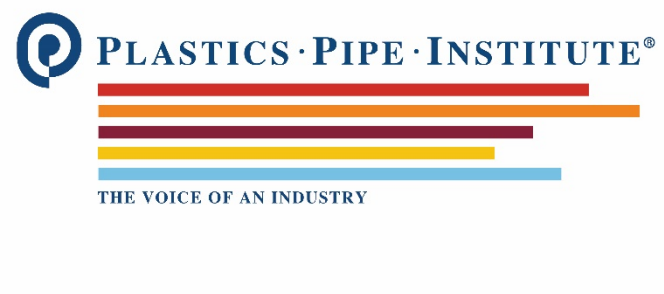
Generic Electrofusion User Guide for Field Joining of Polyethylene Gas Piping

TR-49

2020



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encirclement clamp as a guide so that the pipe can then be cut along the line as shown in Figure 5.

Figure 5: Marking and cutting larger diameter pipes

8.0 MEASURING PIPE

8.1. **Diameter**

Electrofusion fittings are designed for use on pipe made to standard diameters in dimensions for Iron Pipe Size (IPS) and Copper Tube Size (CTS). Pipe that is outside of the diameter tolerance band of the appropriate pipe standard should not be used. The following tables include diameters and tolerances from ASTM D2513 and ASTM D2737 and can be used for reference when measuring gas distribution pipe diameter to ensure that is within tolerance.

Table 1: Standard Pipe Dimensions - Iron Pipe Size (IPS) ASTM D2513

IRON PIPE SIZE (IPS) ASTM D2513		
Nominal Pipe Size	Nominal Diameter (inches)	Tolerance (+/-)
1/2 IPS	0.840	0.004
3/4 IPS	1.050	0.004
1 IPS	1.315	0.005
1 1/4 IPS	1.660	0.005
1 1/2 IPS	1.900	0.006
2 IPS	2.375	0.006
3 IPS	3.500	0.008
4 IPS	4.500	0.009
6 IPS	6.625	0.011
8 IPS	8.625	0.013
10 IPS	10.750	0.015
12 IPS	12.750	0.017

Table 2: Standard Pipe Dimensions - Copper Tube Size (CTS) ASTM D2737

COPPER TUBE SIZE (CTS) ASTM D2737		
Nominal Tubing Size	Nominal Daimeter (inches)	Tolerance (+/-)
1/2 CTS	0.625	0.004
3/4 CTS	0.875	0.004
1 CTS	1.125	0.005
1 1/4 CTS	1.375	0.005
1 1/2 CTS	1.625	0.006
2 CTS	2.125	0.006

8.2. Pipe Toe-in

A slight reduction in pipe diameter at the end of the pipe is referred to as toe-in. Pipes that are freshly cut and molded fittings generally do not have toe-in. If severe toe-in is present, trimming up to 2 inches off the pipe end will usually remove it.

8.3. Roundness

Polyethylene is a flexible material. Although pipe may be round at the time of manufacture, pipe roundness can be affected by a number of conditions to include coiling, storage/stacking, bending, and soil load if buried. The following information can be used to determine if a pipe is suitable for electrofusion joining without the use of re-rounding devices.

The condition of pipe roundness can be expressed in two ways; “out-of-roundness” and “ovality”. While both are referencing the same basic condition, it can sometimes be confusing.

8.3.1. Out-of-roundness is the difference in the maximum measured diameter minus the minimum measured diameter. The pipe can be measured with a tape measure or calipers to find the maximum (d1) and minimum (d2) diameter points. The out-of-roundness is calculated as d1- d2 as measured in the field.

8.3.2. Ovality is the difference between the maximum and minimum measured outside diameters expressed as a percentage. Ovality is calculated as (d1 – d2) / $D_{average}$ x 100.

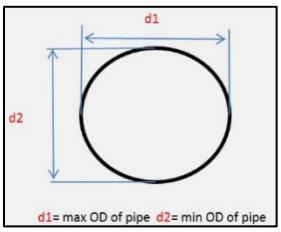

Figure 6: Roundness Measurement

Pipe out-of-roundness can have a negative effect on electrofusion joint quality. If the pipe is out-of-round and is not corrected, the amount of gap between the pipe and fitting can be too large for the melt expansion to close and for proper heat transfer to occur between the fitting and the pipe. An out-of-round pipe can also increase the difficulty of sliding (coupling) or clamping (saddle) the fitting onto the pipe.

Most often, 2 IPS and smaller diameter tubing is flexible enough that the coupling and alignment clamps will provide the necessary rounding forces and no other re-rounding device is needed.

For sizes equal to or larger than 3" IPS, re-rounding clamps may be needed on either side of an electrofusion fitting to ensure that the gap between the pipe and fitting is not too large. The table below can be used for guidance when re-rounding clamps are used.

Table 3: Maximum Out-of-Roundness (IPS/DIPS)

PIPE SIZE	d1 - d2
3"	.0625 or 1/16"
4"	.0625 or 1/16"
6"	.125 or 1/8"
8"	.125 or 1/8"
10"	.125 or 1/8"
12"	.125 or 1/8"

8.3.3. **Pipe scratches, gouges, and damage:** Installation of pipe can cause surface scratches or gouges. Smaller scratches from dragging or normal handling are not problematic and will normally be removed during the pipe preparation process by scraping.

⚠ **Gouges that are deeper than the scrape depth may also require extra attention when scraping the pipe to ensure that any debris or contaminants embedded in the gouges are removed. If the gouge exceeds 10% of the pipe wall thickness**

(refer to Coupling Installation, Sec. 4, p. 17), that pipe section should be cut out and replaced to maintain the maximum pressure rating of the pipe.

⚠ **Hydrocarbon contamination of PE pipe can result in reduced heat fusion joint strength. Do not attempt to electrofuse to pipe that has been permeated by heavy hydrocarbons at the external surface of the pipe area being fused. Refer to ASTM D2513 Appendix X.1 for guidance on joining PE pipe that is known to have hydrocarbon permeation.**

9.0 PIPE PREPARATION

9.1. Cleaning

1. Clean the pipe beyond the area to be scraped with clean water[2] without soap to remove dirt, mud, or other debris. Soaps should not be used because it may contain surfactants or wetting agents that could be detrimental the fusion process.
2. Clean the pipe for a length far enough beyond the area to be fused to ensure that remaining debris on the pipe surface will not be transferred to the area to be prepared during handling.
3. Inspect the cleaned pipe surface for gouges or embedded debris such as rocks that might damage scraping and peeling blades.
4. Next, clean an area approximately twice as long as the area to be scraped with 90% or greater isopropyl alcohol.

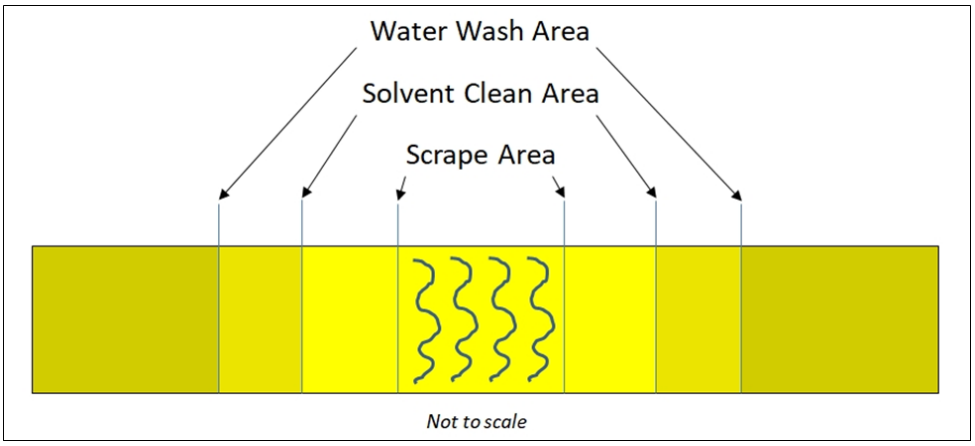

Figure 7: Schematic of Cleaned Pipe Areas

NOTE 1: Other cleaning agents (such as acetone) may be suitable. Refer to local regulations for environmental and health effects.

[2] At installation temperatures at or below freezing, a solvent may be used in place of water for the initial cleaning.

9.2. **Scraping/Peeling**

Pipe preparation is perhaps the most important and least understood aspect of making a sound electrofusion joint. Improper pipe preparation is overwhelmingly the leading cause of unsuccessful electrofusion joint attempts because the installer may not completely understand the goal of pipe scraping, which is to remove a thin layer of the outer pipe surface (see trouble-shooting section for more details) to expose clean virgin material beneath.

Pipe surfaces exhibit surface oxidation from the extrusion process, transportation, and outdoor exposure. Surface oxidation is a normal chemical reaction that results in a physical change to the molecular structure of the polymer chains on the pipe surface. Oxidation acts as a physical barrier and therefore those surfaces cannot be heat fused. Simply roughing the pipe surface is not sufficient. In order to achieve fusion, this layer must be removed. Even new pipe must be properly scraped and prepared before a fusion will be successful.

NOTE 2: The pipe preparation method discussed in this guide and references to "peeling" or "peelers" refers to methods of removing the outer surface of the PE pipes. It should not be confused with commercial products designated as "peelable pipes" which contain a removable outer layer. While peelable pipe is suitable for use with electrofusion, the pipe preparation methods discussed in this guide and references to "peeling" or "peelers" are not related to the use of peelable pipe.

The outer oxidation layer on a pipe surface is very thin. It does not increase in depth of more than a few thousandths of an inch even over long periods of outdoor exposure, so regardless of the amount of time the pipe has been stored before scraping, the scraping depth requirement is the same. An adequate minimum amount of material that must be removed is just seven thousandths of an inch (.007" or 7 mils). That thickness is approximately the same as two sheets of ordinary paper.

Pipe preparation tools should be inspected at each use to ensure that they are performing as intended. Cutting blades can dull quickly as they peel pipe. Measurement of material thickness of peeled ribbon can be helpful to determine if tools are working properly. The figure below shows a caliper being used to measure a plastic peel ribbon. The 0.008 inch thickness indicates that the tool is working properly. Preparation tools should be cleaned before each use to remove any dirt, oils, or other residues from parts that will contact the pipe surface.

Figure 8: Scraping/Peeling measurement using a caliper

⚠ **Sand paper, emery cloth, or other abrasives should never be used to prepare a pipe surface for electrofusion. Abrasives have been proven to be ineffective for electrofusion because they don't adequately remove material, they can redistribute contaminants on the surfaces, and because they can leave behind a grit residue that forms another barrier that will also prevent fusion.**

There are many tools that can be used for pipe preparation, however there are differences in operation that should be considered, differences in appearance of the pipe surface after use, and care must be used depending on the type of tool selected. The only tools suitable for use for pipe surface preparation are those that are specifically designed and qualified for electrofusion scraping and peeling.

9.2.1. **Peelers**

Examples of acceptable tools that “peel” the pipe surface to a controlled depth are most commonly referred to as “peelers” and are shown below.

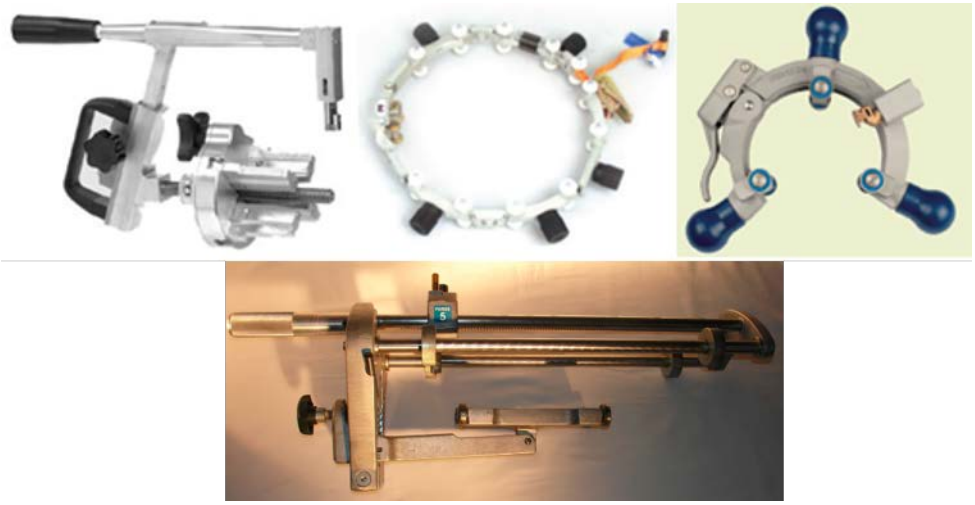

Figure 9: Pipe Peelers

Figure 10: Tubing Peelers (≥ 2 IPS)

9.2.2. **Scrapers**

Tools with serrated blades are also available; these tools physically scrape the pipe surface by pulling the serrated blade across the pipe in a perpendicular position to the pipe. Although these tools can be used satisfactorily for pipe preparation, it is important to know that serrated blades sometimes mask the pipe surface by leaving behind score marks that make it difficult to visually tell if all of the original surface material has been removed. Additionally, if a pipe surface with serrations becomes dirty or contaminated, it may not be reliably cleaned with a solvent and wipe due to the serrations trapping and retaining material.

Figure 11: Examples of serrated type blade scrapers

9.2.3. A third type of tool is referred to as a "hand scraper". **These scrapers are generally not recommended** when peelers and scrapers are commercially available due to inconsistent surface preparation and difficulty in mastering skills required for uniform surface preparation, however they can be used effectively. As a best practice, they should only be used in situations where confined working space or pipe scratches or gouges require a hand tool.

Figure 12: Hand Scrapers

⚠ **<u>Wood rasps and metal files are not acceptable scraping tools.</u>**

- It is strongly recommended that, no matter what type of tool is used, witness marks should be made on the pipe surface with a permanent marker prior to scraping. Some reviews have shown that markers can penetrate the pipe surface so any marking that remains after scraping is clear evidence to the user that areas were missed or that more scraping is required.