

After the joining, a regular double-bead must appear. The bead size shows the regularity of the weldings. Different beads could be caused by different melt flow behaviour of the connected materials. K must always be larger than 0 (see figure 5).

Short version of processing instructions see appendix.

4.2 Heated tool butt welding of tapping tees

The heated tool butt welding of tapping tees is useable with PE-HD pipes according to DIN 8075 of melt-flow index group 010. In the case of PE-HD pipes according to melt-flow index group 005 the welding process is useable only in conjunction with a reinforcement embracing the pipe. The later condition also applies if, especially in the case of fittings attached at a subsequent stage, an attribution within the scope of this standard is not possible.

Heated tool butt welds of tapping tees have to be carried out with the help of welding fixtures.

Table 2. Recommended values for the heated tool butt welding of pipes, fittings and sheets made from PE-HD, at an outside temperature of approximately 20 °C and moderate air flow (interim values have to be interpolated).

1	2	3	4	5	
Nominal wall thickness	**Alignment**	**Heating-up**	**Changeover**	**Joining**	
	Bead height on heated tool at the end of the alignment time (alignment with 0.15 N/mm²)	**Heating-up time = 10 x wallthickness (heating-up with ≤ 0.02 N/mm²)**		**Joining pressure build-up time**	**Cooling time under joining pressure p=0.15 N/mm² ±0.01**
mm	**mm (minimum values)**	**s**	**s maximum time**	**s**	**min (minimum values)**
bis 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

Short version of processing instructions see appendix

4.2.1 Description of method

The connection zones of pipe and tapping tee are aligned and heated up by means of a shaped heated tool under alignment pressure. After withdrawal of the shaped heated tool the joining faces are joined under joining pressure.

4.2.2 Preparation of welding

Prior to the start of the welding process, the welding temperature set on the heated tool is to be checked. This is done e. g. by means of a fast-indicating measuring device for the measuring of the surface temperature. The alignment has to be started 10 minutes after reaching the set temperature at the earliest.

To achieve an optimum welding connection, the heated tool has to be cleaned with non-fuzzy paper before every welding operation. The anti-adhesive coating of the heated tool must be free of damages in the working zone.

Prior to clamping into the welding equipment the joining surface of the pipe has to be scraped by trimming blade or another suitable tool. Shavings have to be removed e. g. by a brush or a paper.

The joining areas of the pipe – unless clean – and the tapping tee have to be cleaned with a dregreasing agent (e. g. technically pure wine spirit with 99.8 % ethyl alcohol, < 0.1 % water in original container). The degreasing agent is to be applied using unused, absorbent, non-fuzzy and non-dyed paper.

The treated welding areas should be neither dirtied nor touched by hand, as a retreatment would be necessary then.

The roundness of the pipe is to be made by the clamps of the welding equipment or corresponding rerounding devices. The fit of the tapping tee face is to be controlled.

Prior welding the required forces for alignment and joining have to be requested out of table from producer of the welding equipment.

4.2.3 Welding procedure

The heated tool, heated to the welding temperature (250 to 270 °C), is introduced between the welding components, and is pressed with an alignment pressure of 0.15 N/mm² to pipe and tapping tee.

After beads have formed (table 3, column 1) the specific set pressure for heating up is reduced to ≤ 0.02 N/mm². The heating time depends on data provided by the manufacturer of the fitting.

When the heating time is elapsed the shaped heating tool is to be withdrawn so, that the heated joining faces are neither damaged or contaminated. The joining areas should be joined together promptly after. The changeover time should be as short as possible (maximum value see table 3, column 3).

After complete cooling the welding fixture is allowed to be removed.

Short version of processing instructions see appendix.

5 Electro fusion welding

5.1 Description of method

The joining areas, that means the pipe surface and the inside of the fitting, are overlapped and the resistance wire inside the fitting (heating-coils) are heated up by electric current (Plastification). The weld is caused by the effect of heat expansion (joint pressure) during the welding time (see figure 6).

5.2 Welding equipment

The welding equipment has to supply the required voltage for the electrofusion-joint The device must switch off as soon as the necessary quantity of heat has been fed to the welding zone. The welding equipment must be adjusted to the Electrofusion fittings.

Table 3. Recommended values for the heated tool butt welding of tapping tees made from PE-HD at ambient temperature of 20 °C and at moderate air flow.

1	**Alignment** under p = 0.15 N/mm² Bead height on heated tool at the end of the alignment time **mm** (minimum value)	1.0
2	**Heating-up** under p ≤ 0.02 N/mm² heating-up time **s**	according to manufacturers data
3	**Changeover** maximum time **s**	10
4	Joining pressure build-up time **s**	5
5	Cooling time under joining pressure p = 0.15 N/mm² **min** (minimum value)	15

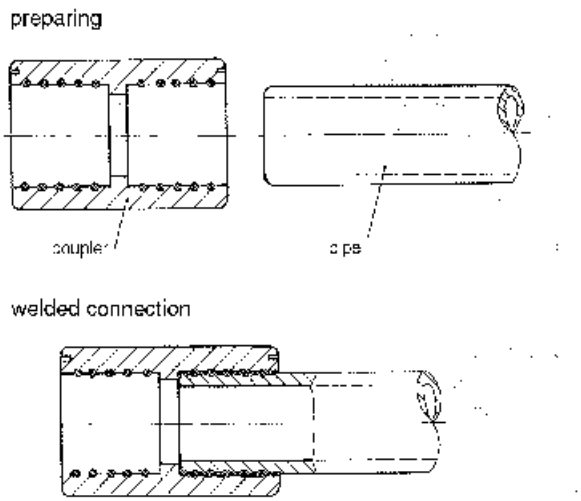

Figure 6. Electro fusion welding (principle).

5.3 Preparation of welding

Clean surfaces are very important for the fabrication of perfect welding joints.

The end of the pipe must be of nominal diameter in the area of the heating coil. The pipe surface has to be scraped in the welding zone and the pipe end has to be burred outside. Ovality must not exceed 1.5 % of the outer diameter in the welding zone. If necessary, corresponding rerounding devices have to be used. The preparation of the joining areas has to be done immediately prior welding is started.

5.3.1 Electrofusion welding of fittings

The welding zone of the pipe has to be treated mechanical.

If a clean surface by scraping cannot be guaranteed, the surface – as far as required by the fitting manufacturer – and the welding areas of the fitting have to be carefully cleaned by means of degreasing agents (e. g. technical clean spirit) and absorbent, non-fuzzy and non-coloured paper. Ovality must not exceed 1.5 % of the outer diameter in the welding zone.

Use a marking or suitable device so that the plug in depth of the pipe can be checked. The fitting must not be canted or pushed into the end of the pipe using force.

The contact sleeves for connecting the welding cable must be located so that they are easily accessible.

The pipes have to be cut rectangular with a suitable tool. The pipe ends have to be treated according to the instructions of the fitting manufacturer.

5.3.2 Electrofusion welding of tapping tees

The welding zone of the pipe has to be treated mechanical.

If a clean surface by scraping cannot be guaranteed, the surface – as far as required by the tapping tee manufacturer – and the welding areas of the tapping tee have to be carefully cleaned by means of degreasing agents (e. g. technical clean spirit) and absorbent, non-fuzzy and non-coloured paper. Clamp the tapping tee onto the pipe using suitable devices.

Ovality must not exceed 1.5 % of the outer diameter in the welding zone. If necessary, corresponding rerounding devices have to be used.

5.4 Welding procedure

The welding equipment is connected by a cable with the part to be welded. The welding cable has to be placed without weight loaded. The contact areas must be clean. The required data of the fitting or tapping tee for the welding process are taken automatically by the welding equipment or must be inserted. After starting the welding process it is finished automatically. The welding time is usually shown on the welding equipment. It has to be inserted to the welding protocol as also other shown data from the welding machine, as far as no data record is done.

The parts to be welded have to be secured by suitable measures resp. devices against change of position. The connection may be moved only after cooling down. The fitting resp. mounting manufacturer supplies corresponding information.

Short version of handling instructions see appendix.

6 Heated tool socket welding

6.1 Description of method

In heated tool socket welding (see figure 7), pipe and pipeline component are welded in overlapped condition. Pipe end and fitting are heated up to welding temperature by a socket or spigot-shaped heated tool and subsequently joined together.

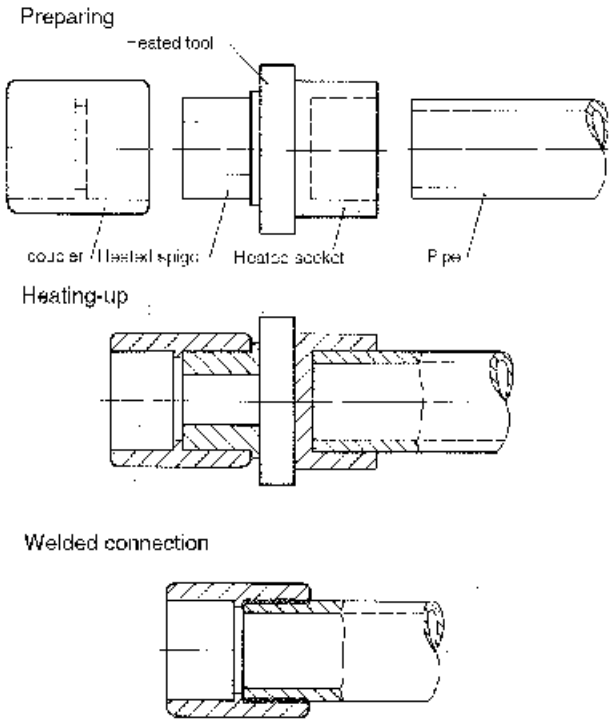

Figure 7. Heated tool socket welding (principle).

Heating tools and fittings are dimensionally adapted so that on joining a joining pressure will be built-up. Heated tool socket welding can be performed manually up to 50 mm pipe diameter. At diameters as from 63 mm, a welding device is required because of the higher joining force.

6.2 Welding device

The heated tools are heated electrically and are coated anti-adhesively.

6.3 Preparation of welding

The treatment of the joining areas of the welding components should take place immediately before welding is started. The pipe end has to be bevelled according to figure 8 and table 4. The joining area of the pipe is to be treated according to the manufacturers guidelines. At manual weldings the insert depth is to be marked on the pipe with distance l according to table 4 afterwards.

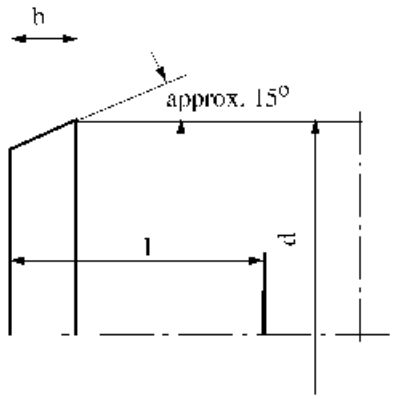

Figure 8. Bevelling of the pipe end.

The inside of the fitting has to be cleaned thoroughly with a degreasing agent (e. g. technical clean spirit) and absorbent, non-fuzzy and non-coloured paper.

Before welding starts, the welding temperature (250 up to 270 °C) set on the heated tool has to be controlled. This checking is done by means of a fast-indicating surface temperature measuring device. The heated tool may be inserted 10 minutes after reaching the set temperature at the earliest.

Heating socket and heating spigot must be free of contaminations and should be cleaned before welding with an absorbent, non-fuzzy and non-coloured paper. The anti-adhesive coating of the heating spigot and heating socket must be free of damages in the welding area.

6.4 Welding procedure

For the purpose of heating, fitting and pipe are pushed swiftly and axially until the stop at machine welding resp. until the mark at manual welding onto the devices fitted on the heated tool and held there. It has to be avoided that the pipe is pushed onto the end of the heating socket. Afterwards, the heating-up time starts according to the time values in table 5, column 2.

After the heating time has elapsed, fitting and pipe should be withdrawn sharply from the heated tool and pushed together immediately without any twisting until the stop or mark (maximum adjusting time see table 5, column 3).

At manual weldings the joined components have to be fixed according to the time mentioned in table 5, column 4. The connection may be loaded by further installation works only after cooling time is over (table 5, column 5).

Table 4. Values for pipe chamfer and insert depth.

Pipe diameter d [mm]	Pipe chamfer b [mm]	Insert depth l [mm]
16	2	13
20		14
25		15
32		17
40		18
50		20
63	3	26
75		29
90		32
110		35
125		38

Table 5. Recommended values for the heated tool socket welding of pipes and pipeline components made from PE-HD, at ambient temperature of 20 °C and at moderate air flow.

1	2		3	4	5
Pipe outside diameter mm	Heating-up time s		Changeover	Cooling	
	for PN 10 SDR 11[2]	for PN 6 SDR 17.6[2]	(maximum time) s	fixed s	Total min
16	5		4	6	2
20	5		4	6	2
25	7	[1]	4	10	2
32	8	[1]	6	10	4
40	12	[1]	6	20	4
50	12	[1]	6	20	4
63	24	[1]	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] Due to the low wall thickness, the welding method is not recommended.
[2] Standard Dimension Ratio ~ d/s

Table 6. Possible test methods for welding connections.

Test method	heated tool butt welding		Electrofusion welding		heated tool socket welding
	sheets, pipes, fittings	Tapping tees	fittings	tapping tees	
Visual test	DVS 2202-1 table 1, cont. no. 1-9	welded joint even formed and existing on the whole circumference	DVS 2202-1 table 3,cont. no. 1-5	DVS 2202-1 table 3, cont. no. 6+7	DVS 2202-1 table 2, cont. no. 1-5
		The mechanical treatment of the pipe surface has to be visible outside of the welding area.			
Radiation test	Applicable Statement about e. g. holes, not about quality are possible	Not meaningful			Applicable Statement about e. g. holes, not about quality are possible
Tensile test	DVS 2203-2 short-term factor. DVS 2203-4 long-term factor. Factors according to DVS 2205-1, table 3	Not applicable			
Technological bending test	DVS 2203-5 Minimum bending angle according to DVS 2203-1, figure 1	Not applicable			
Long time internal pressure test	DIN 16963-5, section 3.2.3.1, length of every pipe piece according to DIN 16963 table 5. Not meaningful for long-term welding factor > 0.5	DIN 3544-1, section 2.3 and 3.2 at 80 °C	DIN 16963-5, section 3.2.3.1 and 4.2 at 80 °C	DIN 3544-1, section 2.3 and 3.2 at 80 °C	DIN 16963-5, section 3.2.3.1 and 4.2 at 80 °C

7 Testing of welded joints

Various tests can be used to test the quality of individual welding processes. Differentiation is made between destructive and non-destructive tests. Details of these are contained in table 6. Tests and sampling can be carried out prior to or during welding work-according to agreement.

8 Valid standards and directives

DIN 3543-4	Tapping tee fittings of rigid polyethylene for pipes of rigid Polyethylene; dimensions
DIN 3544-1	Fittings of rigid polyethylene; requirements and testing of tapping tee fittings
DIN 8074	Pipes of polyethylene, PE 63, PE 80, PE 100; dimensions
DIN 8075	Pipes of polyethylene, PE 63, PE 80, PE 100; general quality requirements and testing
DIN 16776-1	Polethylene moulding materials, classification and designation
DIN 16925	Extruded sheets out of PE-HD; technical terms of delivery
DIN 16963	Pipe joints and pipeline components for pressure pipelines out of PE-HD
DIN 19537	Pipes and fittings out of PE-HD for sewage pipelines
-1	dimensions
-2	technical terms of delivery
DVGW GW 330	Welding of pipes and pipeline components out of PE-HD for gas and water mains; training and testing scheme
DVGW GW 331	PE-welding superviser
DVS 2202-1	Failures on welded joints of thermoplastics; features, description, evaluation
DVS 2203	Testing of welded joints of thermoplastics:
-1	test methods, requirements
-2	tensile test
-4	long time tensile test; testing of fitting/pipe joints supplement 1 (draft)
-5	Technological bending test
DVS 2205-1	Calculation of bins and gadgets out of thermoplastics; characteristics values
DVS 2208-1	Machines and equipment for the welding of thermoplastics; heated tool welding
DVS 2212-1	Testing of plastic welders; test group I, subgroup 5 resp. 6

9 Explanations

For the heat tool butt welding of pipeline components made from PE-HD, the directive DVS 2207-1 – pipes and pipeline components for gas and water mains, 5.84 – and DVS 2207-2 – sewage pipes, 3.86 – were valid. The contents of both parts were unified. Requirements for the gap width between the treated welding areas subject to the pipe diameter are valid also for pipes used in gas- and water applications.

Table 2 has been adapted to the latest technical knowledge (bigger wallthicknesses, enhanced welding equipment and new pipeline components). The non-contact heated tool welding is currently discussed in the working group.

The validity for pipes, pipeline components and fittings has been completed by sheets in the heated tool butt welding method.

Appendix: Processing instructions (short versions)

To 4.1 Heated tool butt welding of pipes, pipeline components, fittings and sheets

Processing instruction (short version)

1. Take care for allowed working conditions. e. g. welding tent.
2. Connect the welding equipment to the net or alternating current generator and control the function.
3. Adjust and clamp the parts to be welded under easy axial movement e. g. by dollies.
4. Treatment of connection areas. at pipes e. g. by planing tool.
5. Take off the planing tool at the pipe welding machine.
6. Remove shaves from the welding area (broom, brush, paper).
7. Close the pipe ends against air movement.
8. Check the plane-parallelity by coming together with the joining areas (maximum gap width according table 1).
9. Check the misalignment (maximum 0,1 x wall thickness).
10. Check the heated tool temperature subject to the wallthickness (figure 3)
11. Clean the heated tool with non-fuzzy paper.
12. Read the moving pressure resp. moving force from the pipe welding machine and insert it to the welding protocol.
13. Determine the value for aligning, heating-up and joining pressure.
14. Fix the guide values according table 2.
15. Set the heated tool to the welding position.
16. Align the welding areas to the heated tool until a bead arises (according table 2, column 2).
17. Heating-up with reduced pressure ≤ 0.02 N/mm², heating-up time according table 2, column 3).
18. Remove the connection areas to be welded from the heated tool after finished heating-up time and remove it from the welding position.
19. The joining areas should be joined together within the changeover time (table 2, column 4) immediately until directly before the contact. At contacting, they have to meet with a speed of nearly zero. Build-up a linear joining pressure (table 2, column 5) immediately afterwards.
20. After joining with pressure 0.15 N/mm², a bead must exist. According figure 5, K has to be > 0 on every section.
21. Cooling down under joining pressure according table 2, column 5.
22. Declamping of the welded parts after cooling time.
23. Complete the welding protocol.

To 4.2 Heated tool welding of tapping tees

Processing instruction (short version)

1. Take care for allowed working conditions, e. g. welding tent.
2. Control the function of the welding equipment.
3. Ensure the roundness of the pipe by the clamps of the welding equipment or corresponding rerounding devices
4. Adjust and clamp the parts to be welded under easy axial movement e. g. by dollies.
5. Scrape the pipe surface.
6. Fix the welding equipment onto the pipe.
7. Choose the correct-shaped heating tool.
8. Clamp and adjust the tapping tee.

9. Clean the treated pipe surface – as far as it is contaminated – and the heated tool by means of degreasing agents (e. g. technical clean spirit) and absorbent, non-fuzzy and non-coloured paper.
10. Determine forces for alignment and joining (table of manufacturer).
11. Check the welding temperature (250 to 270 °C).
12. Set the heated tool to the welding position.
13. Align the welding areas to the heated tool until a bead of 1 mm arises.
14. Heating-up with reduced pressure ≤ 0.02 N/mm², heating-up time according to manufacturers data.
15. Remove the connection areas to be welded from the heated tool after heating-up time finished and remove it from the welding position.
16. The joining areas should be joined together within the changeover time of maximum 10 seconds.
17. Build up joining pressure within 5 seconds.
18. Cooling down under joining pressure, minimum 15 minutes.
19. Declamping of the welded parts after cooling time.
20. Complete the welding protocol.

To 5.3.1 Electrofusion welding of fittings

Processing instruction (short version)

1. Create permitted working conditions, e. g. welding tent.
2. Connect welding unit to the mains or the a. c. generator and check function.
3. Deburr outer edges of pipe ends cut off at right angles (for connection with fittings).
4. Ensure that pipe ends are round using rerounding clamps, permitted ovality up
   to 1.5 % of outer diamter.
5. Process pipe surface in the welding zone with a scraping tool.
6. If soiled, clean the processed pipe surface and, if applicable depending on manufacturer's instructions, the fitting or tapping tee accessory thoroughly with a degreasing agent (e. g. technically pure wine spirit with 99.8 % ethyl alcohol, < 0,1 % water in original container) and unused, absorbent, non-fuzzy and non-dyed paper.
7. Push pipe into fitting and check insertion depth by marking or using suitable device.
8. Connect cable to fitting. Cable must be free of weight load.
9 Where applicable, check settings/displays on the welding unit.
10. Carry out welding process according to manufacturer's instructions.
11. Disconnect cable from fitting.
12. Observe cooling down time according to manufacturer's instructions.
13. Complete the welding protocol form.

To 5.3.2 Electrofusion welding of tapping tees

Processing instruction (short version)

1. Create permitted working conditions, e. g. welding tent
2. Connect welding unit to the mains or the a. c. generator and check function
3. Ensure that pipe is round using rerounding clamps, permitted ovality up
   to 1.5 % of outer diameter
4. Process pipe surface mechanically in welding zone.
5. If soiled, clean the process pipe surface and, if applicable depending on manufacturer's instructions, the fitting or tapping tee accessory thoroughly with a degreasing agent (e. g. technically pure wine spirit with 99.8 % ethyl alcohol, < 0.1 % water in original container) and unused, absorbent, non-fuzzy and non-dyed paper
6. Fasten tapping tee onto the pipe
7. Connect cable to tapping tee. Cable must be free of weight load.
8. Where applicable, check settings/displays on the welding unit.
9. Carry out welding process according to manufacturer's instructions
10. Disconnect cable from tapping tee
11. Observe cooling time according to manufacturer's instructions
12. Complete the welding protocol form.

To 6. Heated tool socket welding

Processing instruction (short version)

1. Take care for allowed working conditions, e. g. welding tent.
2. Connect the welding equipment to the net or alternating current generator and control the function.
3. Clean the heating tools by non-fuzzy paper.
4. Check the welding temperature (250 to 270 °C).
5. The inside of the fitting has to be cleaned by means of a degreasing agent (e. g. technical clean spirit) and absorbent, non-fuzzy and non-coloured paper.
6. Treat the rectangular cut pipe end according figure 8 and table 4, resp. to the fitting manufacturer instruction.
7. Insert the fitting and pipe simultaneously into the heating spigot resp. the heating socket. The pipe end may not contact the end of the heating socket.
8. Keep the heating-up time according table 5, column 2.
9. Pull off the fitting and pipe and push them swiftly and axially together to the stop resp. mark (maximum adjusting time see table 5, column 3) and held this position (see table 5, column 4).
10. Cool down the connection. Mechanical load of the connection only after finished cooling time according table 5, column 5.
11. Complete the welding protocol.

Protocol form for the Heated tool butt welding of pipes and pipelines components

o laid overground o laid underground	Material	Sheet	of

Customer	Executive company	Welding equipment:	Weather 1 = sunny 2 = dry 3 – rain or snow 4 – windy Order as above in case of multiple nominations (e. g. 34 = rain and wind)
Name of order	Name of welder / Identification No.	Label: Type:	Preventive measures 1 = none 2 = umbrella 3 – tent 4 – heating
No. of order	Name and company of the welding supervisor	Machine No.: Year of construction:	

Weld No.	Date	pipe dimensions ø d × s mm	checked heated tool temperature[1] °C min/max	workpiece movin pressure bar	Joining pressure (data of manufacturer) bar	Set values[2] heating up bar	alignment joining bar	heating-up time[3] s	Joining pressure build-up time[3] s	Change-over time[3] s	Cooling time under joining pressure[3] s	Environmental temperature °C	Code-No. Weather	Code-No. Preventive measures	Notes

Welder signature:	Date and signature of welding supervisor:

[1] From periodic interval, frequency according to 4.1.2.
[2] According to data of equipment manufacturer resp. welding equipment test plus workpiece moving pressure.
[3] Enter measured values.

Protocol form for the Heated tool butt welding of sheets											Material	Sheet	of
Customer			Executive company								Welding equipment:		
Name of order			Name of welder			Identification No.					Label: Type:		
No. of order			Name and company of the welding supervisor								Machine No. Year of construction		
Weld No.	Date	Sheet thickness mm	checked heated tool temperature[1] °C min/max	Set values[2] alignment bar	heating up bar	joining bar	heating-up time[3] s	Joining pressure build-up time[3] s	Changeover time[3] s	Cooling time under joining pressure[3] s	Environmental temperature °C	Notes	
Welder signature:							Date and signature of welding supervisor:						

[1] From periodic interval, frequency according to 4.1.2.
[2] According to data of equipment manufacturer resp. welding equipment test plus workpiece moving pressure.
[3] Enter measured values.

Protocol form for the Electrofusion welding of pipes and pipeline components

o laid overground
o laid underground

Material

Sheet of

Customer	Executive company		Welding equipment:	Weather 1 = sonny 2 = dry 3 = rain or snow 4 = windy
Name of order	Name of welder	Identification No.	Label: Type:	Preventive measures 1 = none 2 = umbrella 3 = tent 4 = heating
No. of order	Name and company of the welding supervisor		Machine No.: Year of construction:	Order as above in case of multiple nominations (e. g. 34 = rain and wind)

Weld No.	Date	pipe dimension ø d × s mm	Fitting data A	Fitting data B	Fitting data Serial No.	Unit setting manual	Unit setting automatic	Resistance of the fitting[1] Ohm	Secondary voltage[1] Volt	Welding times[2] joining s	Welding times[2] Cooling s	Environmental temperature °C	Code-No. Weather	Code-No. Preventive measures	Operating mode Mains	Operating mode Generator

Welding signature:

Date and signature of welding supervisor:

[1] Enter where applicable according to system used.
[2] Enter measured values.

A = Manufacturer's code
B = Fitting code
1 = Coupler
2 = Angle
3 = T-piece
4 = Reduction
5 = Saddle
6 = Cap
7 = Connecting piece
8 = Fitting

Protocol form for the Heated tool socket welding of pipes and pipeline components

o laid overground

o laid underground

Material

Sheet | of

Customer

Executive company

Welding equipment:

Name of order

Name of welder

Identification No.

Label:

Type:

Machine No.:

Year of construction:

No. of order

Name and company of the welding supervisor

Weather
1 = sonny
2 = dry
3 = rain or snow
4 = windy

Preventive measures
1 = none
2 = umbrella
3 = tent
4 = heating

Order as above in case of multiple nominations (e. g. 34 – rain and wind)

Weld No.	Date	pipe dimensions ø d × s mm	Fitting data[1] A	B	Batch-No.	checked temperature on heated spigot and socket °C	heating up time[2] s	Change-over time[2] s	Cooling[2] Cooling time (pie and coupler fixed) s	Colling time (total) min	Environmental temperature °C	Code-No. Weather	Preventive measures	Notes

Welder signature:

Date and signature of welding supervisor:

[1] These data is to be completed by agreement.
[2] Enter measured values.

A = Manufacturer's code
B – Fitting code

1 = Coupler 2 = Angle 3 = T-piece 4 = Reduction
5 – Cap 6 – Connecting piece 7 – Fitting

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Welding of Thermoplastics

Heated tool welding of pipes, pipeline components and sheets made from PE-HD

Direction DVS 2207-1

(August 1995)

Content:

1 Scope

This standard relates to the heated tool butt welding of sheets according to DIN 16925, the heated tool butt-, the heated tool socket- and the electrofusion welding of pipes, fittings and tapping tees made from PE-HD according to DIN 8074 and DIN 8075, DIN 16963, DIN 3543-4 and 3544-1, being used for the conduction of gas, fluids and solids.

With regard to the following instructions, suitability within the melt flow rates MFR 190/5 0,3 g to 1,7 g/10 min may be assumed. Take into account the classification of the melt flow index groups in Figure 1. For the heated tool butt welding of tapping tees restrictions according to section 4.2 have to be attended.

Pipes and sheets within the MFI groups 003, 020 and 022 the MFR value must be controlled (e. g. certificate of the producer). Materials outside the hatched area as well as PE 100 require an additional proof to DVS 2203-4.

2 General requirements

The quality of welding joints depends on the qualification of the welder, the suitability of the used equipment and devices as well as on observance to the welding standards. The welding joint can be tested by means of non-destructive and/or destructive methods.

The welding work must be monitored. Kind and range of supervising has to be agreed between the contract partners. It is recommended to record the welding data in welding protocols (sample see appendix) or on data carriers.

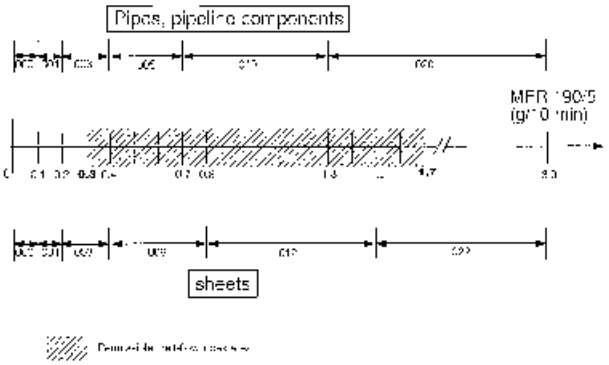

Figure 1. Melt-flow index groups for PE-HD according to DIN 16776-1 (12/84).

Within the frame of the quality assurance it is recommended to perform and test samples of joints before beginning and during the welding works.

Every welder has to be trained and has to be in possession of a valid qualification certificate. The intended application range may be decisive of the kind of qualification. For the heated tool butt welding of sheets as well as in the industrial piping system construction, the standard DVS 2212-1 is valid. For pipes > 225 mm outside diameter an additional certificate of qualification is required.

The training and examination of the welding methods dealt with in this document is described in the relevant directive DVGW GW 330 which applies specifically for the construction of gas- and water pipelines. This directive can be analogously used as qualification proof for the heated tool socket welding and the electrofusion welding in the industrial piping system construction.

The equipment and devices which are used for welding must correspond to the requirements in directive DVS 2208-1. The welding of plastics for indoor applications is described in the guidelines DVS 1905-1 and DVS 1905-2.

3 Measures before welding

The welding zone must be protected against bad weather influences (e. g. moisture and temperatures below + 5 °C). If it is ensured by suitable measures (e. g. preheating, tent, heating) that the conditions are suitable for welding, work may be carried out at any outside temperature insofar as the welder is not hindered in his handling. If necessary, an additional proof must be provided by carrying out sample welds under the mentioned conditions (section 7).

If the semi-finished product is heated up unevenly under influence of sunshine, a temperature compensation in the area of the welding joint can be reached by covering. A cooling down during the welding process by ventilation has to be avoided, e. g. by closing the pipe-ends during welding.

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Pipes from coils are oval immediately after uncoiling. The pipe end must be prepared before welding, e. g. by careful heating up with a hot-air equipment and use of a suitable clamping and/or rerounding device.

The connection zones of the components to be welded must be undamaged and have to be free of contaminations (e. g. dirt, oil, shavings).

4 Heated tool butt welding

4.1 Heated tool butt welding of pipes, pipeline components, fittings and sheets

4.1.1 Description of method

At the heated tool butt welding method, the connection zones of the components to be welded are aligned on the heated tool (alignment), heated up to the welding temperature with reduced pressure (heating-up) and joined under pressure (joining) after removal of the heated tool (tool removal). Figure 2 shows the principle of this procedure.

All weldings must be performed by means of machines and equipment, which correspond to the requirements in DVS 2208-1.

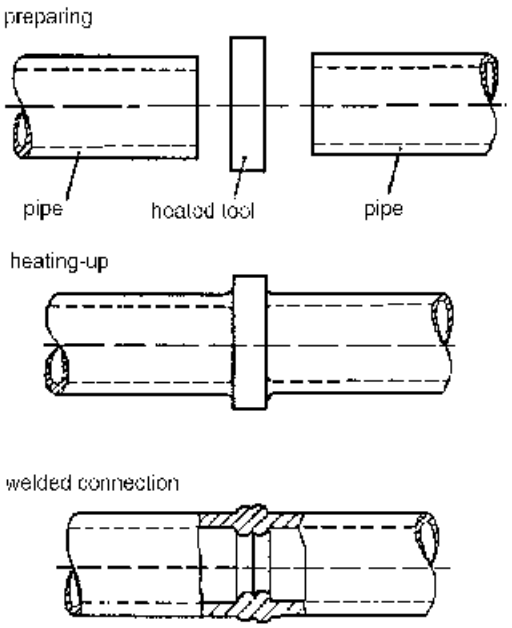

Figure 2. Principle of the heated tool butt welding with example pipe.

4.1.2 Preparation of welding

Prior to the start of the welding process, the welding temperature set on the heated tool is to be checked. This is done e. g. by means of a fast-indicating measuring device for the measuring of the surface temperature. The control measurement must be done within the area on the heated tool which corresponds to the semi-finished product. For adjusting a thermic balance, the heated tool may be inserted 10 minutes after reaching the set temperature at the earliest.

To ensure an optimum welding connection, the heated tool has to be cleaned with an absorbent, non-fuzzy and non-coloured paper before every welding operation. The anti-adhesive coating or covering of the heated tool must be free of damages in the working zone.

The joining forces and joining pressures have to be specified for the machines to be used. These can be based on e. g. manufacturer information, calculated or measured values. Additionally, at the welding of pipes, the workpiece moving force resp. moving pressure is taken from the indicator of the welding machine during the slow displacement of the part to be welded and have to be added to the prior determined joining force resp. joining pressure.

The nominal wall thicknesses of the parts to be welded must correspond in the joining area.

Pipes and fittings have to be aligned in axial direction in the welding machine before the clamping. The easy axial movement of the part to be welded-on can be ensured e. g. by means of dollies or swinging suspension.

The joining areas have to be planed with a clean and grease-free tool directly before the welding, so that they are plane-parallel in clamped condition. Permissible gap width under alignment pressure see Table 1.

Table 1. Maximum gap width between the treated welding zones.

Pipe outside diameter d mm	Gap width mm	Sheet width mm
≤ 355	0.5	
400 ... < 630	1.0	≤1500
630 ... < 800	1.3	>1500 ≤ 2000
800 ... ≤1000	1.5	>2000 ≤ 2300
> 1000	2.0	>2300 ≤ 3000

Both, the gap width and the misalignment have to be controlled. The misalignment of the joining areas on the pipe outside resp. sheet may not pass the permissible size of 0.1 x wall thickness.

The treated welding areas should be neither dirtied nor touched by hand, as a retreatment would be necessary then. Shavings fallen into the pipe have to be removed.

If the gap width of pipes with large outside diameter cannot be kept according to Table 1, it is allowed to achieve the contact of the parts on the heated tool by melting off.

4.1.3 Welding procedure

In heated tool butt welding the welding areas are heated-up to the welding temperature by means of the heated tool and joined under pressure after removing the heated tool. The heated tool temperature is 200 to 220 °C. In principle the upper temperature limit is to aspired for smaller wallthicknesses, the lower temperature limit for bigger ones (see figure 3). The different stages of the process are illustrated in figure 4.

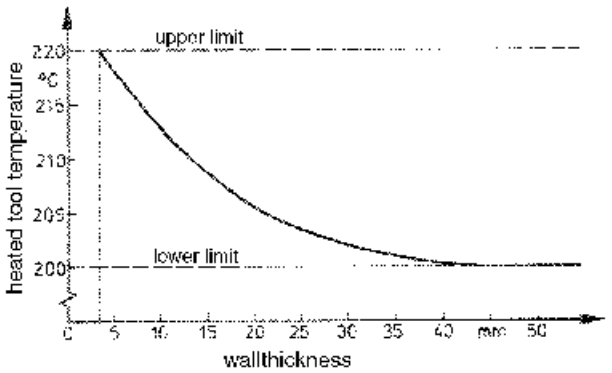

Figure 3. Recommended values for the heated tool temperatures subject to the wallthickness.