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Polyethylene Joining Procedures

CHAPTER 6
POLYETHYLENE JOINING PROCEDURES

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FOREWORD

Polyethylene Joining Procedures is one of the chapters being prepared for inclusion in the Plastics Pipe Institute's *PPI Handbook of Polyethylene Piping, which* will be issued as a complete volume in the future. Other topics to be addressed in the handbook will include design of polyethylene piping systems, joining procedures, engineering properties, relevant codes and standards, and a variety of related information.

PPI is a division of The Society of the Plastics Industry, Inc. (SPI), and the major U.S. trade association representing all segments of the plastics industry.

The *Municipal and Industrial (M&I) Division of PPI are producing the PPI Handbook of Polyethylene Piping*. M&I membership consist of major North American manufacturers of polyethylene (PE) pipe and fittings, PE piping materials, machinery, and equipment used for joining and installing PE piping, related test laboratories, and professional organizations.

PPI maintains additional groups that address other applications such as gas distribution. PPI provides technical and promotional support for the effective use and continued application of thermoplastics pipe and related products, consistent with the best public interest. PPI membership also includes producers of polyvinyl chloride (PVC), chlorinated polyvinyl chloride (CPVC), polybutylene (PB), and crosslinked PE (PEX) piping products and materials.

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CHAPTER 6
POLYETHYLENE JOINING PROCEDURES

INTRODUCTION

This Chapter of the manual has been prepared for the benefit of producers, users, engineers, code officials, contractors, installers, and others interested In plastic piping. It is a discussion of the recommended procedures for the most common methods of joining polyethylene pipe and fittings. While reasonable efforts have been made by The Plastics Pipe Institute, the members of its technical groups, and its technical staff to provide reliable information in this report, it is recognized that the information may be incomplete. However, it is often possible to obtain more detailed information on joining plastic pipe or fitting materials from manufacturers. Safety considerations are very important when joining polyethylene materials, but they are not a part of this document; the user of this joining information must consult and follow appropriate safety instructions, which are available from manufacturers.

An integral part of any pipe system is the method used to join the system components. Proper engineering design of a system will take into consideration the type and effectiveness of the techniques used to join the piping components and appurtenances as well as the durability of the resulting joints. The integrity and versatility of the joining techniques used for polyethylene pipe allow the designer to take advantage of the performance benefits of polyethylene in a wide variety of applications.

GENERAL PROVISIONS

Polyethylene pipe or fittings are joined to each other by heat fusion or with mechanical fittings. Plastics may be joined to other materials by means of compression fittings, flanges, or other qualified types of manufactured transition fittings. There are many types and styles of fittings available from which the user may choose. Each offers it’s particular advantages and limitations for each joining situation the user may encounter. Contact with the various manufacturers is advisable for guidance in proper applications and styles available for joining as described in this document. There will be joining methods discussed in this document covering both large and small diameter pipe. Those persons who are involved in joining gas piping systems must note certain qualification requirements of the U.S. Department of Transportation Pipeline Safety Regulations [1].

HEAT FUSION

Introduction

There are three types of heat fusion joints currently used in the industry; Butt, Saddle, and Socket Fusion. Additionally, there are two methods for producing the socket and saddle heat fusion joints.

The principle of heat fusion is to heat two surfaces to a designated temperature, then fuse them together by application of a sufficient force. This force causes the melted materials to flow and mix, thereby resulting in fusion. When fused according to the pipe and/or fitting manufacturers' procedures, the joint area becomes as strong as or stronger than the pipe itself in both tensile and pressure properties. As soon as the joint cools to near ambient temperature, it is ready for handling. The following sections of this chapter provide a general procedural guideline for each of these heat fusion methods.

NOTE: This is a general discussion. Pipe and fitting manufacturers have established qualified fusion procedures[9] which should be followed precisely when using their specific products.

One method, used for all three types of joints, uses special heating tools for heating the parts to be joined. The other method, 'electrofusion', is used only for socket and saddle-type joints. Heat is generated by inducing electric current into a wire coil that is a part of the fitting.

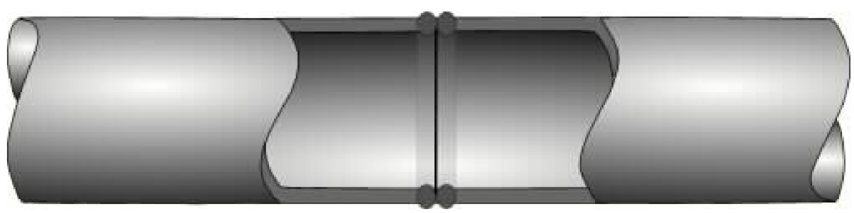

Figure 1 Standard Butt Fusion Joint

Butt Fusion

The most widely used method for joining individual lengths of large diameter polyethylene pipe is by heat fusion of the pipe butt ends as illustrated in Figure 6.1. This technique, which precludes the need for specially modified pipe ends or couplings, produces a permanent, economical and flow-efficient connection. Field-site butt fusions may be made readily by trained operators using specially developed butt fusion machines (see Figure 6.2) that secure and precisely align the pipe ends for the fusion process.

The six steps involved in making a butt fusion joint are:

1. Securely fasten the components to be joined
2. Face the pipe ends
3. Align the pipe profile
4. Melt the pipe interfaces
5. Join the two profiles together
6. Hold under pressure

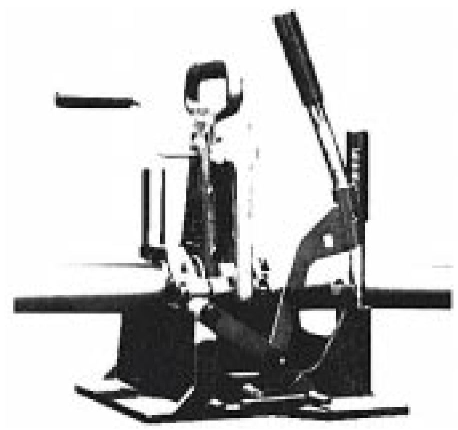

Figure 2 Typical Butt Fusion machine for Smaller Diameter Pipe

(Butt Fusion machines are available to fuse pipe up to 72 inches in diameter)

Secure

Each component that is to be fused must be held in position so that it will not move unless it is moved by the clamping device.

Face

The pipe ends must be faced to establish clean, parallel mating surfaces. Most, if not all, equipment manufacturers have incorporated the rotating planer block design in their facers to accomplish this goal. Facing is continued until a minimal distance exists between the fixed and movable jaws of the machine and the facer is locked firmly and squarely between the jaws. This operation provides for a perfectly square face, perpendicular to the pipe centerline on each pipe end and with no detectable gap.

Align

The pipe profiles must be rounded and aligned with each other to minimize mismatch (high-low) of the pipe walls. This can be accomplished by adjusting the clamping jaws until the outside diameters of the pipe ends match. The jaws must not be loosened or the pipe may slip during fusion.

The minimal distance requirement between fixed- and moveable-jaws mentioned above allows the pipe to be rounded as close as possible to the joint area. The closer to the joint area that the pipe can be clamped, the better control the operator has in properly aligning the pipe.

Melt

Heat the ends of the pipe to the pipe manufacturer's recommended temperature, interface pressure, and time duration. By doing so, the heat will penetrate into the pipe ends and a molten "bead" of material will form at the pipe ends. Heating tools which simultaneously heat both pipe ends are used to accomplish this operation. These heating tools are normally furnished with thermometers to measure internal heater temperature so the operator can monitor the temperature before each joint is made. However, they can be used only as a general indicator because there is some heat loss from internal to external surfaces, depending on factors such as ambient temperatures and wind conditions. A pyrometer or other surface temperature measuring device should be used periodically to insure proper temperature of the heating tool. If temperature indicating crayons are used, do not to use them on a surface which will come in contact with the pipe or fitting. Additionally, heating tools are usually equipped with suspension and alignment guides which center them on the pipe ends. The heater faces which come into contact with the pipe should be coated by the manufacturer to prevent molten plastic from sticking to the heater faces. Remaining molten plastic can interfere with fusion quality and must be removed according to the tool manufacturer's instructions.

Join

After the pipe ends have been heated for the proper time and to the proper temperature, the heater tool is removed and the molten pipe ends are brought together with sufficient pressure to properly mix the pipe materials and form a homogeneous joint. The pipe manufacturer's instructions may specify either interface pressure or bead size of molten material as a guide for a proper joint. There are machines available for pipe sizes from 5/8-inch through 72-inch diameters that will assist the operator to apply sufficient force to obtain the proper fusion pressure. Machines for 4-inch diameter and smaller sizes are normally lever-operated. Many of these smaller machines can be fitted with torque wrenches to obtain a theoretical value which allows the operator to consistently apply the approximate force required to properly fuse a joint. Larger machines employ hydraulics with various types of control systems such as:

1. Manual with hydraulic hand pump.
2. Semi-automatic with motorized hydraulics including pressure reducing, selector, and directional control valves.
3. Fully automatic with computer- or microprocessor-control of the heat and fusion cycles and pressures.

Hold

The molten joint must be held immobile under pressure until cooled adequately to develop strength. The designs of the machines vary from a lever-arm-assist to manual or automatic locking devices that assist the operator to accomplish this step. The proper cooling times for the joint are material-, pipe-diameter-, and wall-thickness-dependent and are established by the pipe manufacturer. Allowing proper times under pressure for cooling prior to removal from the clamps of the machine is important in achieving joint integrity.

OPTIONAL BEAD REMOVAL

In some pipe system usage, the bead from the butt fusion process may be undesirable. Inside beads may create minor flow turbulence of liquids or may become an obstacle on which solids in the fluids may become lodged. Furthermore, outside beads may be a hinderance to sliplining operations. Equipment is available to remove the bead if that is desirable.

SADDLE/SIDEWALL FUSION

The technique to join a saddle to the sidewall, illustrated in Figure 6.3, consists of simultaneously heating both the external surface of the pipe and the matching surface of the “saddle” type fitting with concave and convex shaped heating tools until both surfaces reach proper fusion temperature. This may be accomplished by using a saddle fusion machine that has been designed for this purpose.

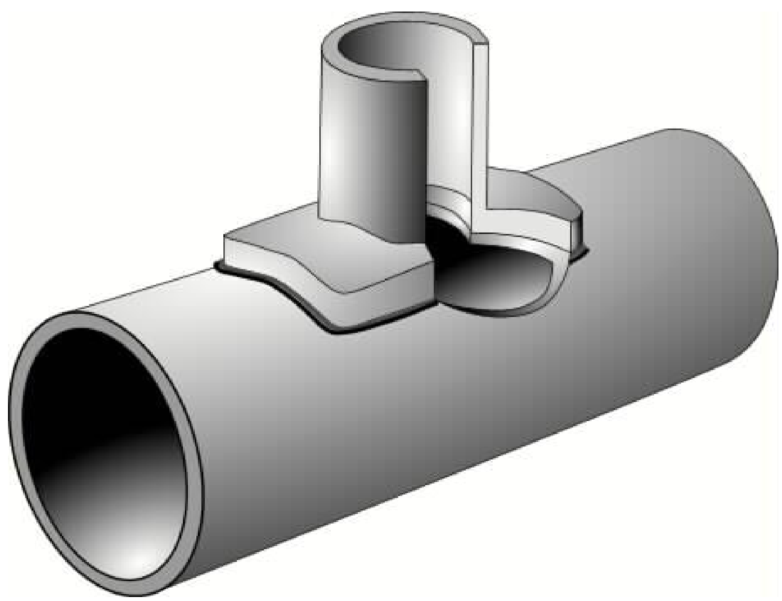

Figure 3 Standard Sidewall Fusion Joint

Saddle fusion, using a properly designed machine, provides the operator better alignment and force control, which is very important to fusion joint quality. The Plastics Pipe Institute recommends that sidewall-type fusion joints be made only with a mechanical assist tool unless hand fusion is expressly allowed by the pipe and/or fitting manufacturer(8). If hand saddle fusion must be performed, it should be done only by following specific instructions provided by the pipe and fitting manufacturer.

There are eight sequential steps that are normally used to create a saddle fusion joint:

1. Clean the pipe
2. Install heater saddle adapters
3. Install the saddle fusion machine on the pipe
4. Prepare the surfaces of the pipe and fitting
5. Align the parts
6. Heat both the pipe and the saddle fitting
7. Press and hold the parts together
8. Cool the joint and remove the fusion machine

Clean the Pipe

Remove any dirt or coating that might interfere with the proper installation of the fusion machine.

Install the Heater Saddle Adapters

Install the proper size heater saddle adapters on the heater plate. Do not overtighten, but insure that mating surfaces of the heater and adapters are clean and flush. Any gap indicates a dirty or rough surface which will retard and limit heat transfer and thereby affect joint integrity. Allow the heater to come to the temperature specified by the pipe and fitting manufacturer.

Install the Saddle Fusion Machine

Install the saddle fusion machine to the pipe using appropriate tooling and the manufacturer's instructions to straighten and round the pipe. Use caution when tightening the clamping fixture so the pipe is not flattened.

Prepare Surfaces

Remove any mud or other contaminants. Then, using 50 or 60 grit utility cloth, clean and roughen the pipe surface and fitting saddle contour to expose fresh material. Brush away residue with a clean, dry cloth after roughening the surfaces. Avoid using sandpaper or other abrasive materials which are likely to leave grit or deposits of other foreign materials on the pipe surface.

Fitting Alignment

Assure that the proper saddle-fitting holding inserts are in the fusion machine. Position the fitting on the pipe and place the fitting into the insert. Apply a slight downward force on the fitting and inspect to insure a precise fit to the pipe. Move the fitting away from the pipe, then back to the pipe and inspect again for precise alignment.

Heating

Check the heater temperature. Periodically verify the proper surface temperature using a pyrometer or other surface temperature measuring device. If temperature indicating crayons are used, do not use them on a surface which will come in contact with the pipe or fitting. Place the heater tool in position to heat the pipe and fitting surfaces in accordance with the pipe and fitting manufacturers' instructions. Procedures will vary with different materials. Follow the instructions carefully.

Fusion

After the prescribed heating requirements have been met, remove the heater from the heated pipe and fitting surfaces with a "snap" action and quickly inspect the melt pattern on both the fitting and the pipe. Join the fitting to the pipe with the prescribed fusion force.

Cooling

Continue to hold the force during the cooling cycle as prescribed by the fitting and pipe manufacturer. Allow the joint to cool to the touch or to reach ambient temperature. Do not subject the joint to any external stresses until the fusion joint has cooled.

SOCKET FUSION

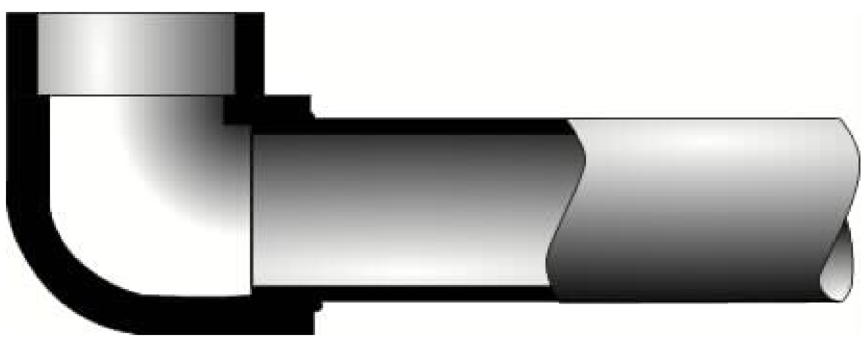

Figure 4 Standard Socket Fusion Joint

This technique consists of simultaneously heating both the external surface of the pipe and the internal surface of the socket fitting until the material reaches fusion temperature; inspecting the melt pattern; inserting the pipe end into the socket; and holding it in place until the joint cools. Figure 6.4 illustrates a typical socket fusion joint. Mechanical equipment is available and should be used for sizes larger than 2-inch diameter to attain the increased force required and to assist in alignment. Follow these general steps when performing socket fusion:

1. Select the equipment
2. Square and prepare the pipe ends
3. Heat the parts
4. Join the parts
5. Allow to cool

Equipment Selection

Select the proper size tool faces and heat the tools to the fusion temperature recommended for the material to be joined. For many years, socket fusion tools were manufactured without benefit of any industry standardization. As a result, variances of heater and socket depths and diameters, as well as depth gauges, do exist. More recently, ASTM Fl056[6] was written, establishing standard dimensions for these tools. Therefore, mixing various manufacturers' heating tools or depth gauges is not recommended unless the tools are marked "F1056," indicating compliance with the ASTM specification.

Square and Prepare Pipe

Cut the end of the pipe square. Chamfer the pipe end for sizes 1'/4-inch diameter and larger (chamfering of smaller pipe sizes is acceptable and sometimes specified in the instructions). Remove any scraps, burrs shavings, oil, or dirt from the surfaces to be joined. Clamp the cold ring on the pipe at the proper position, using the integral depth gauge pins or a separate (thimble type) depth gauge. The cold ring will assist in re- rounding the pipe and provide a stopping point for proper insertion of the pipe into the heating tool and coupling during the fusion process.

Heating

Check the heater temperature. Periodically verify the proper surface temperature using a pyrometer or other surface temperature measuring device. If temperature indicating crayons are used, do not use them on a surface that will come in contact with the pipe or fitting. Bring the hot clean tool faces into contact with the outside surface of the end of the pipe and with the inside surface of the socket fitting, in accordance with pipe and fitting manufacturers' instructions. Procedures will vary with different materials. Follow the instructions carefully.

Joining

Simultaneously remove the pipe and fitting from the tool using a quick "snap" action. Inspect the melt pattern for uniformity and immediately insert the pipe squarely and fully into the socket of the fitting until the fitting contacts the cold ring. Do not twist the pipe or fitting during or after the insertion, as is a practice with some joining methods for other pipe materials.

Cooling

Hold or block the pipe in place so that the pipe cannot come out of the joint while the mating surfaces are cooling. These cooling times are listed in the pipe or fitting manufacturer's instructions.

ELECTROFUSION

This technique of heat fusion joining is somewhat different from the conventional fusion joining thus far described. The main difference between conventional heat fusion and electrofusion is the method by which the heat is applied. In conventional heat fusion joining, a heating tool is used to heat the pipe and fitting surfaces. The electrofusion joint is heated internally, either by a wire coil at the interface of the joint or, as in one design, by a conductive polymer. Heat is created as an electric current is applied to the conductive material in the fitting. Figure 6.5 illustrates a typical electrofusion joint and Figure 6.6 illustrates an electrofusion control box and fitting.

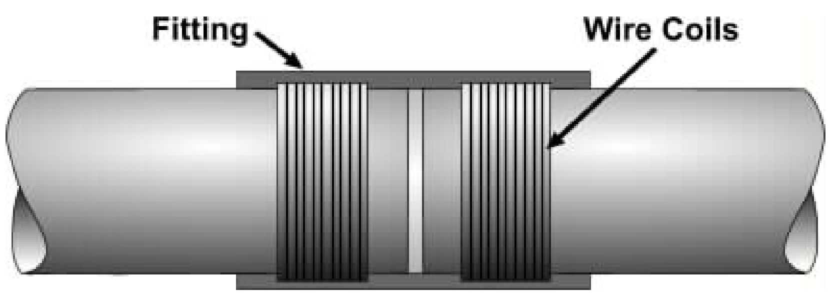

Figure 5 Typical Electrofusion Joint

General steps to be followed when performing electrofusion joining are:

1. Prepare the pipe
2. Clamp the fitting and pipe(s)
3. Apply the electric current
4. Cool and remove the clamps

Prepare the Pipe

First clean the pipe surface in the joint area. Cut the end of the pipe square (omit this operation for saddle-type electrofusion joints). Mark on the pipe surface the proper positioning of the fitting to be installed. Scrape the surface of pipe area to be joined, removing all surface degradation and contamination. Exercise caution to avoid contamination of the scraped pipe surfaces. There are tools available to assist the operator in this procedure.

Clamp the Fitting and Pipe(s)

Place the pipe(s) and fitting in the clamping fixture to prevent movement of the pipe(s) or fitting. Give special attention to proper positioning of the fitting on the prepared pipe surfaces.

Apply Electric Current

Connect the electrofusion control box to the fitting and to the power source. Apply electric current to the fitting as specified in the manufacturer's instructions. If the control does not do so automatically, turn off the current when the proper time has elapsed to heat the joint properly.

Figure 6 Typical Electrofusion Control Box and Leads with Clamps and Fittings

Cool Joint and Remove Clamps

Allow the joint to cool for the recommended time and remove the clamping fixtures. Premature removal from the clamps and any strain on a joint that has not fully cooled can be detrimental to joint performance.

HEAT FUSION JOINING OF UNLIKE POLYETHYLENE PIPE AND FITTINGS

Research has indicated that polyethylene pipe and fittings made from unlike resins can be heat-fused together to make satisfactory joints. Some gas companies have been heat-fusion joining unlike polyethylenes for many years with success. Extra caution in training operators in conventional heat fusion methods (butt-socket-saddle) of unlike materials is recommended. Guidelines for heat fusion of unlike materials are outlined in TN 13[10], issued by the Plastics Pipe Institute. Manufacturers of pipe and fittings can also be consulted. Electrofuslon joining of dissimilar materials requires no special procedures.

Mechanical Connections

INTRODUCTION

As in the heat fusion methods, many types of mechanical connection styles and methods are available. Each of the mechanical connections has particular advantages or limitations of performance in some applications. This section does not address these advantages or limitations; it is, rather, a general description of these types of fittings and how they might be utilized.

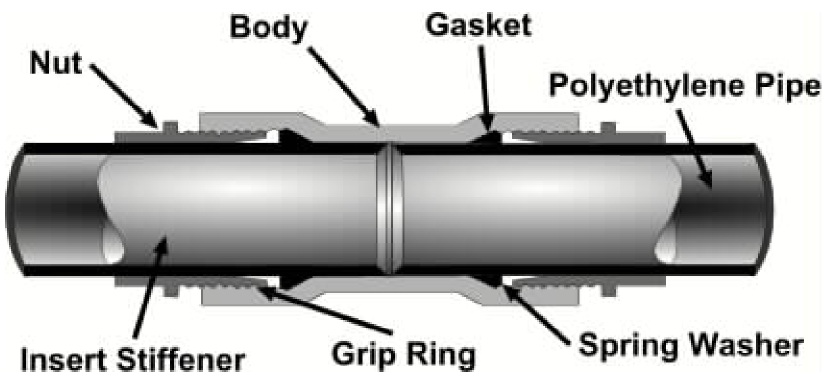

Figure 7 Typical Compression Nut Type Mechanical Plastic Coupling for Joining Polyethylene to Polyethylene

The Plastics Pipe Institute recommends that the user be well informed about the performance limitations of the particular mechanical connector being utilized. A mechanical tapping saddle for connecting the main to the service line is another connection used when fusion is not used.

MECHANICAL COMPRESSION FITTINGS

This style of fitting comes in many forms and materials. The components are generally a body; a threaded compression nut or a follower and bolt arrangement; an elastomer seal ring; a stiffener; and, with some, a gripping ring. Normally the design concept of this type of fitting typically includes an elastomer seal in the assembly.

The seal, when compressed by tightening of a threaded compression nut, as illustrated in Figure 6.7 or by bolts as illustrated in Figure 6.8, grips the outside of the pipe, effecting a pressure-tight seal and, in some designs, providing pull-out resistance. It is important that the inside of the pipe wall be supported by the stiffener under the seal ring and under the gripping ring (if incorporated in the design), to prevent collapse of the pipe. A lack of this support could result in a loss of the seal effected by the seal ring or the gripping of the pipe for pull-out resistance. This fitting style is normally used in service lines for gas or water pipe 2-inches in diameter and smaller. It is also important to consider that two categories of this type of joining device are available. One type is recommended to provide a seal only, and another is recommended to provide a seal plus pipe restraint against pull-out.

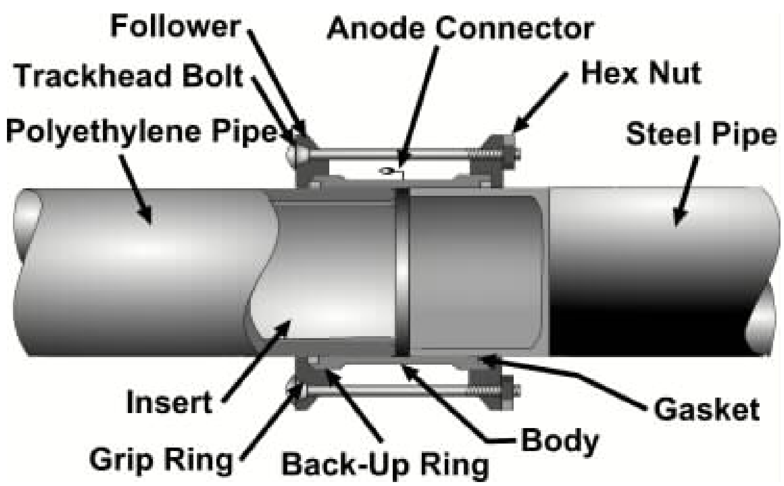

Figure 8 Bolt Type Mechanical Coupling for Joining Steel Pipe to Polyethylene or for Joining Two Polyethylene Pipes

STAB TYPE MECHANICAL FITTINGS

Here again many styles are available, but materials are limited to “Gas Grade” PE2406 and PE3408[2] resins. The design concept is similar in most styles. Internally there are specially designed components including an elastomer seal, such as an “O” ring, and a gripping device to effect pressure sealing and pull-out resistance capabilities. Self-contained stiffeners are included in this design. With this style fitting the operator would have to prepare the pipe ends, mark the stab depth on the pipe, and “stab” the pipe in to the depth prescribed for the fitting being used. These fittings are available in sizes from 1/2 CTS through 2 IPS and are all of ASTM D2513[2] Category I design, indicating seal and full restraint against pull-out.

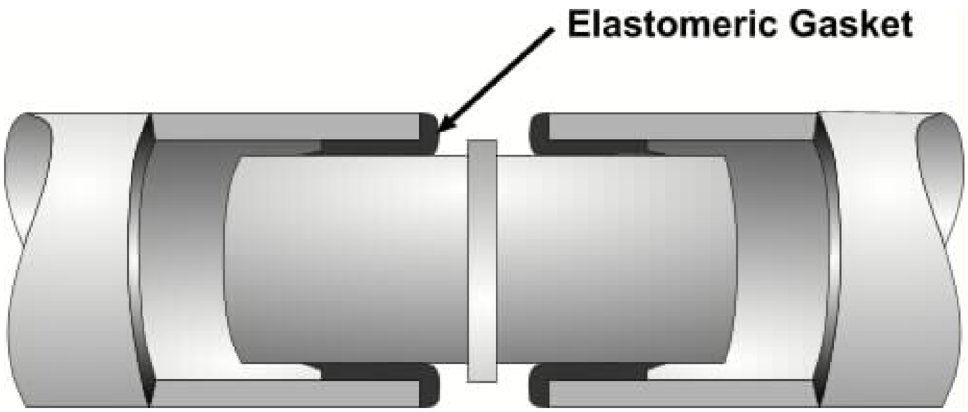

Figure 9 Double Bell Type Fitting

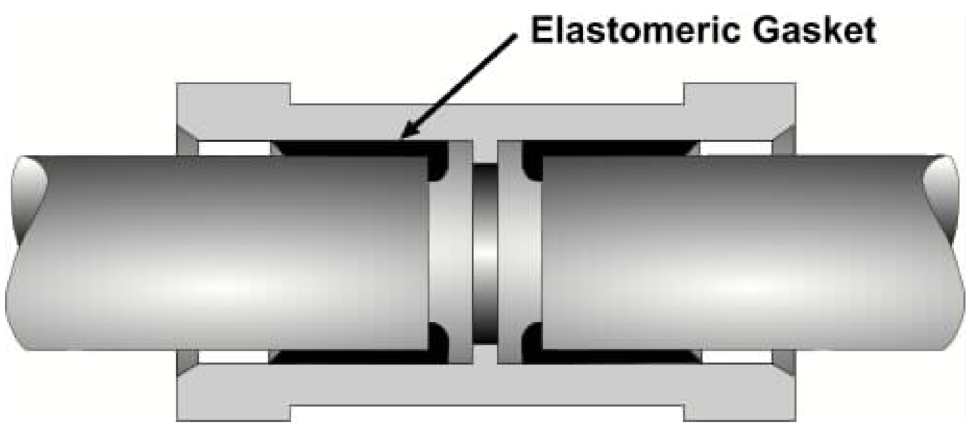

Figure 10 Double Spigot Type Fitting

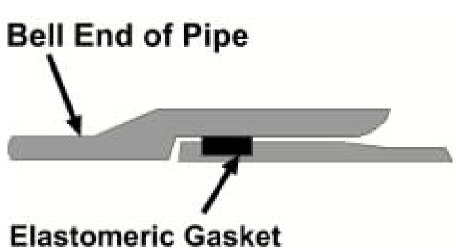

Figure 11 Bell & Spigot Pipe End Joint

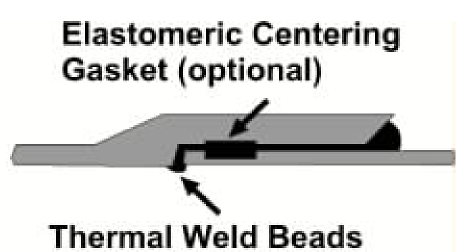

Figure 12 Bell & Spigot Pipe End Joing with Additional Weld Beads

JOINING OF PROFILE PIPE

The “profile” type pipes normally used in gravity flow and low pressure applications may be joined by some of the previously mentioned methods such as butt fusion or electrofusion, or with flange adapters. Profile pipe also utilizes “Bell” and “Spigot” types of joining methods. In this type of joining, the “Bell” or the “Spigot” may be separate components as illustrated in Figures 6.9 and 6.10, or actually formed on the profile pipe ends as illustrated in Figure 6.11. In either concept, the “Bell” always slips over the “Spigot” and an elastomeric gasket between the two surfaces effects a seal. If deemed necessary, the joint may also be anchored and a seal effected by use of a portable field extruder, forming a weld bead around the jointed surfaces. An example of this method is illustrated in Figure 6. 12. More detailed information on profile type pipe may be found in ASTM F894[(4)].

FLANGED CONNECTIONS

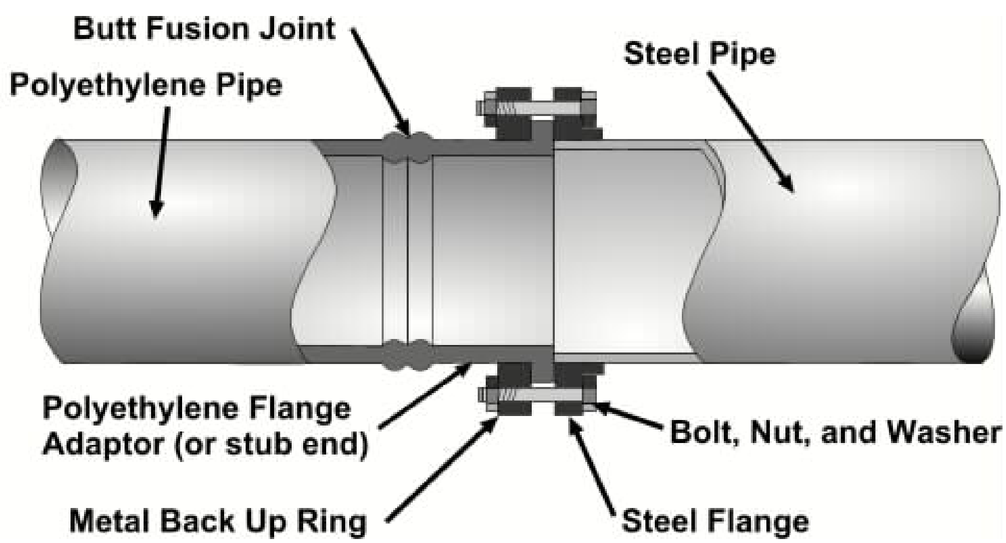

Figure 13 Typical Application of Polyethylene Flange Adapter or Stub End

When joining to metal or to certain other piping materials, or if a pipe section capable of disassembly is required, polyethylene flange adapters are available. The “Flange Adapter” and it’s shorter version, the “Stub End”, are designed so that one end is sized the same as the plastic pipe for butt fusion to the plastic pipe. The other end has been especially made with a flange-type end that, with a metal back up ring, permits bolting to the non-plastic segment of a pipe line—normally a 1 50-pound ANSI flanged [(1)].

The procedures would be:

1. Slip the metal ring onto the plastic pipe section, far enough away from the end to not interfere with operation of the butt fusion equipment.
2. If a stub end is used, first butt-fuse a short length of plastic pipe to the pipe end of the stub end. If a “flange adapter” is used, the plastic pipe-sized end is usually long enough that this step is unnecessary.
3. Butt fuse the flange adapter to the plastic pipe segment.
4. Position the flanged face of the adapter at the position required so that the back up ring previously placed on the plastic pipe segment can be attached to the metal flange.
5. Install and tighten the flange bolts in an alternating pattern normally used with flange type connections, drawing the metal and plastic flange faces evenly and flat. Do not use the flanges to draw the two sections of pipe together.

TRANSITION FITTINGS

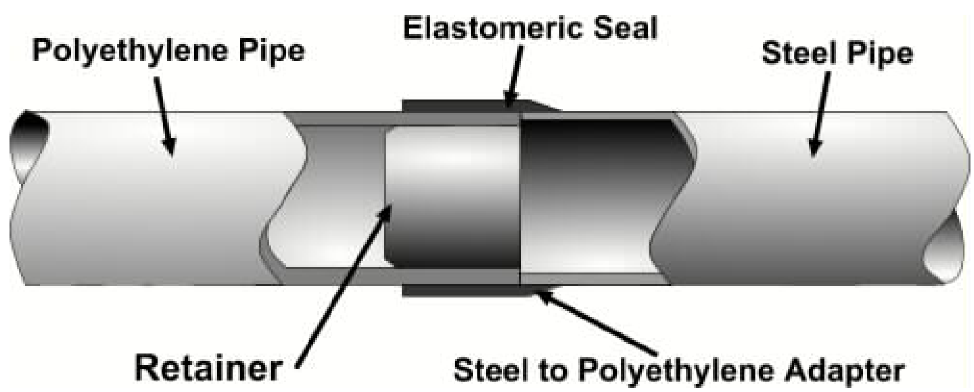

Figure 14 Standard Fitting for Plastic Pipe to Steel Pipe Transition

Other methods are available that allow joining of plastic to metal. Transition fittings are available which are pre-assembled at the manufacturer’s facility. These transition fittings are normally pull-out resistant and seal tight with pressure and tensile values greater than that of the plastic pipe part of a system. However, the user should insist on information from the manufacturer to confirm design capabilities or limitations. Transition fittings are commonly available with a short segment of plastic pipe for joining to the plastic pipe section. The metal end is available with a bevel, for butt welding, with male pipe threads, or is grooved for a Victaulic[13] style or flanged for connecting to an ANSI 150-pound flanged [1].

THREADED CONNECTIONS OF PLASTIC

Polyethylene pipes can be threaded the same as metal pipes for a tapered NPT thread for joining to a matching female NPT thread. Caution must be used in this type of application. Polyethylene materials are subject to creep and cold flow under long-term stress. The life of a polyethylene threaded joint is very dependent on proper anchoring against pull-out forces and pressure regulations. These values will vary with pipe materials. Contact the pipe manufacturer before making this type of installation for possible limitations. Many federal, state, and local codes do not allow threaded plastic connections for containment of certain products.

FLARED CONNECTIONS

The practice of making polyethylene joints by "flaring" is one which has gradually been used less and less. The process is accomplished by "Cone Flaring" where heat is applied from an external source, or by "Spin Flaring" where the heat is produced by friction. These flared pipe ends are used with mechanical flare nuts and couplings to form a joint. Recent changes in AWWA C901(7) and other written codes by PPFA(12) and IAPMO(11) have discouraged or specifically prohibited flaring of PE pipe. The possibility of an unsatisfactory joint is much greater with this type of joint than with the other available joining techniques. The Plastics Pipe Institute recommends that the pipe manufacturer be contacted to determine if flared connections are recommended on the particular pipe material being considered for flare-type joining. Refer to ASTM D3140(3) for guidance on how this type joint should be made.

ADHESIVE JOINING

At this time, there are no known adhesives or solvent cements that are suitable for pressure sealing or that have sufficient strength characteristics to join polyethylene pipes.

SQUEEZE-OFF

Regardless of the joining method applied in the installation of polyethylene pipe, it may become necessary to shut off the flow in the system. With PE pipe materials, squeeze-off of the pipe with specially-designed tools is a common practice. Consult the pipe manufacturer for guidance in tool selection and instructions for squeeze-off of their pipe material. General procedures for squeeze-off of polyethylene pipe can be found In ASTM F1041(5).

SUMMARY

The applications for polyethylene piping products continue to expand at an accelerating rate. Gas distribution lines, potable water systems, submerged marine installations, gravity and force main sewer systems, and various types of above-ground exposed piping systems are but a few of the installations for which polyethylene pipe and fittings have been utilized.

A key element to this continued success is the diversity of methods available to join polyethylene pipe and fittings. The integrity of the butt and socket fusion joining technique has been proven by the test of time in a variety of applications. The manufacturers of polyethylene pipe and fittings have made every effort to make the systems as comprehensive as possible by producing a variety of fittings and components to insure compatibility with alternate piping materials and system appurtenances.

The purpose of this chapter has been to provide the reader with an overview of the various methods by which polyethylene piping materials may be joined. As a result, hopefully, the reader has developed a further appreciation for the flexibility, integrity, and overall utility afforded in the design, installation, and performance of polyethylene piping systems and components.

It should be noted that this document does not purport to address any safety problems associated with the use of these procedures. Information on safe operating procedures can be obtained from the manufacturers of the various types of joining equipment or polyethylene products.

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