8 Jointing methods

8.1 Joint methods

Akatherm HDPE is suitable for High Density Polyethylene, a material made with welded joints. Secure and durable connections lasting 50 to 100 years. Welded joints are made without the need for glue or rubber ring joints and are actually stronger than the surrounding piece of pipe or fitting. HDPE welded joints are both pull tight and leak proof, once tested there is very little risk of future failure because of the flexibility, impact resistance and overall toughness of the material.

Besides welded joints Akatherm HDPE pipes and fittings can be joined by different methods, depending on the applications. Joints are divided in welded/mechanical and pull-tight/not pull-tight. Pull tight joints can't come apart under influence of external forces.

To be opened (dismountable)
Jointing methods which can be disconnected after assembly. These jointing methods are ideal for pipe sections which need to be cleaned, calibrated, inspected or dismantled on a regular basis.

Not to be opened (fixed)
Jointing methods which cannot be disconnected after assembly. These are permanent joints in which the joints can remain closed for their lifetime.

Tension-resistant (pull tight: PT)
This are connections which withstand tensional forces. This is ideal when thermal movement is expected or gravity pulls on the connection.

Non-tension-resistant (not pull tight: NPT)
This are connections which cannot withstand tensional forces. This joint is used when the pipe system is designed to accommodate movement without risk that the joint is pulled apart.

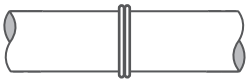
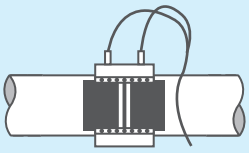
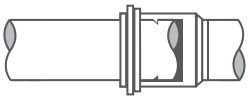
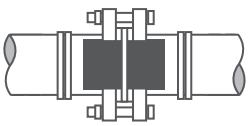
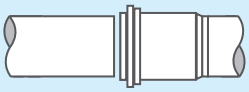
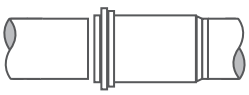
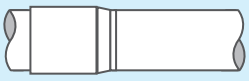
Jointing technique	Product	Welded/mechanical	Pull-tight	Dismountable
Butt-weld joint		Welded	Yes	No
Electrofusion		Welded	Yes	No
Snap socket		Mechanical	Yes	No
Screw coupler		Mechanical	Yes	Yes
Flange		Mechanical	Yes	Yes
Plug-in socket		Mechanical	No	Yes
Expansion socket		Mechanical	No	Yes
Contraction joint		Mechanical	No	No

Table 8.1

8.2 Butt-weld joint

Butt-welding is an economical and reliable way of jointing without using additional components requiring only butt-welding equipment.

All Akatherm products can be welded using this jointing method (DVS 2207-1). Fittings can be shortened by up to the k-dimension when indicated in the catalogue, still allowing butt-welding. This jointing method is very suitable for prefabrication and producing special fittings.

Preparations
Before starting the welding process it is important to establish a work space where the jointing can be done consistently:

- The temperature of the welding plate needs to be between 200°C and 220°C. In general it is advisable to consider welding with higher temperatures in this temperature range when welding pipes and fittings with small wall-thickness. Pipes and fittings with a relative higher surface area need to be heated more slowly
- Ensure that the welding plate has reached the correct temperature and is thoroughly heated. In order to do so allow for a 10 minute heating period after the correct temperature is measured initially
- Before welding clean the heating element with paper and a pre approved cleaning solution (ensuring 100% evaporation). Ensure that the heating surface is undamaged
- Establish a work space where the jointing can be done without being affected by major weather conditions. The use of wind shields is advised to keep the weld plate at a constant temperature
- The functionality of the butt welding equipment needs to be checked regularly. Especially on those machines which are used at the building site.

Welding process
In general butt-welds are made using an Akatherm butt-welding machine. Only diameters up to 75 mm can be welded by hand. For diameters at 90 mm and above the welding pressure is too big to make a good weld by hand. The welding process consists of the following steps:

- Preheat: Push the pipe/fittings against the heating plate until the required welding bead has been formed (refer to appendix B)
- Heating up: Hold the pipe/fittings against the heating plate with no pressure (for time see appendix B)
- Change over, welding and cooling: When the spigots are thoroughly heated both parts need to be joined as quick as possible using a gently buildup of pressure. Moving the parts during or after cool down is not permitted. Keep the parts jointed together under pressure as long as the welding bead is still plasticized. Ensure that the joint is allowed to cool down without any additional load.

Using a butt-welding machine gives a better result under all circumstances.

Machining the surface
Both sides should be machined until they run parallel. When machining is finished, open the carriages (the plastic shavings must be continuous and uniform in both sides to weld).

Verify the alignment between the machined surfaces. remove the plastic shaving. Do not touch and keep machined surfaces clean.

Without removing the oxygen layer a weld cannot be guaranteed. The oxidation layer will form again within one hour.

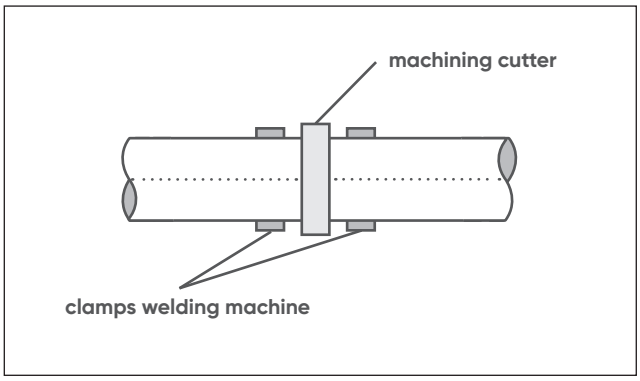


Illustration 8.1 Machining the surface

Preheating under pressure
During heating, the two spigot ends must be placed under low pressure to the heating element (0,2N/mm²). Through contact with the heating element a welding bead will form. The size of the bead is a good indication that the appropriate pressure and time is used. The correct welding bead height and preheating pressure is provided in appendix B.

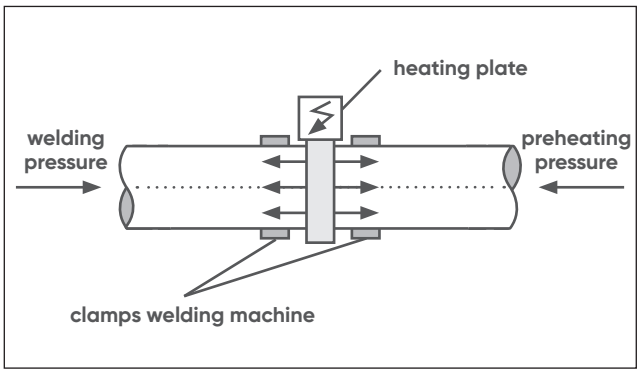


Illustration 8.2 Preheating under pressure

Heating with less pressure
HDPE is a good insulator, therefore at this stage it is necessary that the correct heating depth of the pipe ends is obtained. Only a small amount of pressure 0,01 N/mm² is required to maintain the contact of the ends with the heating element. The heat will gradually spread through the pipe/fitting end. The size of the bead will increase a little. The time and pressure needed for this phase can be found in appendix B.

Change over
Remove the heating element from the jointing areas and immediately join the two end together. Do not push the ends abruptly onto each other. The removal of the heating element needs to be done quickly to prevent the ends from cooling down. The maximum allowed change over times can be found in appendix B.

Welding and cooling
After the jointing areas have made contact they should be joined with a gradual increase in pressure up to the specified value. The build-up of pressure should be done linear and not differ more than 0,01 N/mm^2. When the buildup occurs too fast the plastic material will be pushed away. Contrary, when the buildup is too slow the material cools down before a homogenous weld is formed. In both cases the quality of the weld is questionable. Keep the specified welding pressure at a constant level during the complete cooling period. There must not be any load or strain at the joint.

It is not allowed to artificially cool the joint!

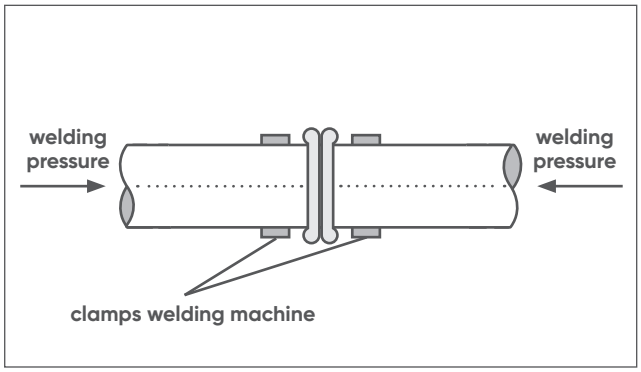


Illustration 8.3

The welded components can be removed from the machine when 50% of the cooling period has elapsed providing the following criteria are met:
- Prefabrication in workplace conditions.
- No load and strain placed on the joint.
- No additional load and strain when the fitting is removed from the clamping equipment.

The weld may only be subjected to full operational load after the cooling time provided in appendix B has elapsed.

Welding by hand
The welding process when welding by hand is in general the same as the welding process by using a machine. The following steps are to be considered

1. **Preheating**: Push the pipe/fittings against the heating plate until the required welding bead has formed (for height of the welding bead see appendix B - welding parameters).
2. **Heating up:** Push the pipe/fittings against the heating plate until the required welding bead has formed (for height of the welding bead see appendix B).
3. **Change over:** As the spigots are thoroughly heated up both parts need to be joined. It is important to minimize the change over time as much as possible. (the maximum allowed change over time is given in appendix B).
4. **Welding:** The jointing has to be carried out accurately. Moving the parts during and after jointing is not possible. (the height of the welding bead is given in appendix B).
5. **Cooling:** Keep the parts jointed together under pressure as long as the welding bead is still plasticized. The joint needs to cool down without any additional load. The use of a support structure is recommended when jointing long pipe parts.

The use of a butt-welding machine is highly preferable and will give better and more consistent results.

Evaluating the butt-weld joint
For evaluation of the butt weld on the job site visual inspection methods can be used. Additional testing can be done using both destructive and non-destructive evaluation methods. For these evaluation methods special equipment may be necessary. For a first visual evaluation consider the following factors:

Shape of the welding bead
The shape of the welding bead is an indication for proper operation of the welding process. Both welding beads should have the same shape and size. The width of the welding bead should be approximately 0,5x the height. The height of the welding bead is provided in appendix B. In illustration 8.4 a good weld is shown with a uniform welding bead.

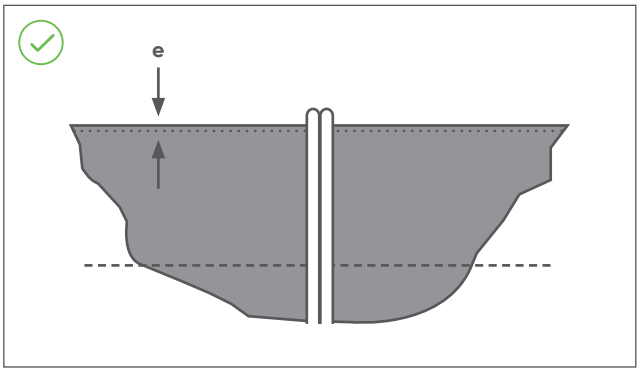


Illustration 8.4 Butt-weld with even welding beads (acceptable)

Differences between the beads can be caused by the difference in HDPE material used in the welded components. Despite the differences in welding bead the butt-weld can be of sufficient strength. In illustration 8.5 a cross-section of a regular, round fusion bead is shown. When differences in welding bead are observed the collar X value is greater than 0.

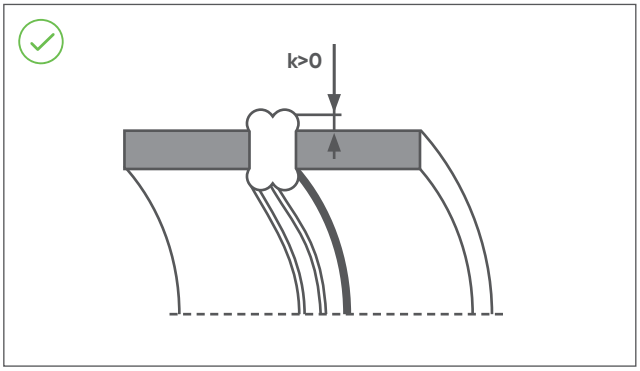


Illustration 8.5 Cross section of a good butt-weld

Alignment
Misalignment between fittings and pipe can occur for several reasons. Oval pipe ends or irregular pipe necking can cause an incorrect fit. If this sagging is less than 10% of the wall thickness the weld can still be classified as acceptable (see illustration 8.6).

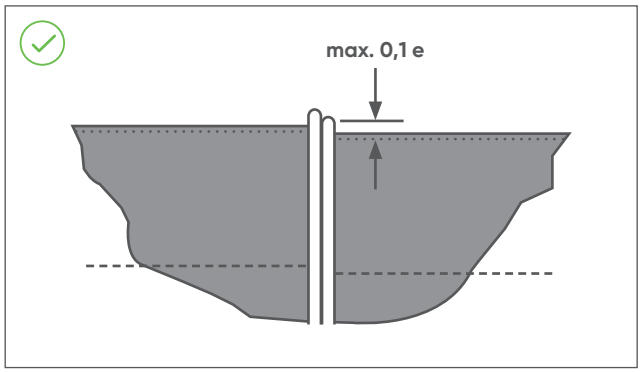


Illustration 8.6 Butt-weld with mis-alignment of pipe (acceptable)

Welding bead size
Illustration 8.7 shows a joint with beads that are too big. The uniformity indicates a good joint preparation. However, heat supply and/or jointing pressure seems to be too high. A purely visual assessment would still classify the weld as acceptable.

Consider illustration 8.5. When the collar value X is greater than 0 the weld can be classified as acceptable regardless of the welding bead shape.

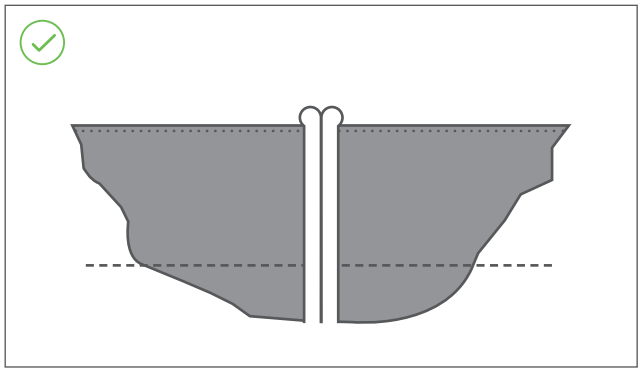


Illustration 8.7 Butt-weld with big welding beads (acceptable)

When there is either insufficient heating up or not enough welding pressure there are hardly any beads. In cases like this thick walled pipes often form shrinking cavities. The weld must be classified as non acceptable

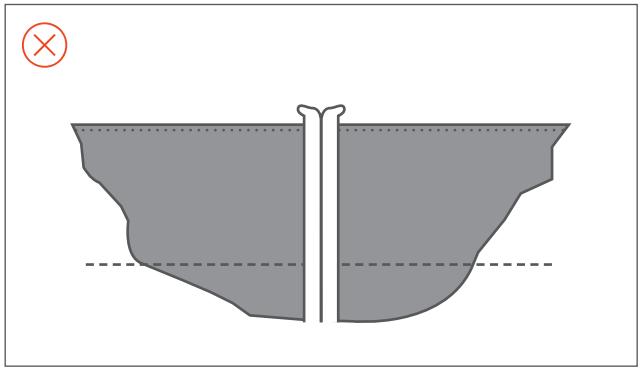


Illustration 8.8 Butt-weld with hardly beads (onacceptable)

8.3 Electrofusion joint

Electrofusion is a rapid and simple way of permanent jointing. Using the electrofusion coupler and equipment, pipe, fittings and prefabricated pipe section can be efficiently assembled.

All Akatherm products can be welded by electrofusion unless specifically stated in the product table.

It is highly recommended to make use of Akatherm electrofusion equipment as compatibility with other welding machines cannot be guaranteed.

Preparations

The following guidelines are to be respected when welding using the electrofusion process:
- Establish a work space where welding can be done without being effect by major weather conditions. The operating temperature of electrofusion control boxes is -10°C/+40°C. Welding above or below these temperatures may not be possible.
- Check if the equipment functions properly. Welding equipment used on site has to undergo regular maintenance. It is necessary to recalibrate the electrofusion control boxes at least every 2 years.
- The resistance wire in the electrofusion coupler lies at the surface for optimal heat exchange. The resistance wires need to be fully covered by the inserted pipe or fitting.

The resistance wires are positioned in the fusion zone. On both sides of the fusion zones, a cold zone prevents the molten HDPE from outpouring thereby containing the fusion process. During the fusion process the pipe/fitting expands and touches the inner coupler wall. The electrofusion joint is made with the pressure caused by the expanding HDPE and the heat from the resistance wires.

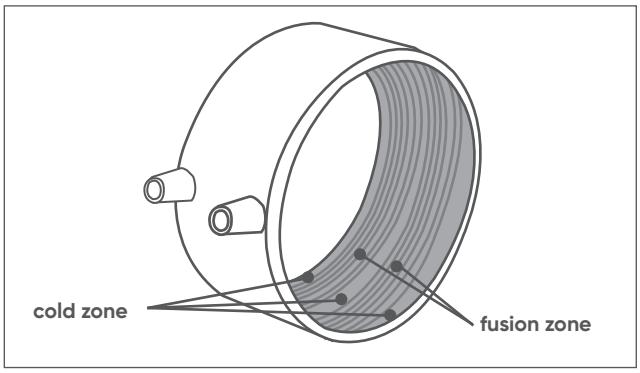


Illustration 8.9

Welding process
In order to make a good electrofusion connection, it is important that the following steps are carried out carefully.

Cut pipe square

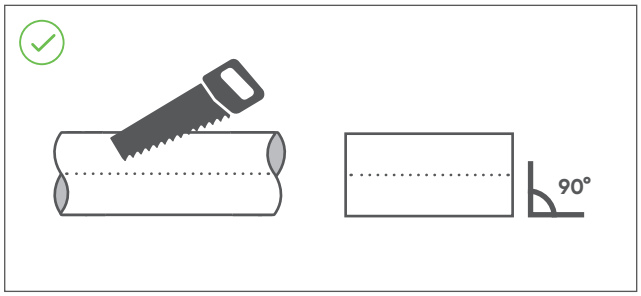


Illustration 8.10

The pipe ends must be cut square to ensure that the resistance wire in the coupler is completely covered by the pipe or fitting

After cutting the pipe ensure that burrs are removed.

Mark surface for scraping
Mark insertion depth to ensure that across the full welding zone the oxidized layer will be removed.

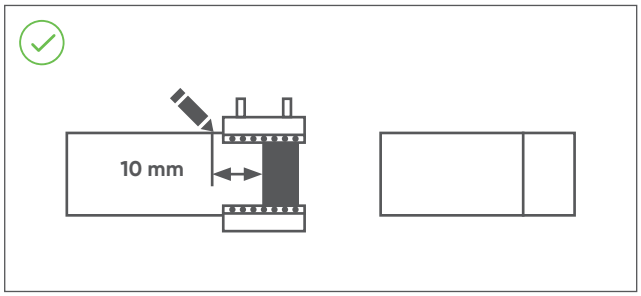


Illustration 8.11

Scrape pipe and mark insertion depth
The full outer surface of the pipe that will be covered by the coupler must be scraped. Scraping depth must be approximately 0,2 mm deep to remove any surface 'oxidation'. The insertion depth should be marked again to safeguard full insertion.

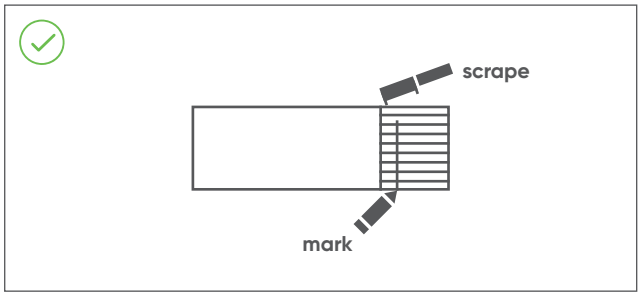


Illustration 8.12

Without removing the oxidation layer a weld cannot be guaranteed. The oxidation layer will form again within one hour. The electrofusion needs to be made right after scraping the ends.

Clean electrofusion coupler
Before assembling the pipes into the coupler ensure that all to be welded surfaces are clean and dry.

Before welding clean the electrofusion coupler and the to be welded spigot ends with paper and a pre approved cleaning solution (ensuring 100% evaporation). Do not touch the inside of the electrofusion coupler or outside of the spigot ends after cleaning!

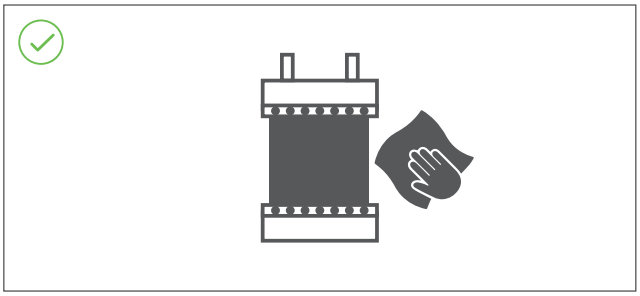


Illustration 8.13

Insert pipe/fitting

Insert pipe/fitting until marked line.

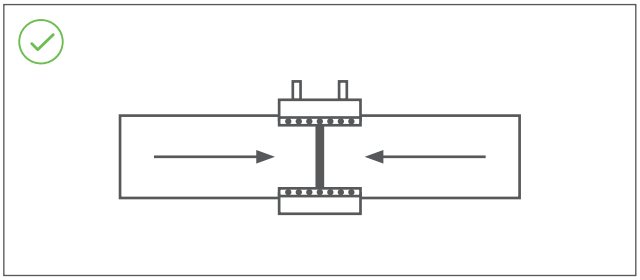


Illustration 8.14

Ensure that the pipe is pushed into the coupler as straight as possible up to the marked insertion depth This will ensure that all the wires are covered with HDPE during the fusion cycle. Misalignment will cause extra load on the fusion zone causing additional HDPE to melt resulting in the outpouring of HDPE or wire movement.

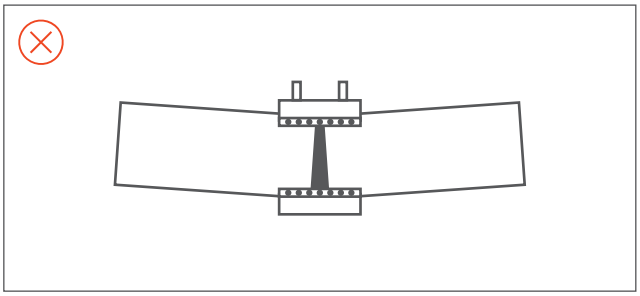


Illustration 8.15

The movement of the pipe can cause melted HDPE to flow out of the joint. This can result in wire movement and possibly a short circuit and thus a bad weld or fire hazard.

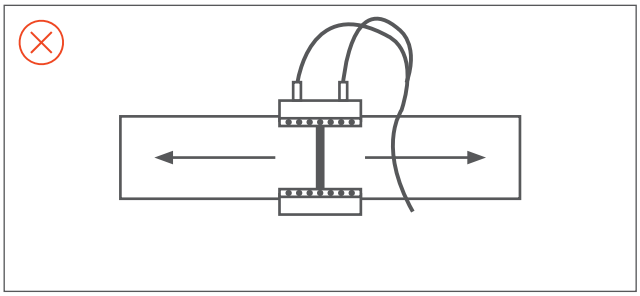


Illustration 8.16

When an electrofusion coupler is used as a repair coupler the center stop is to be removed. This may result in the coupler sliding down when placed vertically. Ensure that the coupler cannot move. Movement may result in short circuit and thus a bad weld or fire hazard.

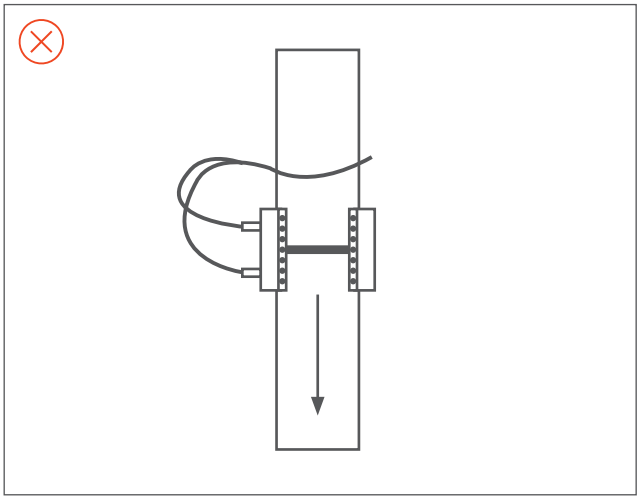


Illustration 8.17

An additional load on the vertical pipe will transfer extra HDPE material to the fusion zone. This will cause movement of the wires and possibly a short circuit and thus a bad weld or fire hazard.

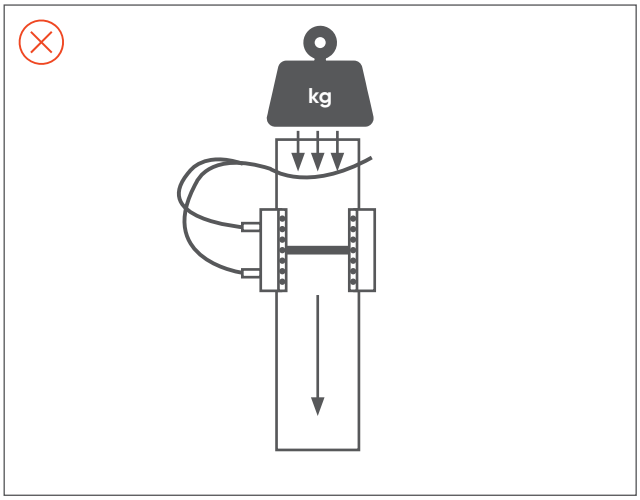


Illustration 8.18

Welding electrofusion coupler and cooling down

After connecting the cables of the control box the fusion process can be commenced by pushing the start button. Both the CB315 and CB160 control boxes adapt the welding time to the ambient temperature. When it is colder than 20°C the welding time is extended and when the ambient temperature exceeds 20°C the welding time is shortened. Welding below an ambient temperature of -10°C is not recommended.

Ambient temperature °C	40-160 mm	200 - 315 mm
-10	97 s	482 s
-5	95 s	469 s
0	92 s	455 s
5	90 s	442 s
10	87 s	428 s
15	84 s	415 s
20	82 s	401 s
25	79 s	388 s
30	77 s	374 s
35	74 s	361 s
40	72 s	347 s
45	69 s	334 s
50	66 s	320 s

Table 8.2 welding time

Cooling times for the 40-160 range are 20 minutes, whilst a cooling time of 30 minutes has to be respected for the 200-315 range products. The cooling period can be reduced by 50% when there is no additional load or strain during cooling (in workshop setting)

Never weld a coupler twice.

During the fusion cycle the right amount of energy is put into the fusion zones. A second fusion cycle would put so much energy into the joint causing the HDPE to melt extensively. This will cause movement of the wires and possibly a short circuit. In the extreme case it may even cause fire.

Assessing an electrofusion weld
Compared to a butt- weld, it is harder to judge a good electrofusion weld. The welding indicators on the electrofusion coupler provide only an indication if the weld has actually been executed. However, they do not guarantee the integrity of the joint. The amount of movement of the pop-out depends on several factors including the size tolerances of the components and any ovality of the pipe or fitting.

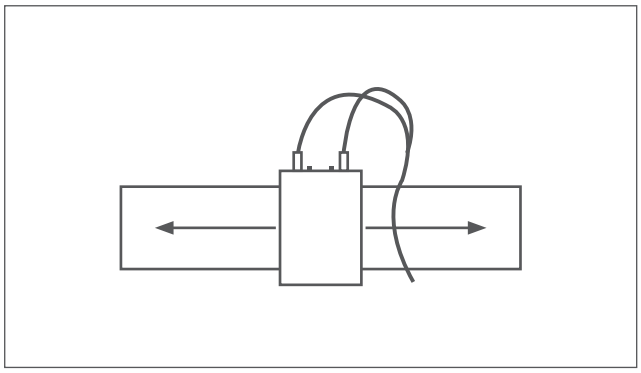


Illustration 8.19

A joint can be marked o.k. when the welding indicators are protruded, all welding preparations such as marking insertion depth, scraping, making sure that there was no additional load during welding and cooling have been executed successfully. If a significant quantity of melt flows out from the fitting after welding, there may be a misalignment of the components, the tolerances may be excessive or a second welding may have accidentally occurred. The integrity of such a joint is suspicious.

Please note that the fitting will become too hot to touch during the welding process. The temperature will continue to increase for some time after the fusion process has been completed.

Deformation
A too big deformation can cause problems during assembly and welding of the components. The maximum allowed deformation of pipe or fitting spigot is 0,02 x d_1. This results in a maximum difference between the largest and smallest diameter corresponding with table 8.3. The pipe or fitting spigot needs to be "rounded" using clamps when the deformation is larger.

diameter d_1 (mm)	d_1 max - d_1 min (mm)
40	1,0
50	1,0
56	1,0
63	1,0
75	1,5
90	2,0
110	2,0
125	2,5
160	3,0
200	4,0
250	5,0
315	6,0

Table 8.3 Deformation pipe

8.4 Rubber ring joint

Plug in joint

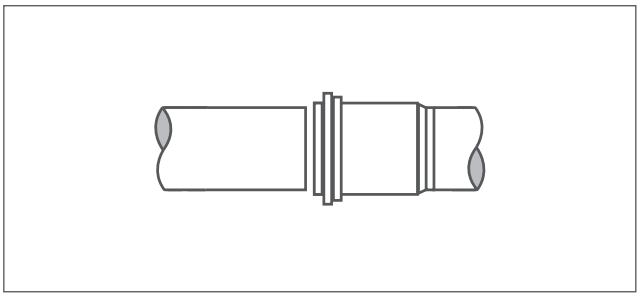


Illustration 8.20

A plug-in joint is an easy to make, detachable and not pull-tight jointing method. Additionally, expansion sockets allow for expansion compensation in the piping system using the same easy to make joint.

Snap joint
For making pull-tight rubber ring joint connections, snap sockets are available. These sockets are rubber ring joints with an additional snap ring which provides, in combination with a groove in the pipe, a pull-tight connection.

Jointing process

1. Cut pipe square and remove burr

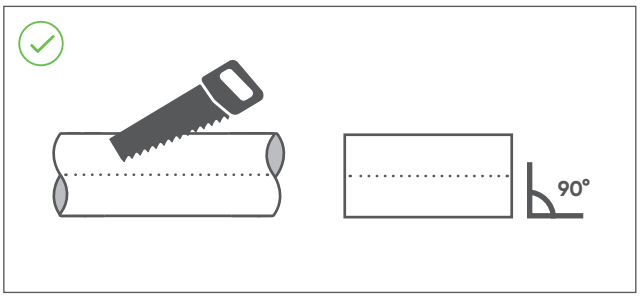


Illustration 8.21

2. Mark Insertion depth

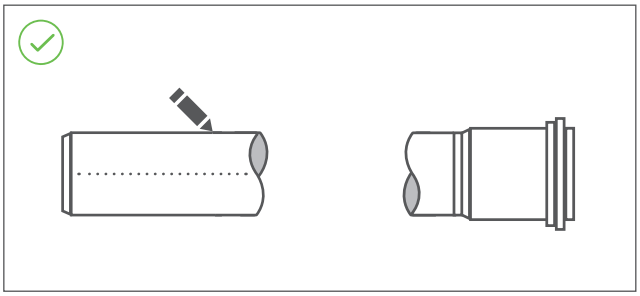


Illustration 8.22

Expansion socket
An expansion socket is used to accommodate the expansion and contraction of a pipe system.

The insertion depth is marked on the socket for both ambient temperatures of 0° and 20°C. For detailed information on insertion depth expansion and socket calculation see paragraph 7.3.1.

3. chamfer pipe end

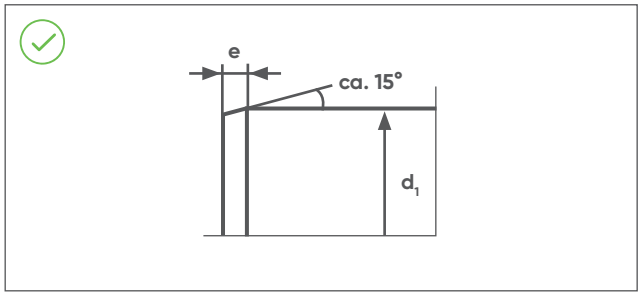


Illustration 8.23 Plug-in joint

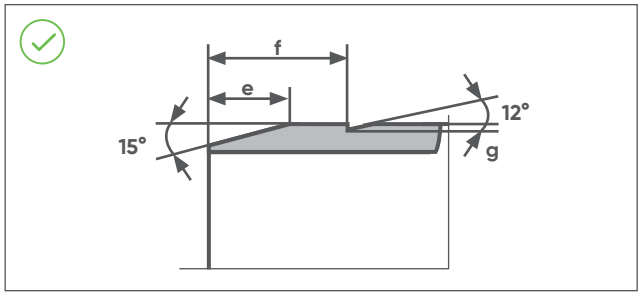


Illustration 8.24: Snap joint

The pipe-ends needs to be chamfered under an angle of 15°. A chamfering tool should be used to get an even cut and chamfer.

When using snap joints a groove needs to be cut under an angle of 12°. The correct dimension can be found in table 8.4. To get an even cut and chamfer it is recommended to use an Akatherm groove cutter.

When no groove is made, the Akatherm snap sockets are detachable like a non pull-tight joint.

d_1 (mm)	e	f	g
40	5	15	1
50	5	15	1
56	5	15	1
63	5	15	1
75	5	15	1
90	6	15	1
110	8	15	1
125	9	15	1
160	11	15	1
200	11	30	2
250	15	30	2
315	18	50	3

Table 8.4 Dimensions chamfer and groove

4. Make joint
Lubricate the pie end and insert the pipe up to the marked insertion dept. When jointing a snap joint a distinguished click can be heard when the snap ring is engaged to the groove.

8.5 Screw-threaded joint

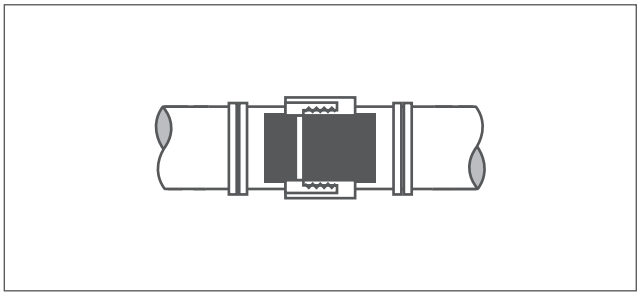


Illustration 8.25

The Akatherm screw threaded joint can be used in both pull-tight and not pull-tight joints.

Not pull-tight joints
In this case the pipe or fitting is inserted directly into the joint.

Jointing process:
- **Cut pipe square and remove burr**
- **Disassemble screw threaded joint**
  Orange protection cap is no longer needed.
- **Assemble joint and insert pipe**
  Push the nut, washer and seal (in this order) over the pipe and insert the pipe end into the threaded piece completely. Tighten nut.
  The washer prevents damage to the seal and delivers an even pressure onto the joint.

Pull-tight joints
In combination with the flange bushing a pull-tight joint can be made.

Jointing process:
- **Cut pipe square and remove burr**
- **Disassemble screw threaded joint**
  Orange protection cap and washer are no longer needed.
- **Assemble joint an insert pipe**
  Push the nut over the pipe before butt-welding the flange bushing onto the pipe. After welding everything can be assembled.
  The flange bushing prevents damage to the seal and delivers an even pressure onto the joint.

8.6 Flange joint

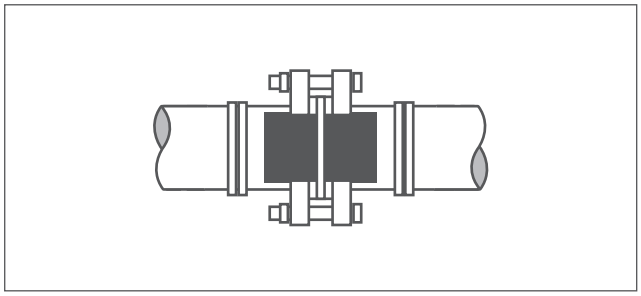


Illustration 8.26

The flanged joint is a detachable joint not that common in soil and waste systems. It is the ideal jointing method to connect the system onto flanged equipment and to install valves. The joint can be made by the following steps:

- Mount backing ring over pipe or fitting
- Weld stub flange to fitting or pipe
- Apply seal
- Mount bolts, nuts and washers and tighten nuts crosswise with the bolt torque of table 8.5

d_1 (mm)	Bolt torque (Nm)
40	20
50	30
56	35
63	35
75	40
90	40
110	40
125	40
160	60
200	70
250	80
315	100

Table 8.5 Bolt torque for non-pressure applications

8.7 Contraction sleeve joint

A simple transition to other materials than HDPE can be made using the contraction sleeve. The sleeve provides a not pull-tight connection and is installed as follows:

- Mark insertion depth on the connecting pipe.
- Connect contraction sleeve to HDPE pipe or fitting using electrofusion or butt-welding.
- Mount the O-ring in the middle of the insertion zone.
- Heat up the contraction sleeve evenly with a torch or an industrial heater. Diameters above 125 mm are best heated up using a second heat source.

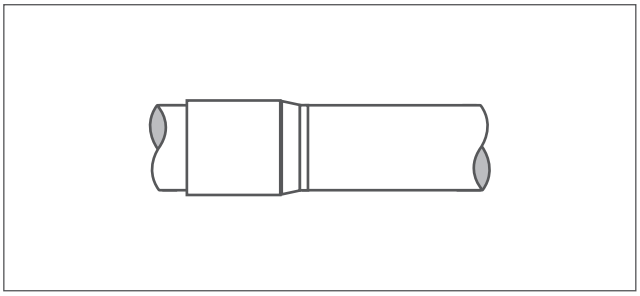


Illustration 8.27

8.8 Metal coupling

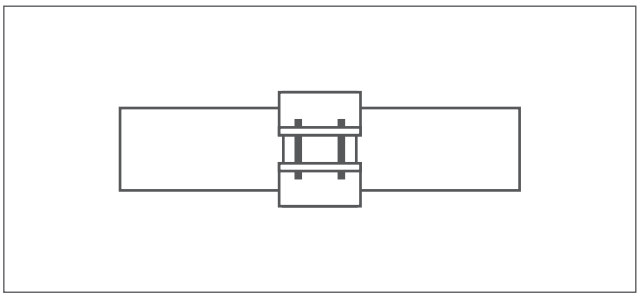


Illustration 8.28

For the transition to another material the standard metal coupler can also be used. Depending on the type, either a pull-tight or not pull-tight joint is possible. To prevent the HDPE pipe from deforming and to disengage from the coupler, a metal support ring should be inserted in the pipe or fitting. The coupling is installed as follows:

- Cut pipe square
- Insert metal support ring into pipe or fitting
- Push connecting pipe ends into coupling
- Tighten nuts with recommended torque