

GENERAL INSTALLATION PRACTICES

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BENDING

Pipe Bending

Many thermoplastic piping systems can be bent to reduce the usage of fittings. Pipe bending procedures are dependent on the intended radius, material, and size and wall thickness of the pipe. Consult with Asahi/America for procedural recommendations.

Polypropylene and HDPE can be bent in the field, but bending PVDF is not recommended.

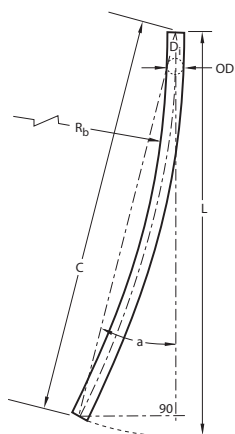


Figure E-1. Asahi/America pipe allowable bend

SOCKET

Socket Fusion

In socket welding, the pipe end and socket fittings are heated to welding temperature by means of a socket and spigot heater inserts. Socket welding may be manually performed on pipe diameters up to 2" (63 mm). Sizes above that require a bench socket tool due to the required joining forces. In sizes greater than 1", a bench style machine may be preferred for ease of operation.

Welding Temperature

The recommended welding temperature for PPH, PPR, PE-HD, and PVDF is between 482°F and 518°F (250°C and 270°C).

Welding Parameters

Table E-1 below can be used as a reference when socket welding PP and PE-HD pipes and fittings at an outside temperature of about 68°F (20°C) with low air-speed rates.

Pipe Size (inches)	A Heat Soak Time (sec)	B Adjusting Time (sec)	C Cooling Time (min)
1/2	5	4	2
3/4	7	4	2
1	8	6	4
1-1/4	12	6	4
1-1/2	18	6	4
2	24	8	6
2-1/2	30	8	6
3	40	8	6
4	50	10	8

Table E-1. Welding Parameters

Welding Process

Hand-Held Socket Fusion

Once the heating element is warmed to the proper temperature, welding proceeds as follows:

1. Follow the welding parameters provided with Asahi/America's socket welding equipment.
2. Follow these steps:
 - a. Cut the pipe faces at right angles, and remove burrs using a deburring tool.
 - b. PE & PP pipe require scraping according to DUS guidelines using Asahi P.R.E.P. tools to remove oxidation
 - c. Clean the pipe and fittings with lint free paper and cleansing agents (isopropyl alcohol or similar).
 - d. Mark the socket depth with a scraper knife or marker on the pipe to ensure proper insertion depth of the pipe during welding.
 - e. Thoroughly clean heater inserts before each weld.
3. Quickly push pipe and fittings in an axial direction into heater inserts until the pipe bottoms (or meets the marking). Avoid twisting while heating. Hold in place for the heat soak time (column A).
4. After the heat soak time, remove the fitting and pipe from the heating element and immediately push them together within the changeover time (column B), without twisting them, until both welding beads meet. The changeover time is the maximum period of time between the removal from the heating element and the final settings of the components.
5. Components should be held together and allowed to cool, per the specified cool-down time, prior to stressing the joint.

Visual Inspection

During the final joining step, it is important that the bead formed on the pipe meets the bead on the fitting. If the beads do not meet, a small gap will be present. Welds that have a gap between the fusion beads should be cut and rewelded (see Figure E-3). The bead on the pipe should be uniform around 360° of the pipe. Beads that vary in size or disappear altogether are a sign of improper heating and/or joining.

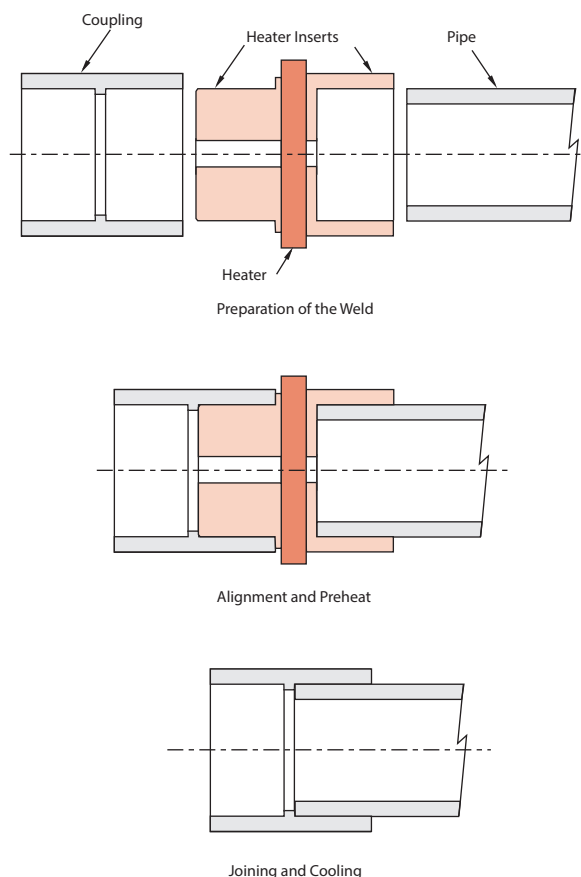


Figure E-2. Socket Fusion Welding Process

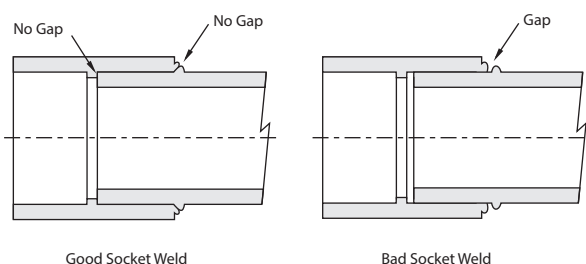


Figure E-3. Socket fusion welding samples

Pipe Size (inches)	A	B	C
	Heat Soak Time	Change Overtime	Cooling Time
1" Pro 150	8	6	240

Table E-2. Sample Welding Data (time-sec)

Performing of Pressure Test

Before pressure testing, all welding joints have to be completely cooled down (as a rule, one hour after the last welding process). The pressure test has to be performed according to the relevant standard regulations. The piping system has to be protected against changes of the ambient temperature (UV radiation).

Devices for heating element socket welding are used in workshops as well as at building sites. As single-purpose machines, they should allow for a maximum degree of mechanization of the welding process.

Clamping Devices

Marks on work piece surfaces that are caused by special clamping devices for pipe components must not affect the mechanical properties of the finished connection.

Guide Elements

Together with clamping devices and a heating element, the guide elements have to ensure that the joining parts are guided centrically to the heating element and to each other. If necessary, an adjusting mechanism can be provided.

Machine Design and Safety in Use

In addition to meeting the above requirements for construction and design, the following points should be considered for the machine design:

- Stable construction
- Universal basic construction (swivelling or retractable auxiliary tools and clamps)
- Quick clamping device
- Maximum degree of mechanization (reproducible welding process)

BUTT/IR

Butt Fusion (for single wall piping systems)

The butt fusion of PP, HDPE, PVDF, and E-CTFE is accomplished with Asahi/America's recommended butt fusion welding equipment. Asahi/America provides welding equipment to handle all diameter sizes offered and has an extensive line of equipment available to buy or rent for every application.

The principle of butt fusion is to heat two surfaces at the melt temperature, make contact between the two surfaces, and then allow the two surfaces to fuse together by application of force. The force causes the flow of the melted materials to join. Upon cooling, the two parts are united. Nothing is added or changed chemically between the two components being joined. Butt fusion does not require solvents or glue to join material.

Butt fusion is recognized as the industry standard, providing high integrity and reliability. It does not require couplings or added material. The procedure, recommended by Asahi/America, conforms to ASTM D-2857 for Joining Practices of Polyolefin Materials and the recommended practices of the ASME B 31.3 Code.

Welding Process

Once the pipes or fittings have been secured in the proper welding equipment, as well as aligned and planed with the facing tool (planer), and the heating element is warmed to the proper temperature, welding proceeds as follows:

- Follow the welding parameters (temperature, time, and force) provided with Asahi/America's butt fusion equipment (see sample welding data in Table E-4).
- Insert the heating element between secured pipes or fittings, making sure full contact is made around surfaces.
- Apply full welding pressure, as shown in (Column A), until a maximum 1/64" ridge of melted material is present around the outside circumference of both pipes or fittings. This indicates that proper melt flow has been accomplished and further guarantees two parallel surfaces.
- Reduce the pressure to the recommended melt pressure (Column B), and begin timing for recommended heat soak time (Column C).
- At the end of the heat soak time, in a quick and smooth motion, separate the pipe fitting from the heating element, and then apply weld pressure (Column E). It is important to gradually increase pressure to achieve welding pressure. The weld must be performed within the allowable changeover time (Column D). Changeover time is the maximum period of time when either the pipes or fittings can be separated from the heating element, yet still retain sufficient heat for fusion. Bring the melted end together to its welding pressure.
- The heat soak time may need to be increased in cold or windy environments. Several practice welds should be conducted at the installation site to ensure that welding can be performed, as a test of conditions. Consult Asahi/America for any modification of weld parameters.
- A visual inspection must be performed as well. After joining, a bead surrounding the whole circumference will have been created. A good weld will have two symmetrical beads on both the pipe and fittings that are almost equally sized and have a smooth surface.
- Allow components to cool to the touch or until a fingernail cannot penetrate the bead. This is recommended in ASTM D-2857, Section 9. The pipes or fittings may be removed from the welding equipment at the completion of the specified cooling time.
- Do not put components under stress or conduct a pressure test until complete cooling time (Column F) has been achieved.

Pipe Size (inches)	A	B	C
	Initial Melt Pressure	Melt Pressure	Heat Soak Time
2" Pro 150	23	2	60

Pipe Size (inches)	D	E	F
	Change Overtime	Welding Pressure	Cooling Time
2" Pro 150	5	23	420

Table E-4. Sample Welding Data (time-sec, pressure-psi)

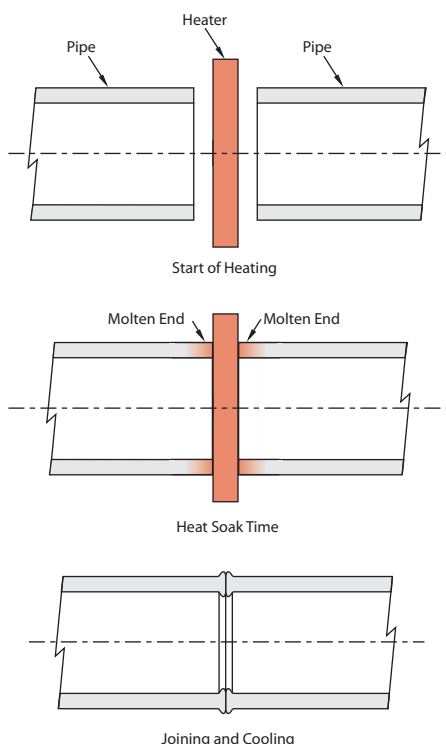


Figure E-4. Butt fusion welding process

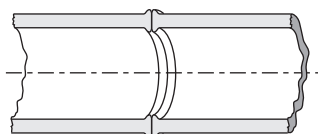


Figure E-5. Butt fusion welding example

Butt Fusion (for double wall piping systems)

Installation of Duo-Pro®, Chem Prolok™, Fluid-Lok®, and Poly-Flo® piping systems involves the use of thermal butt fusion for both the carrier and containment piping. Depending on the system design, the size, material, and layout will determine the required equipment. Asahi/America offers all of the necessary sizes and styles of equipment for any installation type.

Systems that are fully restrained and consist of the same carrier and containment materials can take advantage of the simultaneous butt fusion method. Simultaneous fusion allows for the quickest and easiest installation by conducting the inner and outer weld at once. For Duo-Pro® designs that consist of dissimilar materials or require the inner (carrier) piping to be loose for thermal expansion, use the staggered welding procedure.

Staggered welding consists of welding the inner carrier pipe first and the containment piping second. Finally, if a leak detection cable system is required, special heating elements or procedures are provided to accommodate for pull ropes.

The basic installation techniques for double containment piping systems follow the principles that apply to ordinary plastic piping applications.

Simultaneous Butt Fusion Method

The object of simultaneous fusion is to prepare both the carrier and containment pipe so that both pipes are fixed to each other and therefore can be welded at the same time. In some systems, such as Asahi/America's Fluid-Lok® and Poly-Flo®, only simultaneous fusion can be performed due to their design. The net result of the simultaneous method is a substantial reduction of labor and equipment requirements.

As previously discussed, simultaneous fusion is only applicable for welding installations that have the same carrier and containment material. In addition, simultaneous fusion is used for systems that are completely restrained. Prior to using the simultaneous method, an analysis based on operating conditions is required in order to determine the suitability of a restrained design. Contact Asahi/America's Engineering Department for assistance.

Equipment

For simultaneous welding, standard butt fusion equipment used for single wall systems is used. No special heating elements are required. For Duo-Pro® and Fluid-Lok® systems, hot air or extrusion welding equipment is necessary to weld the support discs and spider clips to the pipes. Hot air welding is not used for any pressure rated components.

Fittings

Fittings used for simultaneous fusion are either molded or prefabricated at the factory with the necessary support discs. Prefabricated fittings greatly reduce the amount of hot air welding required in the field and, in turn, reduce labor time. If an installation is pipe-intensive, labor costs may be reduced by ordering prefabricated pipe spools in longer dimensions.

Welding Procedure

The welding theory for double containment is the same as for single wall pipe. Asahi/America has developed welding tables for the appropriate heating times and forces for simultaneous fusion. The following procedure outlines the necessary steps for simultaneous fusion.

Double Wall Pipe Assembly

Pipes and fittings in a simultaneous double wall system from Asahi/America are always prefabricated at the factory and supplied to a job-site ready for butt fusion. However, when varying lengths are required, in-the-field assembly is necessary. In staggered welding systems, pipe and fitting assembly is common. The basic procedure for properly assembling Duo-Pro® and Fluid-Lok® components is outlined below.

In double containment piping assembly, proficiency in hand and extrusion welding procedures is necessary.

1. A good weld requires proper preparation of the material. The pipe should be free of any impurities, such as dirt, oil, etc. Additionally, some thermoplastics develop a thin layer of oxidized molecules on the surface that require scraping or grounding of the material. Another effect, especially with HDPE, is the migration of unchained lower density molecules to the surface caused by internal pressure of the material. This gives the usually “waxy” surface appearance of HDPE. Grinding or scraping is required. Wipe off any dust with a clean cloth. Do not use solvents or cleaners; they introduce chemicals with unknown and likely negative effects.

2. Using Table E-5, place the molded or fabricated support spider clips, with tops aligned, on the carrier pipe, and then hot gas (PP) or extrusion weld (HDPE) the clips into place, as shown in Figure F-6. Use the required amount of clips on the full lengths of the carrier pipe.

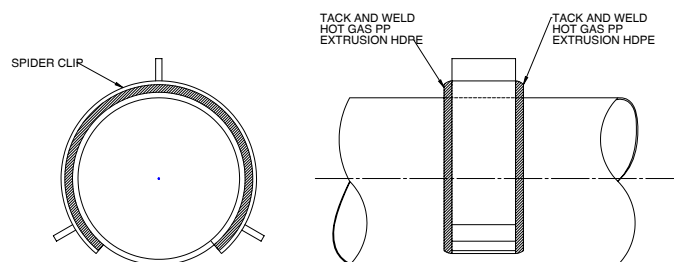


Figure E-6. Spider clip attached to carrier pipe

3. Insert carrier pipe into containment pipe. Be sure the two pipes have been stored in the same environment for equal expansion or contraction to occur before welding end centralizers into place.

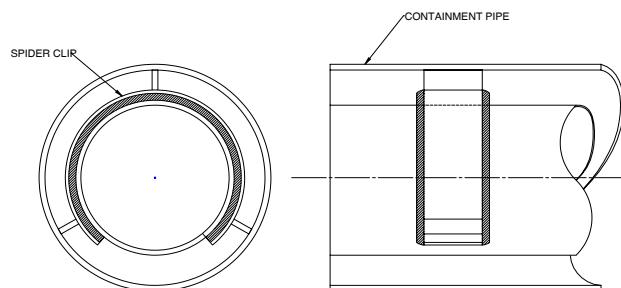


Figure E-7. Carrier pipe and spider clips inserted into containment pipe

4. For simultaneous welding, end centralizers, known as support discs, are hot air or extrusion welded to the carrier and containment pipes. This prevents any movement of the carrier pipe during the butt fusion process. The alignment must match that of the spider supports for the installation of leak detection cables, as well as for leak flow. In fitting assemblies, install end centralizers only. All centralizers are installed approximately 1” from the ends using a 4mm welding rod.

Carrier	Pro 150	Pro 45	PVDF	Halar	HDPE 11	HDPE 17	HDPE 32
1"	42	NA	42	44	30	NA	NA
2"	54	NA	54	59	42	36	NA
3"	66	NA	66	69	48	42	36
4"	72	42	72	72	54	48	42
6"	84	48	84	NA	66	60	54
8"	90	48	90	NA	78	72	60
10"	102	54	102	NA	84	78	66
12"	114	60	114	NA	96	84	72
14"	120	66	NA	NA	102	90	78
16"	126	72	NA	NA	108	96	84
18"	138	78	NA	NA	114	102	90
20"	NA	78	NA	NA	120	108	96

NOTE: At 68°F (See Appendix A for temperature deratings).

Table E-5. Double Containment Internal Support Spacing (inches)

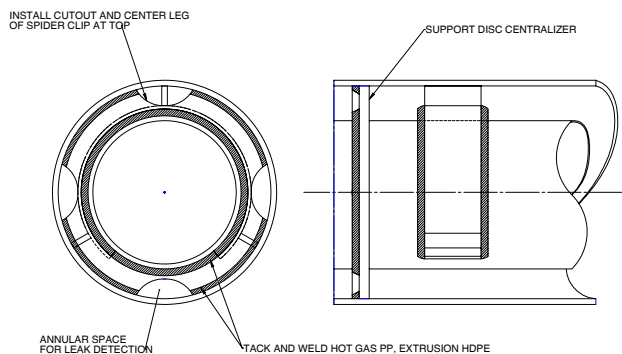


Figure E-8. Support disc attached to carrier and containment pipes

5. The pipe and fitting with support discs are now ready for simultaneous butt fusion using the recommended ASTM D-2857 joining practices.

Butt Fusion Procedure for Double Wall Pipe Without Leak Detection Cable Systems

Simultaneous fusion as outlined below is ideal for:

- Duo-Pro® systems made of similar carrier and containment material
- Fluid-Lok® HDPE systems
- Restrained double wall systems only
- All Poly-Flo® systems

Fusing Duo-Pro® and Fluid-Lok® is accomplished with Asahi/America's recommended butt fusion welding equipment. Asahi/America provides welding equipment to handle all diameters and system configurations. Equipment is available for rental or purchase.

The principle of butt fusion is to heat two surfaces at a fusion temperature, make contact between the two surfaces, and then allow the two surfaces to fuse together by application of force. After cooling, the original interfaces are gone and the two parts are united. Nothing is added or changed chemically between the two pieces being joined.

Butt fusion is recognized in the industry as a cost-effective joining method of very high integrity and reliability. The procedure, recommended by Asahi/America, conforms to ASTM D-2857 for Joining Practices of Polyolefin Materials and the recommended practices of the ASME B 31.3 Code (Chemical Plant and Petroleum Refinery Piping).

The procedure is outlined as follows: Once the pipes or fittings have been secured in the proper welding equipment with the tops and annular space aligned, and the heating element is warmed to the proper temperature, welding should proceed as follows:

1. Follow the welding parameters provided with Asahi/America butt fusion equipment (see sample welding data in Table E-6).

Pipe Size (inches)	A	B	C
	Initial Melt Pressure	Melt Pressure	Heat Soak Time
2" x 4"	49	5	60

Pipe Size (inches)	D	E	F
	Change Overtime	Welding Pressure	Cooling Time
2" x 4"	4	49	420

Table E-6. Sample Welding Data (time-sec, pressure-psi)

2. To ensure that the carrier pipe is planed and flush with the containment pipe, put four marks on the end of the carrier pipe at three, six, nine, and twelve o'clock prior to planing. If the outer pipe is completely planed and the marks on the carrier have been removed, planing is complete. With experience, visual inspection can determine that the planing process is complete. Remove all shavings, and recheck alignment. For Poly-Flo®, the pipes should be installed in the machines so that the ribs do not align, thereby allowing any fluid to flow to the low point of the annular space in the event of a leak.

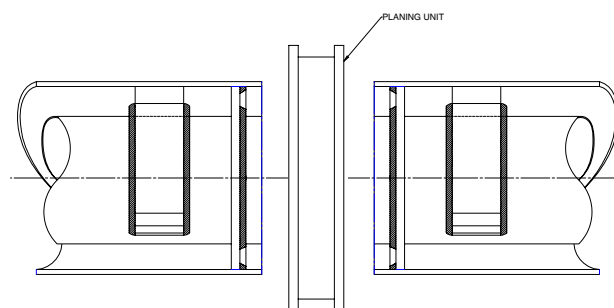


Figure E-9. Plane carrier pipe flush with containment pipe

3. Insert a heating element between secured pipes or fittings, making sure full contact is made around surfaces.

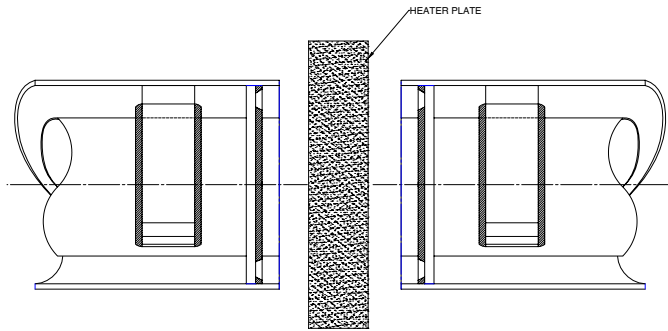


Figure E-10. Insert heating element between pipe ends

4. Apply full welding pressure (as shown in Table E-6, Column E) until a maximum 1/64" ridge of melted material is noticed around the outside circumference of the components. This indicates that proper melt flow has been accomplished and further guarantees two parallel surfaces.

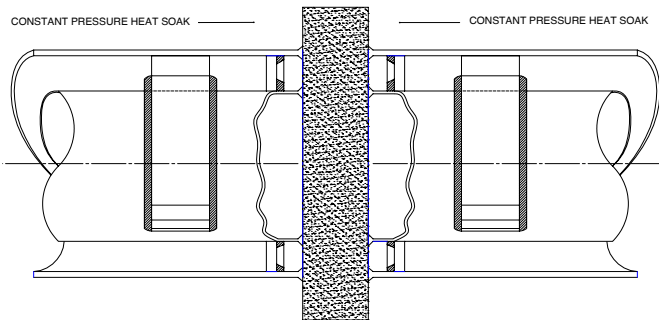


Figure E-11. Apply welding pressure to the heating element

5. Reduce the pressure to the recommended melt pressure (Column B), and begin timing for the recommended heat soak time (Column C).
6. At the end of the heat soak time, in a quick and smooth motion, separate either the pipes or fittings, remove the heating element, and then apply weld pressure (Column E). It is important to gradually increase pressure to achieve welding pressure in Column E. The weld must be performed within the allowable changeover time (Column D). Changeover time is the maximum period of time when either the pipes or fittings can be separated from the heating element, yet still retain sufficient heat for fusion. Bring the melted ends together to its welding pressure.

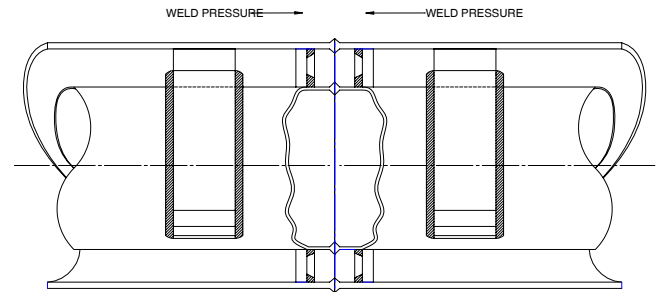


Figure E-12. Bring pipe ends together, and apply welding pressure

7. The heat soak time should be increased if the environment is cold or windy or if either the pipes or fittings are cold. As a test of environmental conditions, several practice welds should be done at the installation site to ensure that welding can be performed. Consult with Asahi/America for recommendations on cold weather welding.
8. A visual inspection must be performed as well. After joining, a bead surrounding the whole circumference will have been created. A good weld will have a symmetrical bead on both pipes or fittings and a smooth surface.

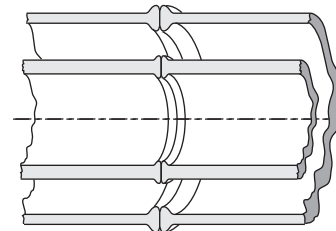


Figure E-13. Visual inspection of welds

9. Allow components to cool to the touch or until a fingernail cannot penetrate the bead. This is recommended in ASTM D-2857, Section 9. The pipes or fittings may be removed from the welding equipment at this time.
10. Do not put pipe or fittings under any type of stress or conduct a pressure test until the complete cooling time (Column F) has been achieved.

Butt Fusion Procedure for Double Wall Pipe With Leak Detection Cable Systems

This method is available for the following systems:

- Duo-Pro® made of similar material on the carrier and containment
- Fluid-Lok® HDPE system
- Restrained systems only

Asahi/America split-leak detection heating elements allow both the carrier and containment pipes to be welded simultaneously, with a pull cable in place. The mirror design, as shown in Figure E-14, is capable of splitting apart and wrapping around a wire. The small hole centered at the bottom of the heater allows a pull wire to be in place during the fusion process. Once the pipe is heated, the heating element is split apart and removed, leaving the wire in place for the final pipe joining.

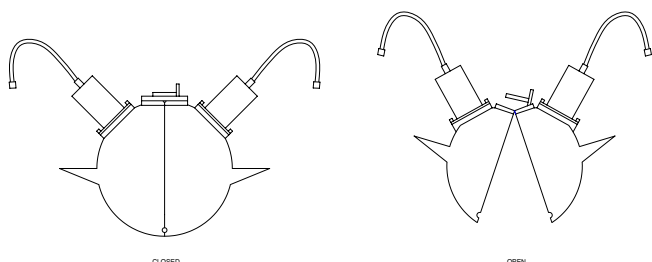


Figure E-14. Split heating elements for leak detection systems

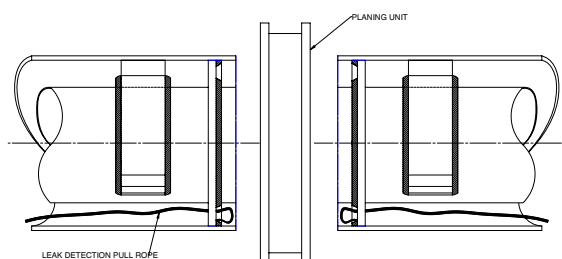


Figure E-15. Planing ends with pull rope installed

A short piece of wire is attached to the pull rope on both ends after planing. The wire runs through the heater during welding in order to prevent the damaging or melting of the pull rope (see Figures E-15 to E-18). After each section is complete, the wire is pulled down to the next joint to be welded. The installation of the pull rope is at the six o'clock position. A continuous pull rope, free from knots and splices, should be pulled through as the system is assembled.

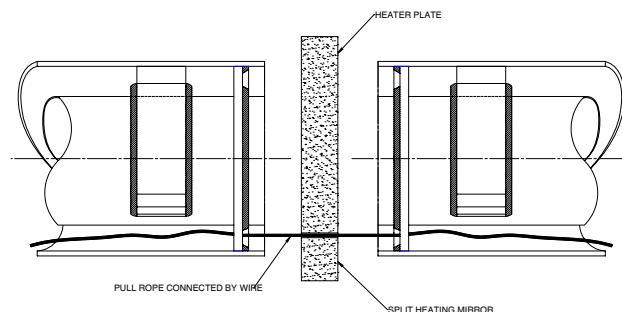


Figure E-16. Pull rope connected by wire through heating element

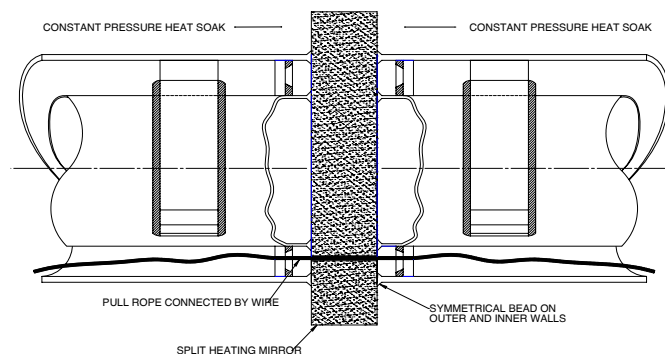


Figure E-17. Pipe ends heated with pull rope installed

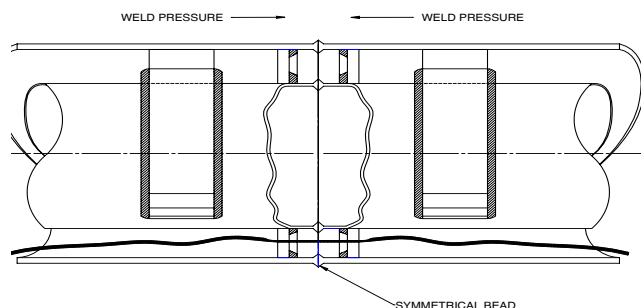


Figure E-18. Welding complete with pull rope installed

Follow the standard butt fusion procedure for welding. Other methods for welding with a solid heating element are available that will accommodate a leak detection cable system.

Staggered Butt Fusion Method

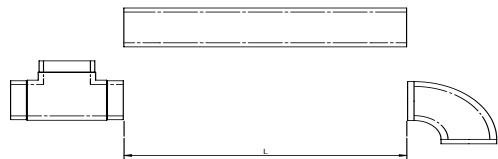
Using the staggered fusion procedure to assemble a Duo-Pro® system is more complicated and labor-intensive than simultaneous fusion. However, it offers the ability to install a double containment system with a flexible inner pipe or with different carrier and containment materials. Asahi/America provides all of the necessary equipment for this welding method.

In staggered welding, the carrier pipe is welded first, followed by the containment pipe. In a staggered system, there are no end support discs. This allows for the movement of the carrier components. It is important to plan which welds will be made and in what order. Enough flexibility is required to move the inner pipe out from the outer pipe to perform a carrier weld.

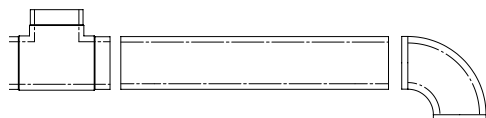
In long, straight runs, the procedure is simple, due to significant carrier pipe movement. In systems that are fitting-intensive, the procedure becomes more difficult because the pipe movement is limited to the amount of annular space between the carrier and containment fittings (see Figure E-19).

Welding Procedure

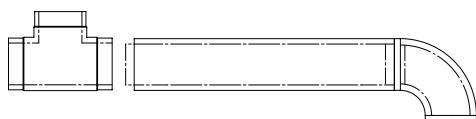
1. Begin by attaching spider clips to the carrier pipe (follow steps in double wall pipe assemblies).
2. Insert carrier pipe or fittings into the appropriate containment line. At the start of a system, it may be easier to weld the carrier first and then slide the containment pipe over the carrier pipe. However, as the installation moves along, this will not be possible.
Note: If containment piping has been roughly cut, make sure to plane it prior to welding the carrier pipe. Once the carrier is welded, the containment pipe cannot be planed.
3. In the machine, use the two innermost clamps to hold the carrier pipe for welding. Use the outer clamps to hold the containment pipe in place. In cases where movement is limited, fitting clamps will be necessary to hold the carrier pipe.
4. Once all of the pieces are locked in place, weld the carrier pipe using standard butt fusion techniques see Figures E-19 A and E-19 B).
5. Once the carrier weld is complete, remove the inner clamps and pull the containment pipe together for welding (see Figures E-19 C and E-19 D). At this point, switch all clamps to containment sizing. It may be preferable to use two machines to eliminate the constant changing of clamps. Also, in some designs, two machines may be required to weld the two different diameter pipes.
6. To weld the containment pipe, a split annular mirror is required (see Figure E-19 F). The mirror is hinged to let it wrap around the carrier pipe while welding the containment pipe.
7. It is important to ensure that the mirror is properly centered so it does not rest on and melt the carrier pipe.
8. Once the mirror is in place, the welding procedure is the same as standard single wall butt fusion.



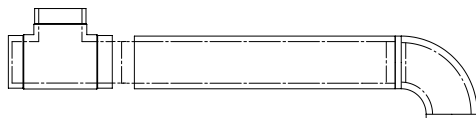
A. Cut carrier and containment pipes to length L



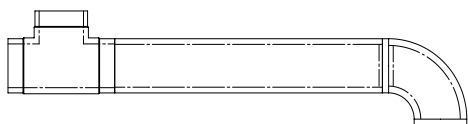
B. Pull carrier elbow out of containment elbow and weld to carrier pipe



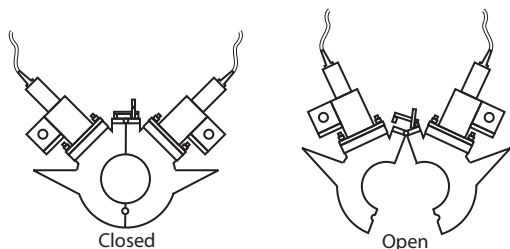
C. Weld containment elbow to containment pipe



D. Flex carrier elbow and pipe toward tee and weld to carrier tee pipe



E. Weld containment pipe to containment tee



F. Annular heating element

Figure E-19. Staggered butt fusion

Helpful Hints

- When welding PVDF and Halar®, move swiftly while removing the mirror and joining the pipes. Delayed reaction will cause the material to cool and a “cold weld” to form. PVDF and Halar® cool off more quickly than polypropylene.
- Always plan welding so the longest and heaviest section of pipe is positioned on the stationary side of the welding machine.
- Start at one end, and work to the other end of the pipe system. Do not start on two different ends and meet in the middle. Moving the pipe for welding will be extremely difficult or impossible.
- When planing, long strips indicate that you are flush all the way around.
- Consult the factory for a proper equipment recommendation for the system being installed.
- Machines are extremely adaptable and can be positioned in many ways to accommodate difficult welds.

IR Fusion

Improving upon conventional butt fusion, IR welding uses a non-contact method. IR welding uses the critical welding parameters of heat soak time, changeover time, and joining force as found with butt fusion. However, by avoiding direct contact with the heating element, IR fusion produces a cleaner weld with more repeatable and smaller bead sizes. The end result is a superior weld for high purity applications.

The graph in Figure E-21 outlines the forces applied during the non-contact joining process. Notice that the ramp-up force to full joining pressure is a smooth curve where force is gradually ascending over time. Even force build-up is critical to join material without creating a cold joint.

Welding Process

Material is prepared for IR fusion by creating smooth, arid, and level surfaces among the ends to be joined. Butting the material against an internal planer acts as a centering and leveling device. The planer is then used to cut a clean and smooth surface. The material should then be checked for vertical and horizontal alignment. Welding machines should allow for minor adjustments to the vertical and horizontal orientation of the material.

Once alignment has been verified, the material is heated by close proximity to the heating source. Through radiant heat and proper heat soak time, the material becomes molten to allow physical bonding between the two pieces. After the heating source has been removed, the material should be joined together in a steady manner, slowly ramping up the force until the desired joining force has been achieved.

Ramping up and monitoring the force is critical for repeatable and successful IR welding. This ensures that the molten material has joined at the right force and prevents against cold welds, which are caused by the molten material being overly pushed to the inside and outside of the weld zone.

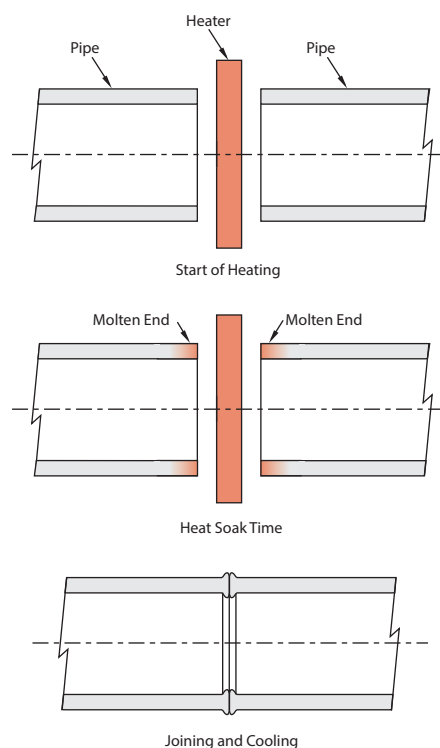


Figure E-20. IR fusion welding process

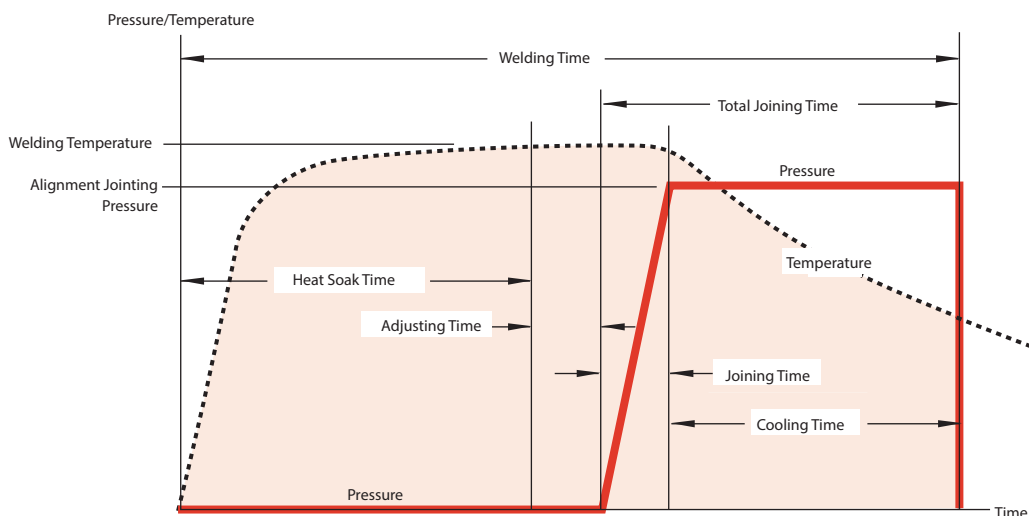


Figure E-21. IR fusion timing diagram

ELECTROFUSION

Electrofusion Welding

Electrofusion is a simplified and safe method of joining pipe and/or fittings based on melting the outer surface of the pipe and the inner surface of the electrofusion coupling by using an integral electric wire. Electrofusion is a cost-effective method for joining polypropylene and HDPE pipe. As an alternative to butt fusion, electrofusion can be used for repairs, double containment assembly, and difficult connections in tight quarters.

Welding Equipment

The Asahi electrofusion equipment performs the welding for all of Asahi/America's electro fittings. The control box has a computerized command system for fully automatic control and energy supply monitoring. Each fitting has a bar code label, which contains the information needed for correct fusion. The welding time is preprogrammed at the factory and set by the use of the bar code. Simply scan the bar code to set up the machine for material to be joined.

Preparation Before Welding

Cut pipe at right angles, and mark the insert length (insert length = socket length/2). For successful welding, it is essential to clean and scrape the surface of the parts to be joined. In addition, cuts must be straight to ensure proper insertion into the coupling. Scraping must be done using a proper hand-operated or mechanical scraper. Do not use tools such as rasp, emery paper, or sand paper.

Slide the socket on the prepared end of pipe right to its center stop until it reaches the marking. Insert the second pipe end (or fitting) into the socket, and clamp both pipes into the holding device. The clamping device protects the components from being pushed out during fusion.

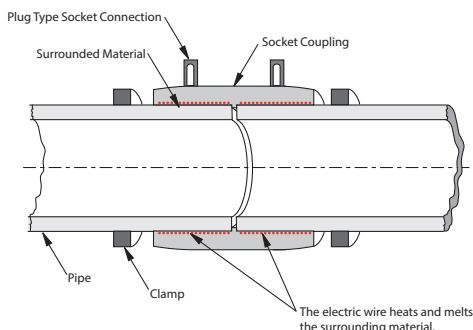


Figure E-22. Electrofusion welding setup

Welding Procedure

Observe the operating instructions for the welding device, as individual tools may vary. Plug-type socket connections should be turned upward and then connected with the cable.

After the welding equipment has been properly connected, the welding parameters are input by means of the bar code reader. An audio signal will acknowledge the data input.

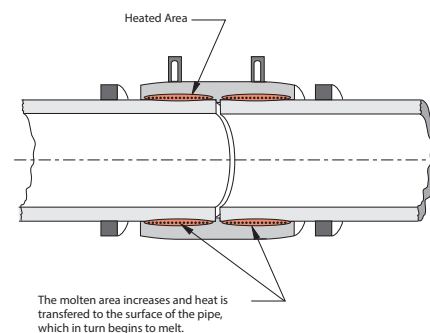


Figure E-23. Initial heating occurs in coupling

Pressing the start key initiates the welding process. The time on the display is also programmed into the machine and allows the correct heating time for various pipe sizes.

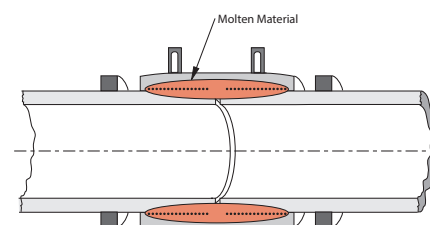


Figure E-24. Molten material from both coupling and pipes form weld

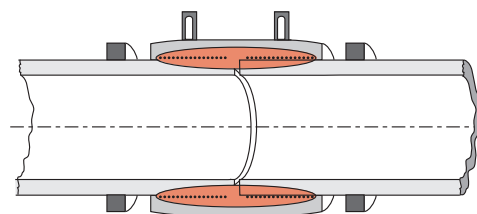


Figure E-25. Completed electrofusion weld

During the welding process (including the cooling time), the clamping device should remain in place. The end of the welding process is indicated by an audio signal.

The welding indicator on the socket performs visual control.

Before pressure testing, all welded joints must have completely cooled down based on the welding parameters provided with the equipment. The pressure test must be performed according to recommended procedures.

HOT AIR

Welding Method

Hot air (gas) welding is the process of fusing a bead of material against a like material. This welding is common with sheet fabrication and applications not requiring pressure resistance. Asahi/America uses hot air (gas) welding to locate support discs for pipe centering in its Duo-Pro® system.

In hot air (gas) welding, the heat transfer medium is a heated gas, either nitrogen or clean air. Originally, the use of nitrogen proved most successful, preventing material contamination and oxidation. With today's material quality and equipment technology, nitrogen is becoming less common, except with critical materials. The combination of clean, oil and moisture-free air with the controlled temperature proves equally successful, eliminating the continuous expense of the inert gas. The temperature of the hot air ranges between 572°F and 662°F (300°C and 350°C) for HDPE and 536°F to 626°F (280°C to 330°C) for PP, when outside welding conditions are about 68°F (20°C). The temperature range will vary with changing ambient conditions.

To accomplish high-quality welds, it is important that the fillers (welding rod) are of the same material and type. The most common welding fillers are 3mm and 4mm round. There are also special profiles, such as oval and triangular rods. The welding tip used must also match the cross section of the welding rod.

Qualification of Welder and Requirements on Welding Devices

The plastics welder must have obtained the knowledge and skill required for the performance of welding processes. As a rule, this would mean that he is a qualified plastics worker and welder who continuously

practices or displays long-time experience. Hot gas welding machines have to comply with the requirements, according to guideline DVS 2208, part 2.

Welding of E-CTFE

The choice of gas is a very important factor in E-CTFE welding. It is not necessary to use nitrogen in E-CTFE welding; good quality E-CTFE welds can be obtained when a clean and dry source of air is used. Welding in nitrogen is recommended only when the welding facility lacks a clean and dry source of air.

Safety Precautions for E-CTFE

When welding E-CTFE, melt temperatures of > 572°F (300°C) release hydrogen chloride and hydrofluorics. They could be toxic at higher concentrations and should not be breathed in. The recommended load limit, according to TWA, is 5ppm for HCl and 3ppm for HF. If E-CTFE vapors are inhaled, the person should be brought out into fresh air, and medical aid should be requested immediately, as there is a danger of polymer fever. The following safety measures should be considered:

- Have good ventilation in the workplace (or use breathing protection)
- Use eye protection
- Use hand protection

Air Supply

For hot gas welding, air is normally supplied by a compressed air network, compressor, pressure gas bottle, or ventilator. The air supplied has to be clean and free of water and oil to avoid decreases in the quality of the welding seam and the lifetime of the welding devices. Therefore, adequate oil and water separators have to be used. The air volume supplied to the device has to be adjustable and maintained constantly, as it is a main factor influencing the temperature control of the device.

Welding Devices (with built-in ventilator)

The devices are comprised of a handle, a built-in ventilator, heating, a nozzle, and an electrical connecting cable. Due to their construction features, they can be used at sites where an external air supply is not available. On account of their dimensions and weight, they are less suitable for longer lasting welding processes.

Requirements for Design

The ventilator has to supply the quantity of air required for welding various types of plastics to all nozzles (see DIN 16 960, part 1). The electrical circuit has to ensure that the heating is only turned on when the ventilator is operating. The noise level of the ventilator has to comply with the relevant stipulations.

Safety Requirements

The nozzles used for the particular devices have to be securely fastened and easily exchangeable, even when heated. The material must be corrosion-proof and of low scaling. In order to prevent heat from dissipating, the surface of the nozzle has to be as smooth as possible, (e.g. polished). For reducing friction, the inner surface of the slide rail of the drawing nozzle has to be polished. The same applies to the sliding surfaces of tacking nozzles. In order to avoid strong air vortex at the outlet of the nozzle, the round nozzles have to be straight for at least $5 \times d$ (d = outlet diameter of the nozzle) in front of the outlet.

Preparations for Welding

Before starting the welding process, check the heated air temperature adjusted on the welding machine. Measurement is performed by means of a control thermocouple, inserted approximately 5 mm into the nozzle, and with rod-drawing nozzles in the opening of the main nozzle. The diameter of the thermocouple must not exceed 1 mm. Air quantity is measured by means of a flow control instrument before the air stream enters into the welding machine.

Processing Guidelines

Install welding tent or equivalent if weather conditions suggest. A good weld requires proper preparation of the material. The part should be free of any impurities such as dirt, oil, etc. Additionally, some thermoplastics develop a thin layer of oxidized molecules on the surface that require scraping or grounding of the material. Another effect, especially with HDPE, is the migration of unchained lower density molecules to the surface caused by internal pressure of the material. This gives the usually “waxy” surface appearance of HDPE. Grinding or scraping of the surface is required. Wipe off any dust with a clean cloth. Do not use solvents or cleaners; they introduce chemicals with unknown and likely negative effects.

The forms of the welding seams on plastic components generally correspond with the welding seams on metal

parts. Parts 3 and 5 of the guideline DVS 2205 are valid with respect to the choice of welding seam forms on containers and apparatus. In particular, pay attention to the general principles for the formation of welding seams. The most important welding seam forms are: V-weld, Double V-weld, T-weld, and Double T-weld.

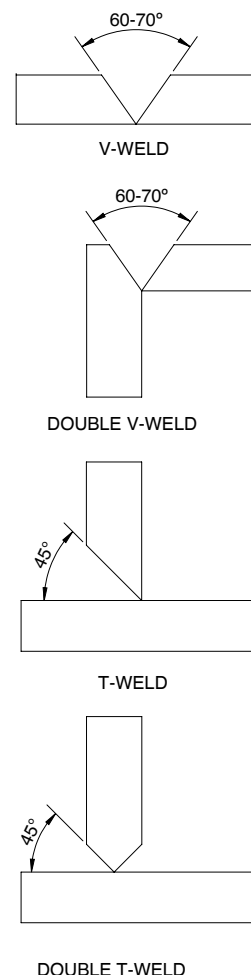


Figure E-26. Typical welding seam forms

Tack Welding

The initial step in the welding process is the “tack weld.” The objective is to put the parts into place, align them, and prevent any slippage of the material during the structural welding process. Welders should use their own discretion when applying an intermittent or continuous tack. Larger structures and thick gauged materials may require addition clamping.

High-Speed Welding

In this process, a filler material, the welding rod, is introduced into the seam to give supportive strength. Standard rod profiles are round or triangular. A triangular rod is a single supportive weld and does not allow for the kind of surface penetration achieved with a round welding rod.

A round welding rod is used where heavy-duty welds are required. It allows the fabricator to lay several beads of welding rod on top of each other. This way, a relatively thin welding rod can be used to produce a strong weld.

By performing a few practice welds, the welder should develop the speed and force necessary to complete a successful weld. Heat the welding rod within the rod-drawing nozzle, and push it into the welding groove. The force applied on the rod controls the speed of the welding. The operator should look for a small bead of melted rod on both sides. Apply additional welds to fill the groove.

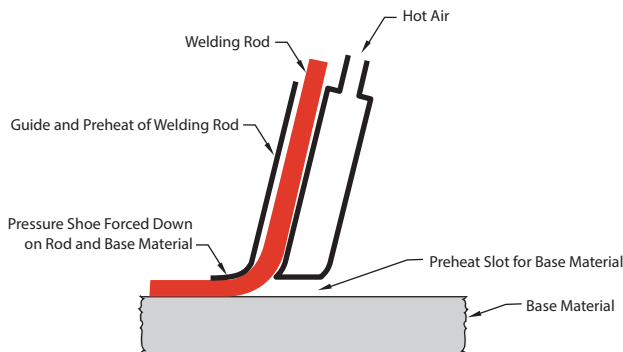


Figure E-27. High-speed welding process

Freehand

The oldest method of welding filler rod is freehand. This process is much slower than high-speed welding, but it must be used where very small parts are being welded or where the available space prohibits the use of high-speed welding tips. The only nozzle used in this process is a small jet pipe with an opening of 1/8" or 5/32" to concentrate the heat. The welder performs a waving action of the nozzle at the base material and the welding rod with an "up and down" and "side to side" motion to bring the rod and material to melting form. Hand apply pressure vertically at 90° to begin. After reaching the correct amount of pressure and heat for the

rod and base material, a small wave of molten material forms in front of the welding rod. If bent backward, the welding rod will stretch and thin out; if bent forward, no wave will occur in front, resulting in insufficient pressure. Freehand welding requires a highly skilled operator and should be avoided if a simpler method can be used.

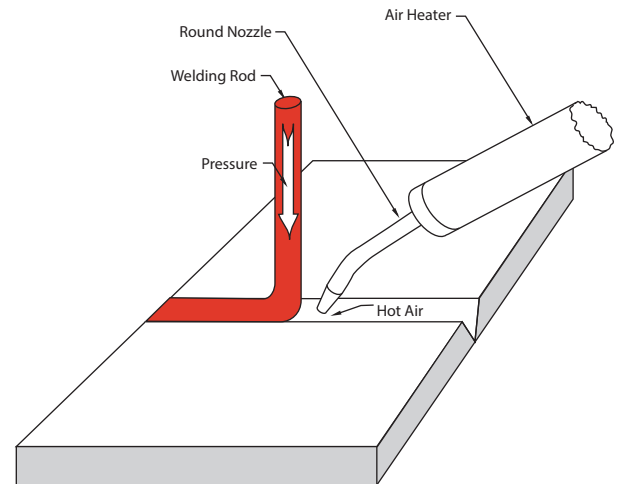


Figure E-28. Freehand welding

Structure of Welding Seam

The first layer of the welding seam is welded with filler rod, diameter 3 mm (except for material thickness of 2 mm). Afterward, the welding seam may be built up with welding rods of larger diameters until it is completely filled. Before welding with the next welding rod, the welding seam, which has been formed with the preceding welding rod, has to be adequately scrapped.

Additional Machining of Welding Seam

Usually, welding seams do not need reworking; however, pay attention to the fact that the thickness of the base material must be maintained.

General Requirements

- Safe functionality at a temperature application range between 23 and 140°F (-5 and 60°C)
- Safe storage within a temperature range of 23 and 140°F (-5 and +60°C)
- Adequate corrosion protection against moisture entering from the outside
- As light as possible

- Favorable position of the gravity center
- Functionally formed handle
- No preferred direction in relation to the supply lines
- Nozzle that can be fixed in any position
- Easily accessible functional elements
- Feed hoses and cables can be extended by the welder with minimal effort and do not kink or twist in proper operation
- Safe storage of equipment when the welding work is finished or during interruptions
- Used nozzles are easy to remove and to fix in heated state
- Indefinitely variable power consumption
- If possible, handle with built-in control system
- Operating elements arranged in a way that prevents unintentional changes
- Material of handle: break-proof, thermo-resistant, thermo-insulating, and non-conducting
- Corrosion-proof hot gas supply pipes of low scaling
- Constant welding temperature achieved after a maximum of 15 minutes

Safety Requirements:

The devices have to be safe with consideration for all personal injuries. In particular, the following requirements apply:

- Parts next to hands should not be heated to temperatures above 104°F (40°C), even after longer use
 - Protection against overheating (e.g., due to lack of air) of the device has to be present
 - Equipment surfaces presenting a burn hazard are to be kept as small as possible, or isolated and labeled as required
- Sharp edges on equipment and accessories are to be avoided

EXTRUSION

Extrusion Welding

Extrusion welding is an alternative to multiple pass hand welding and can be used whenever physically possible to operate the extruder. Extrusion welding is used for joining low pressure piping systems, constructing tanks and containers, joining liners (for buildings, linings for ground work sites), as well as completing special tasks.

This welding technique is characterized as follows:

1. The welding process is performed with welding filler being pressed out of a compound unit
2. The welding filler is homogenous with the material being joined
3. The joining surfaces have been heated to welding temperature
4. The joining is performed under pressure

Qualification of Welder and Requirements of Welding Devices

The plastics welder must have obtained the knowledge and skill required to perform the welding processes. As a rule, this would mean that he is a qualified plastics worker and welder who is continuously practicing or who displays long-time experience. For extrusion welding, several kinds of devices may be used. The most common device is a portable welding device consisting of a small extruder and a device for generating hot air. The welding pressure is applied onto the Teflon® nozzle, directly fastened at the extruder, which corresponds to the welding seam form. Depending on the type of device, the maximum capacity of the welding fillers is about 4.5 kg/h.

Preparation of Welding Seam

The adjusting surfaces and the adjacent areas have to be prepared adequately before welding (e.g., by scraping). Parts that have been damaged by influences of weather conditions or chemicals have to be machined until an undamaged area appears. This process must be adhered to, especially when performing repair work.

Do not use solvents or cleaners; they introduce chemicals with unknown and likely negative effects, which cause them to swell. In order to equalize higher differences in temperature between the different work pieces, the work pieces have to be stored long enough at the workplace under the same conditions.

Welding Seams

When choosing welding seam forms for containers and apparatus, consider the general technical principles for welding seam formations. Generally speaking, single-layer seams are welded on extrusion welding. If it is not possible to make DV welds on welding of thicker semi-finished products, multi-layer seams can also be performed. The welding seam should laterally extend by about 3 mm beyond the prepared welding groove.

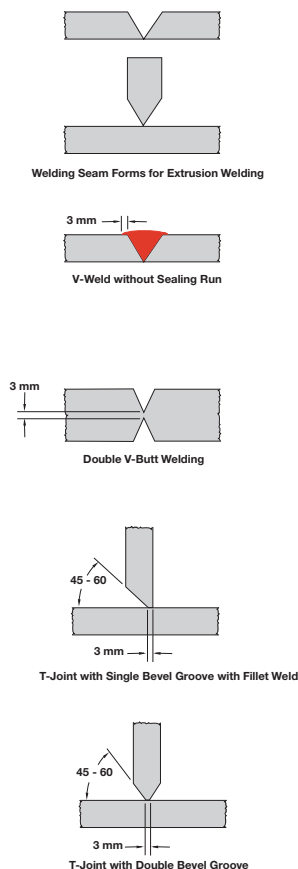


Figure E-29. Welding seam forms for extrusion welding

Equipment and Procedure

For extrusion welding, a portable welding device consisting of a small extruder and a device for

generating hot air are the most common devices.

An extruder uses either pellets or welding rods as a filler material. Do not use pellets or rods of unknown origin, uncontrolled composition, or regenerated material for welding. Make sure the filler is dry and clean before beginning the welding process. The extrusion welder includes a melting chamber with an extrusion screw, driven by an electric motor.

With the pellet extruder, the pellets are gravity fed from a hopper into the melting chamber. A rod extruder has a feed mechanism attached to the rear of the extrusion screw that pulls the welding rod into the melting chamber. The adjusting surfaces of the parts to be welded are heated up to the welding temperature by means of hot air passing out of the PTFE nozzle on the welding device. The welding filler, continuously flowing out of the extruder device, is pressed into the welding groove. The welding pressure is applied onto the PTFE nozzle, directly fastened at the extruder end, which corresponds to the welding seam. The discharged material pushes the welder ahead, determining the welding speed.

Lap Joint

In order to accomplish sufficient heating and thorough welding, it is necessary to provide an air gap depending on wall thickness (width of air gap should be 1mm minimum).

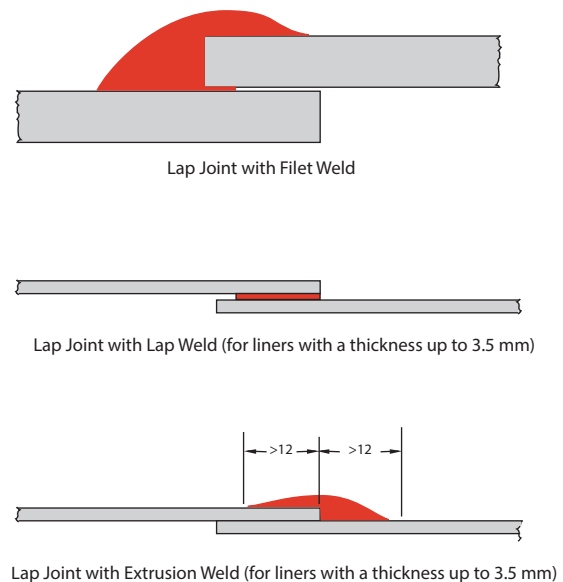
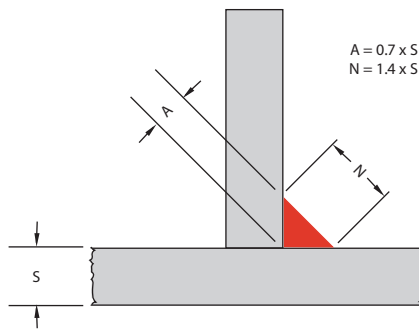


Figure E-30. Lap joints



NOTE: If material thickness does not match, use the “s” value from the thicker material to calculate bead size.

Figure E-31. Guideline for calculation of extrusion bead size

Visual Inspection

The primary function of the operator is to ensure that sufficient pressure is applied while also maintaining proper speed. Too little pressure will result in the molten mass not being formed into the final bead, and too much speed will cause the bead to thin. Both of these mistakes are easy to spot on the finished product.

Testing

The means for non-destructive testing are limited. Therefore, visual checking of the weld appearance becomes important. A good weld on thermoplastic material will show a slight distortion along the edge of the welding rod, indicating proper heat and pressure. Changes of the surface appearance of the base material right next to the weld indicate proper preheat temperature. A uniform appearance of this area indicates constant welding speed.

If the bead shows no distortion, the bead lacked proper pressure. Combine no distortion with a shiny appearance, and the bead lacks proper pressure and too much speed. On the other end of the scale, a welding temperature that is too high or a welding speed that is too slow will overheat the base material and/or welding rod. Overheating PP or PE will result in the bead looking extremely shiny and small splashes of material will seem to spray away from the bead.

In pipe seams, the best method for testing is to conduct a hydrostatic pressure test according to Asahi/America procedures.

MECHANICAL CONNECTIONS

Connection Technology

Connection systems have to be designed to avoid any kind of stresses. Stresses, which may arise from differences in temperature between installation and operation conditions, must be kept as low as possible by taking appropriate measures as described in the section design and calculation guide.

Depending on the pipe dimension, the following connection systems are applicable:

Dimension OD	IR fusion	Butt fusion	Beadless fusion	Flange connection	Union connection	Sanitary joint connection
20 mm-63 mm (1/2" to 2")						
75 mm-90 mm (2-1/2" to 3")						
75 mm-315 mm (2-1/2" to 12")						
355 mm-400 mm (12" to 16")						

Figure E-32. Applicable connection systems

Welding Personnel

The quality of the welded joints depends on the qualification of the welder, the suitability of the machines and appliances, as well as the compliance of the welding guidelines. The welding joint can be tested and inspected by destructive and/or visual methods.

The welding work must be supervised. The type and scope of supervision must be agreed on by the parties. It is recommended to record the procedure data in welding protocols or on data carriers.

Within the scope of the quality assurance, it is recommended to produce and test samples of joints before beginning and during the welding works.

Every welder has to be trained and must have valid proof of qualification. The intended application range may be decisive for the kind of qualification. The welding exam certificate, according to DVS 2212-1 in the groups I-4 res. I-8, in conjunction with the complementing training certificate issued by an authorized training institute or by the particular machine manufacturer, is valid as qualification proof.

Welding Machines

Utilize proven welding techniques for the joining of components; only approved welding machines should be used. The application of non-approved welding techniques can result in reduced joint quality in both strength and purity. In addition, welding parameters should be recorded for every performed welding. A print-out label with significant welding information is required to identify and evaluate every welding joint.

The utilized welding machines and appliances must correspond to the guidelines of the DVS 2208.

In general, the following facts should be considered for welding high purity thermoplastic piping systems:

- Application of suitable and approved welding machines
- Application of trained and certified personnel

- Consideration of the prescribed welding guidelines (parameters)
- Performance of the welding process in the cleanroom area
- Complete control and documentation of the performed welding operations

The design of a system should consider installation conditions, such as space and environment conditions. Based on the above criteria, the choice of welding technique is crucial for a successful installation. The installation should be planned to fabricate assemblies and subassemblies to reduce the amount of welds conducted in restricted (confined) locations.

Measures Before the Welding Operation

The welding zone must be protected against bad weather influences (e.g., moisture, wind, UV-radiation, and temperatures below 41°F (5°C) or higher than 104°F (40°C)). If it is ensured by suitable measures (e.g., preheating, tent, or heating) that a component temperature sufficient for welding can be kept, as far as the welder is not hindered in his handling, work may be carried out at any outside temperature. If necessary, an additional proof must be provided by carrying out sample welds under the mentioned conditions.

If the welding products are heated up unevenly under the influence of sunshine, a temperature compensation in the area of the welding joint can be reached by covering.

The pipe ends should be closed during the welding process.

The joining areas of the parts to be welded must be clean (free from dirt, oil, shavings, or other residues) and in a straight-cut, planed surface condition before start the welding process.

On applying any of these methods, keep the welding area clear of flexural stresses (e.g., careful storage, use of pipe supports, etc.).

Welding Joint Evaluation

The control of the welding joint quality on site should be performed only by certified personnel with proper knowledge of the welding technique. Different tests, according to DVS guidelines, may be performed:

- Visual test of the welding joint (DVS 2202-1)
- Tensile test for the determination of the short-term welding factor (DVS 2203, part 1)
- Bending test for the determination of the bending angle (DVS 2203, part 5)
- Pressure test on the installed pipeline, according to DVS 2210, part 1, supplement 2 (DIN 4279)

Flange

Flanging and AV Gaskets

When bolting a flange connection, it is required to tighten the bolts in a specified pattern and to a required specification. Asahi/America offers a line of low-torque AV gaskets in sizes 1/2"–12" for single wall pipe connections. These gaskets offer a unique double-convex ring design that gives optimum sealing with one-third the torque of a common flat gasket seal. The gaskets are available in the following materials:

- EPDM
- PVDF bonded over EPDM
- Teflon® over EPDM

They are available in both standard and high-purity grade. PTFE and PVDF bonded gaskets are produced in a proprietary laminating process for bonding to EPDM. The use of the rubber backing provides greater elasticity for lower bonding torques.

Detail of Gasket

When tightening a flange, the torque rating is dependent on the gasket used. For the AV gasket, see Table E-8 for the recommended tightness. In addition, follow the star pattern shown Figure E-33 when tightening. Conduct two or three passes, tightening the flange uniformly. Finish by doing a circular pass to check the torque values. Always use a torque wrench when tightening a flange. A common mistake when tightening a flange is to squeeze it as tightly as possible; however, this action will damage the gasket and eventually lead to reduced elasticity and leakage. Do not tighten beyond the rating.

Size (inches)	Teflon-PVDF	EPDM
1/2	174	157
3/4	174	157
1	174	157
1 1/4	191	165
1 1/2	217	174
2	217	174
2 1/2	304	217
3	304	217
4	304	217
6	348	260
8	435	304
10	435	304
12	522	435

Expressed in Inch-pounds

Table E-8. Recommended Bolt Torque for AV Gaskets (lbs.)

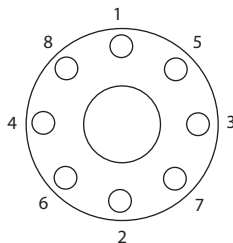


Figure E-33. Torque pattern

Butterfly Valves

Most Asahi/America piping systems are produced to metric dimensions according to ISO standards. However, Asahi/America butterfly valves are produced according to iron pipe size dimensions. The outcome is that in certain sizes, the disk of the butterfly valve can meet interference with the inside pipe wall when opening. The interference is typical in SDR11 polypropylene systems in 6" or larger and SDR32.5 polypropylene in 8" or larger. In PVDF systems, the effect is 8"–12" in SDR33 and 6" or larger in SDR 21 systems. Polypropylene stubs in the interfering dimensions are always beveled at the factory to avoid this issue. PVDF stub ends mounted for butterfly valve installation must be ordered special from Asahi/America. PVDF stubs are not automatically supplied with a beveled end for other reasons. Contact Asahi/America for special part numbers on PVDF beveled stub ends.

Flange Connections of Piping Systems

If pipe joints are connected by means of flanges, the following guidelines must be adhered to:

- **Aligning of parts**

Before applying initial stress on the screw, the sealing faces have to be on an aligned plane, parallel to each other, and fit tight to the sealing. Under any circumstances, the flange connection should not draw near to the occurring tensile stress.

- **Tightening of screws**

The length of the screws has to be chosen so that the screw thread possibly flushes with the nut. Washers have to be placed at the screw head and also at the nut. The connecting screws have to be screwed in with a torque key (for torque values see www.agru.at).

Generally, it is recommend to brush over the thread, (e.g., with molybdenum sulfide) so that the thread runs easily for a longer operation time. For the selection of sealing material, the chemical and thermal resistance has to be considered.

Adhesive Joints

Adhesive joints with polyolefines are not applicable. The achieved strength values range extremely below the minimum requirements for adhesive joints in practice.

Tri clamp

Tri clamps, otherwise known as sanitary fittings are a common form of mechanical joining of pipes in high purity applications. A typical tri clamp connection consists of two ferrules, a gasket with raised groove, and one of several types of clamps. The combined flange and gasket do not impede the flow of fluids though the pipe. The clamping system can be easily removed when using a fold-over hinged clamp. Plastic tri clamps are designed to allow connection to existing stainless steel, and sanitary systems. Please consult Asahi/America for additional information about thermoplastics for use in pharmaceutical.

Thread

In general, threaded connections are not recommended for high pressure thermoplastic piping systems. If thermoplastic pipe is threaded, the pressure rating is derated significantly. In certain instances, an installer may choose to thread the system. Recommendations for threading plastic piping have been developed by the

Plastic Piping Institute. It should be noted that certain Asahi/America systems with thinner walls simply cannot be threaded. In addition, metric pipe systems, even with thick pipe walls, cannot be threaded because the outside diameters are not the same as IPS pipe, making the threads too short in height.

Only pipe that has a wall thickness greater than Schedule 80 should be threaded. Only pipe dies that are clean, sharp, and specifically designed for plastic piping should be used. If a vise is used to restrain the pipe during the cutting, exercise caution to avoid scratching or deforming the pipe. Wooden plugs inserted in the pipe ends can reduce this risk.

Before cutting threads, the pipe must be deburred of all sharp edges. A die stock with a proper guide that will start and go on square to the pipe axis should be used. The use of cutting oil should be kept to a minimum. Once the threads are cut, they should be seated with PTFE tape.

In most cases, the use of threading pipe can be avoided altogether by the use of molded male and female adapters. These fittings have been designed and produced to provide a full 150 psi pressure rating at 21°C (70° F). The male and female adapters address the need to connect to existing pipe systems or equipment without derating the system. The use of these fittings welded to the pipe is recommended instead of attempting to thread pipe.

Asahi/America does not recommend threading or threaded fittings made of HDPE.

Weatherability/UV

Weather Effects

Polypropylene, HDPE, and PVDF are resistant to nearly every effect of weather. However, they differ on one important characteristic: resistance to ultraviolet light degradation. PVDF is almost completely unaffected by UV light. HDPE, with its black additive, is resistant to UV light, as is Poly-Flo® black polypropylene. Standard polypropylene from Asahi/America is a European gray polypropylene that is affected as the energy from ultraviolet radiation initiates a chemical reaction in the polymer. Natural polypropylene is not UV-resistant.

The reaction between polypropylene (gray) and UV radiation only takes place at the surface to shallow depths measured in minute fractions of an inch. The

molecules at the surface of the plastic are permanently altered to form a complex formation of various chemicals, such as polypropylene-type formations. A noticeable chalky-yellow appearance ensues, which results in a slight reduction in impact strength. This effect will only become noticeable upon prolonged exposure, and it will not continue to progress if the ultraviolet source is removed. The effect can be measured after a prolonged period of time as a slight increase in tensile strength, a slight increase in elastic modulus, and a minor decrease in impact strength. The degradation only occurs to a shallow depth, although in time the chemically altered surface molecules may slightly flake off. Thin-walled polypropylene pipe fittings should be protected against ultraviolet light penetration if placed in an outdoor environment. Some of the various methods include painting, providing a “shield,” or taping/wrapping the pipe. In order to paint the piping, polypropylene must first receive a coating of a suitable primer to allow the acrylic lacquer to be applied. The primer can be applied by brush to small diameter pipes and sprayed onto larger diameter pipes. Then, a suitable paint can be selected and applied in a similar fashion. It is advisable to strictly adhere to the manufacturer's instructions concerning safe operating practices when applying the selected paint.

A thin-walled insulation-type shield or rigid vapor jacket barrier can eliminate the effects of ultraviolet light. A thin aluminum shield should provide all the protection that is necessary.

A third method includes covering the piping with tape. A recommended type of tape is called “TapeCoat” and is made by TapeCoat, Inc. of Evanston, IL. This tape should be applied with 50 percent overlap, and when properly applied, it will completely protect the piping against ultraviolet attack.

Chlorine and Chlorinated Hydrocarbon Installations

When PVDF is used to transport chlorine or chlorinated hydrocarbons, special precautions should be taken if the possibility of a reaction is suggested by the application. In certain post-chlorination pipe lines, downstream in a bleached paper process (chlorine dioxide reactor, for instance), there exists a small amount of spent reactants that ordinarily would not proceed to completion. However, it has been shown that ultraviolet light from sunlight or fluorescent light fixtures may offer enough energy to initiate this reaction to completion.

In the process, free-radical chlorine is released instantaneously, and there is a tendency for some substitution of chlorine molecules for hydrogen in the polymer chain. As this happens, stress cracks may appear in the pipe wall through a mechanism that is not yet completely understood, and the system may fail. Therefore, it is required to protect any PVDF system from the possibility of ultraviolet light propagation from reactions involving the generation of free-radical chlorine. One method of providing this protection is through the same method of taping described in the previous section for protecting polypropylene piping from ultraviolet attack.

Union

Unions of Piping Systems

If pipe joints made out of thermoplastics are connected by means of unions, the following regulations have to be adhered to:

- For avoiding impermissible loads at installation, unions with round sealing rings should be applied
- The union nut should be screwed manually or by means of a pipe band wrench (common pipe wrenches should not be used)
- Prevent the application of unions at areas with bending stresses in the piping systems

Tip: thread seal only with Teflon® do not use hemp

