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Thermoflex Installation Guide

Gathering, Injection and Disposal Lines and Liners

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POLYFLOW

This manual provides the basic tools, preparation, installation and start up procedures for installing Thermoflex tubing for oil and gas gathering lines, injections lines and disposal lines. This document is intended to provide the line operator and the installer with the key considerations required for installation and operation of the tubing, and is not intended to be the sole training for installation. New installers should contact Polyflow, Inc. for training.

Intended Use:

Gas and oil wells require pipelines to transport product to sales lines, processing facilities or storage sites. Thermoflex® tubing provides corrosion resistant continuous polymer tubing exhibiting dramatically lower pressure drops than steel with faster and lower cost installation to move the gas and or fluids. The same benefits apply to injection and disposal lines.

In order to properly size the tubing and select suitable polymers for the operating environment, a Polyflow Gathering Line questionnaire should be filled out and evaluated by Polyflow. Please contact Polyflow for a copy of the questionnaire. For initial installations, a Polyflow representative should be present to train personnel on proper installation techniques and operating procedures.

Thermoflex® tubing can be direct buried or inserted inside of existing tubing. Insertion requires size analysis to properly pull the tubing through the existing lines. Please consult a Polyflow representative to evaluate the candidate.

Shipping and Handling of Spools:

Below are the specific loading, unloading, handling and storage instructions for Thermoflex® tubing. A Polyflow Representative should be contacted for any specific questions that may arise.

Spools:

Polyflow utilizes various size spools depending upon the diameter and pressure rating of the pipe. Spools sizes are 66", 72", 84", 90", 96" and 124". Each spools size does have a 3.5" arbor and are designed from tubular steel that can be disassembled after use. The sizes are designed to fit on a regular flat bed truck or single drop deck trailer without the need for permits for oversize loads.

Storage:

Spools should be stored upright. (Spools are resting on both flanges) and not on their side. Resting the spools on their side does have the potential of denting the tubing on the flange spindles. If the spools are resting on soft ground where the spool flanges sink into the ground causing the pipe to rest directly on the

ground, the spools should rest on blocks to prevent this occurrence. Blocks should also be pushed against each side of each flange to prevent the spools from rolling. 4 X 4 blocks are suitable to prevent the spools from rolling. Below is an example of storage blocks.

Spools resting on blocks

Thermoflex® tubing's outer jacket does have UV inhibitor added to protect the pipe from UV damage. If pipe will be stored for extended periods of time (in excess of six months) the pipe should be covered to maintain color. Polyflow can also jacket the spools with a white protective wrap to protect the pipe from shipping and storage damage.

Lifting of Spools:

Spools can be lifted with forklifts, overhead cranes or contstruciton equipment in the field such as a backhoe or excavator. A 124" spool of 4.5" weights a total of approximately 2,800lbs so properly rated equipment should be considered when lifting or moving the tubing.

For forklifts single pole lifts or forks can be used for lifting. For pole lifts, the pole needs to be at least 8 foot long (2.44 Meters) and under 3.5" OD to fit through the 3.5" Arbor opening of both sized spools. The pole is inserted through the arbor on one flange, is pushed and inserted through the arbor on the second flange. The spool is ready for lifting.

When lifting with forks, there must be enough length to grab both of the flanges. The forks should be inserted under a set of flange spines that are opposite one another from the center arbor**. The spools should not be picked**

up from the top of the spool nor should the forks lift the tubing directly. This may cause damage to the tubing.

If an overhead crane, backhoe or other overhead lifting device is utilized, a steel shaft should be inserted through the arbor of the spool and chains or straps of suitable lifting capacity attached to both sides of the shaft. Lifting from a center point tends to squeeze the spool flanges together, so a spreader bar should be utilized to eliminate this issue. See Figure Below.

Transporting:

Spools up to eight foot in diameter can be transported on a standard flat bed truck. The 124" spools must be loaded on a single drop deck trailer to eliminate height restriction issues during shipment. For shipments by container, please consult Polyflow for spool sizing and loading requirements.

Spools should always be loaded vertically and not on their sides. The spools are to be loaded on the truck parallel to the trailer length and chained down through the arbor. Straps can be used but must lay on a cross member of the spool and not directly on the pipe. A minimum of two chains or straps must be used to hold down the spool**. When shipping multiple spools, the edges of the flanges must but up against one another to provide stability and prevent the edge of one spool flange from impacting the tubing.**

Site Preparation:

Direct Burial of Tubing:

Thermoflex® tubing can be installed either by plowing, ditch witch trenching, backhoe or excavator digging or continuous trenching. The type of terrain, consistency of the soil, rock content, road, pipeline and river crossings, and right of ways all impact the selection of trenching method. The contractor and engineer on the project should be consulted on the most suitable method for the intended area. Below outlines the key components of a proper installation, but does not replace a trained contractor. Polyflow will provide technicians to train contractors on the proper installation techniques and provide technical support for any questions that may arise.


Ditch Witch Trenching


Backhoe Trenching

Site Preparation:

Once the right of way has been cleared and made ready for trenching and the contractor has selected the suitable trenching method, several considerations should be evaluated before digging.

The depth of the trench must be determined. Frost depths, federal, state, & local codes, and level tie-in's with existing lines all impact this decision. The project engineer and contractor should be consulted for proper burial depth design. Thermoflex® tubing should lay flat and not have sharp changes in elevation to minimize movement in the ground during operation. Therefore, the depth of the trench should be consistent without severe changes in elevation. If a section of the trench was dug too deep and was backfilled to level, the backfill may have to be compacted depending upon the soil conditions. Un-compacted fill can allow the Thermoflex® tubing to move under pressure potentially causing the pipe to kink.

In stable ground, minimum trench width will vary by the pipe diameter as shown below.

Nominal Pipe OD	Minimum Trench Width	Max Trench Width
<3"	12"	18"
≥3"	Pipe OD +12"	Min +6"

To minimize the load on the pipe, the maximum trench width should not exceed the minimum trench width by more than 6". For trenches containing multiple pipes, add the diameters of all of the pipes in the trench to establish an equivalent nominal pipe OD to determine minimum trench width.

Sharp changes in direction should be avoided to minimize kinking. A minimum radius of thirty feet should be maintained.

Tubing Installation:

For straight runs, Polyflow suggests to keep the spool of Thermoflex® tubing fixed in one location and pull the tubing along the right of way. This allows the tubing to lie straight in the trench. An A-frame can be used as an unwinding stand or the spool can be lifted with a crane or excavator. The outer jacket of the Thermoflex® tubing can be scratched and scuffed without impact to the tubing's performance, but care should be taken not to tear the jacket and expose or damage the aramid fibers. When laying the tubing in the trench, it should be inspected before backfilling to make sure it is laying flat in the bottom of the trench. No special sand bedding is required but if the trench is passing through a rocky area or an area where rock was hammered away, bedding should be applied to protect the tubing from sharp edges of the rock. Terminations of the line,

which rise out of the ground, should be with steel pipe. Risers may be welded, flanged or threaded to the termination coupling. Please consult the coupling and welding instructions further details.

Gradual Bends in the Trenching

Pulling Tubing from a Stationary Spool

Winding right of ways requires the spool to be lifted and tubing un-spooled as the spool is carried along the designated path. Pulling from a stationary frame tends to lay the tubing in a straight line causing the tubing to be pulled off the right of way. All other techniques are the same as pulling a straight line.

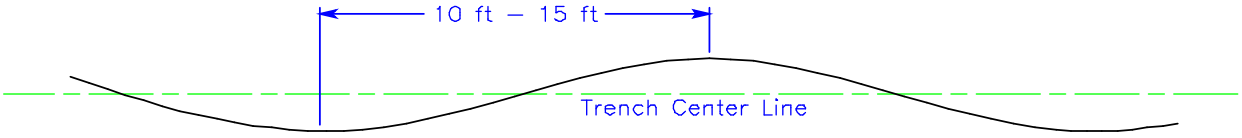
Moving Spool Along Right of Way

Laying the Pipe in the Trench:

When laying the pipe in the trench care should be taken to make sure the pipe lays flat on the bottom of the trench. If backfill had sloughed in before the pipe was laid in the trench, the fill should be removed. Thermoflex® tubing is very flexible and can follow the contour of the bottom of the trench. Humps in the line can force the pipe out of the ground or kinking when under pressure.

When laying pipe in the trench, the pipe should be snaked (side to side) in gentle alternate curves along the bottom of the trench, such that, 102 feet of pipe occupies about 100 feet of trench. This snaking, or offsetting the pipe with respect to the trench

centerline, is necessary to allow for anticipated expansion and/or contractions that may take place in the pipe. The pipe should contact the opposite sides of the trench every 10-15ft.



Oscillation of the Pipe in the Trench

When laying the pipe in trenches with curvature, the pipe should be laid toward the outside of the trench bend. This will minimize movement of the pipe during pressurization.

Backfilling:

The techniques employed for proper backfilling are varied and highly dependent upon soil conditions. A Polyflow technician or trained contractor should be contacted regarding any questions surrounding a specific region.

Fill does not have to be screened to remove all rocks because the jacket of the Thermoflex® tubing is an abrasion resistant cover. Any scratches or gouges to the cover does not affect the performance of the Thermoflex® tubing so long as the cover is not torn or ripped exposing or damaging the reinforcement fibers. With this said, large rocks or boulders can crush the pipe during backfilling. Large quantities of sharp rocks can cut the outer jacket during backfilling. Common sense should be used when backfilling in this environment.

For heavy dirt or clay soils, backfilling the entire trench can be performed with one step. The ground tends to self-compact and should result in minimal settling over time. If there is water in the trench at the time of backfilling, it should be removed. The Thermoflex® tubing will float in water and my not sit on the bottom of the trench during backfilling. For creek crossings where the ground may saturate during high water flows, cement bags may be required to hold down the tubing if the soil becomes supersaturated. Please consult a Polyflow Technician if there are any questions about the need for weighing down the tubing.

Typical Backfill Material

For light sands or soils, it may be required to backfill in multiple lifts and tamp the soil to enhance compaction. Thermoflex® tubing can move in un-compacted light soils under pressure and potentially kink. For a four foot deep trench, two intermediate tamps may be required during the backfilling process to assure good compaction. For some extremely light sands or soils pouring water over the backfill will provide good compaction and minimize trench settling. Again, please consult a Polyflow Technician for any questions regarding backfilling with light sands or soils.

Light Sandy Soil

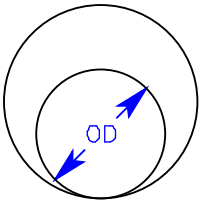
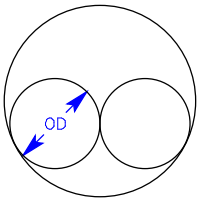
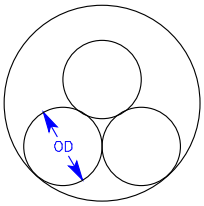
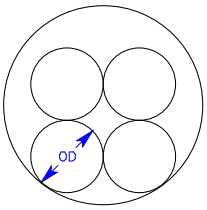
Other Conditions:

Road crossings may be direct buried or pulled through steel conduit. The operator, engineering firm or contractor must consult local regulations to determine if conduit is required. Without conduit a minimum burial depth for the Thermoflex® tubing is three feet and is subject to the proper compacting requirements listed above. If steel conduit is

required or desired for the road crossing, there are a few steps to assure proper installation of the Thermoflex® tubing.

The edges of the conduit should be inspected and if any sharp edges are observed they should be ground out or removed. The tubing should enter straight into the tubing and not come in on an angle. This minimizes the possibility that the tubing will rub against an edge of the steel eventually cutting the jacket and damaging the tubing. It is suggested that the straight section prior to entry and exit to and from the conduit be a minimum of eight feet. Allowing the pipe to snake inside of the conduit can usually accommodate changes due to expansion and contraction of the pipe during use.

The maximum diameter of conduit or directional bores for Thermoflex® tubing will vary by tubing diameter and quantity as shown below.

	Qty: 1 Line	Qty: 2 Lines	Qty: 3 Lines	Qty: 4 Lines
				
Max conduit or bore ØDia.	**1.5 x OD Of Tubing**	**2.12 x OD Of Tubing**	**2.5 x OD Of Tubing**	**2.75 x OD Of Tubing**

Directional bores work well with Thermoflex® tubing. The tubing should be pulled from a termination coupling so that the pull force is applied to the aramid fibers. The length of the bores varies upon the number of curves in the line, and the size of the Thermoflex® tubing. No special treatment to the jacket of the tubing is required for the pull. Please consult Polyflow regarding maximum pull forces and length allowed for specific products.

Underwater trenching requires counterweights on the tubing because of the buoyancy of the tubing. Polyflow technicians are required to evaluate the conditions to determine a proper counterweight procedure. Pulling through existing steel that is underwater is not considered an issue. Please consult the section surrounding pulling through existing pipelines.

Thermoflex® tubing becomes much stiffer in temperatures below freezing. It can also crack if unspooled too rapidly. To minimize these effects, covering the spools with a tarp or tent and heating the area under the cover with a heating unit will warm the pipe and increase flexibility and minimize the potential of cold temperature cracking. After heating, the spool will maintain its heat for up to three hours, providing time to lay the pipe on the right of way. This time does vary and is dependent upon the wind, ambient temperature and humidity.

Below is a picture of a heating unit that blows warm air through two spools simultaneously. It takes about 1.5 hours to increase the spool temperature 30F degrees. Again it is dependent upon the wind ambient temperature and humidity. If there is significant steady wind, the spools may have to be covered while using this unit.

Pulling Through Existing Pipelines:

The installation procedures listed below provides an outline of the steps required to install Thermoflex® tubing inside of existing surface piping systems. Applications include gathering lines, flow lines, injection lines and disposal lines for natural gas, oil and brine fluids. This document is not intended to provide all of the details for installation but rather to familiarize operators and contractors of the key components required for a successful installation. A Polyflow representative must provide on site training for new installation crews, and Polyflow's technical representatives are available to assist in the sizing and proper material selection for specific applications.

Overview:

The aramid fibers in Thermoflex® tubing provide the strength of steel but the weight of HDPE tubing. This allows for the ability to pull long lengths of tubing without excessive permanent stretch of un-reinforced plastics and without the excessive pull forces required for steel.

The general steps are as follows:

- Run a sizing pig through the existing line to assure that the pipeline is open and capable of accepting Polyflow's Thermoflex® tubing.
- A foam or rubber pig is blown through the pipeline pulling a cable to pull back the Thermoflex® tubing.

- The cable is connected to the Thermoflex® tubing and is pulled back, sliding the tubing through the existing lines.

The tubing is then available for hook up to the connections at the terminations.

Installation Procedures:

The first step is to size and rate Thermoflex® tubing for the applications. Pressure drop curves can be modeled for the line based upon entry pressure, elevation changes, line length, fluid to be moved and operating temperature. By utilizing the Polyflow gathering line questionnaire, an operator can have pressure drop curves modeled by a Polyflow Representative. The grade of polymer must also be selected based upon the temperature and chemical environment. Polyflow does not use polyethylene or polypropylene when exposed to hydrocarbons due to softening and swelling issues. Nylon (PA) liners or Fortron (PPS) are utilized upon the application. Please consult a Polyflow Representative.

The next step is to determine the drag force on the tubing so that maximum length pulls and location for the pulls can be determined. This requires a topography map (including elevation change) to evaluate the number of turns, elevation changes and access points for the pull process. Polyflow technicians will assist with this process.

The pull through process outlined above provides the steps for pulling but a trained contractor should be selected for the job. Each contractor has their own equipment and techniques for performing the pull through projects.

Pulling Through Line from Offshore Well

Cable Pooling Tubing

Assembling the Termination Couplings:

Overview:

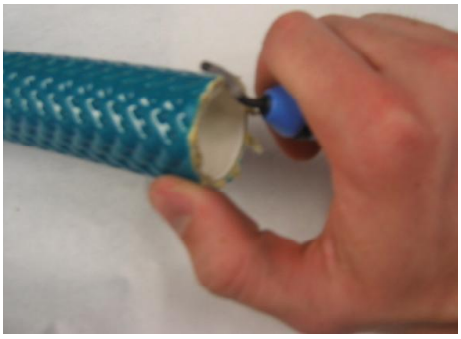
These instructions provide the step by step requirements for installation of a Polyflow Thermoflex® termination coupling to Thermoflex® tubing. Only Polyflow couplings can be used with Polyflow tubing and model numbers for the couplings and tubing should match. Couplings Assembly part number for a coupling to mate with 1.75" tubing is defined as CA1750R1 where 1750 designates the 1.75" tubing size to be mated with the coupling.

The following tools and items need to be available for proper coupling of Thermoflex® tubing:

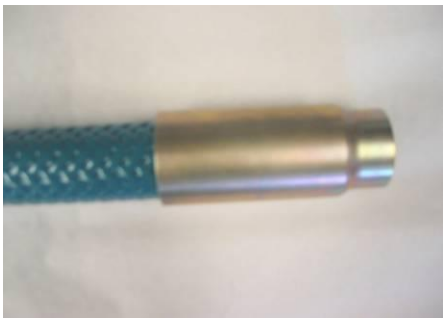
1.) Polyflow Coupling machine (with hydraulic pump) and appropriate dies for the size coupling to be mated to the tubing.
2.) Molybdenum disulfide high pressure grease
3.) Hacksaw or PVC cutter
4.) Deburring tool
5.) Marker
6.) Rag for wiping off the coupling
7.) Rubber Hammer

Installation Procedures:

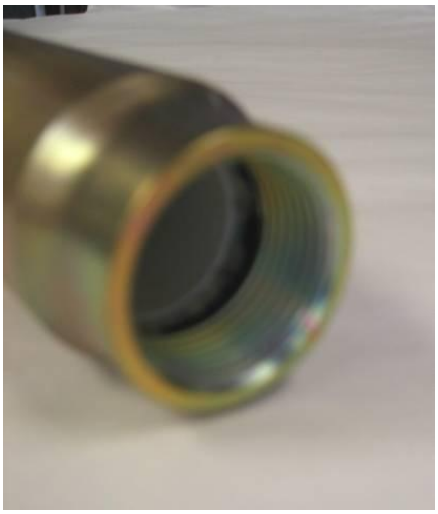
1.) Cut the end of the pipe squarely and de-burr the ID and OD to smooth the edges and remove any fraying that may have occurred. A chop saw with a fine blade or a hack saw are suitable for cutting and PVC cutters can be used for tubing 1.5” or less.

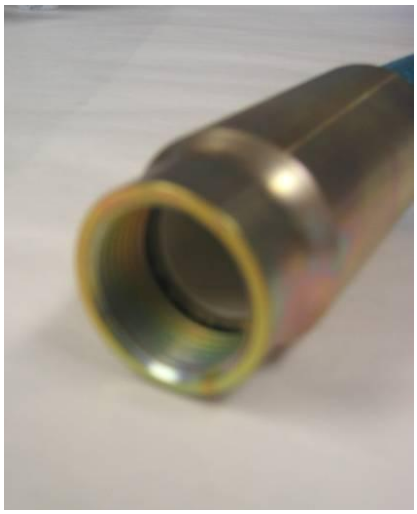


2.) Slip the ferrule onto the end of the pipe.



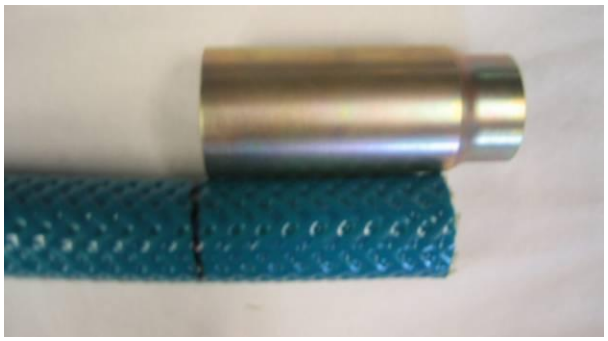
3.) Insert the pipe into the ferrule, pushing the end of the pipe to the tapered edge of the ferrule. Leave a small space (≈ 1/8’’) between the end of the pipe and the edge of the ferrule to allow for plastic to flow into this void during coupling.





4.) Using a pen, mark the location of the back edge of the ferrule on the pipe.

5.) Pull the ferrule off the pipe.



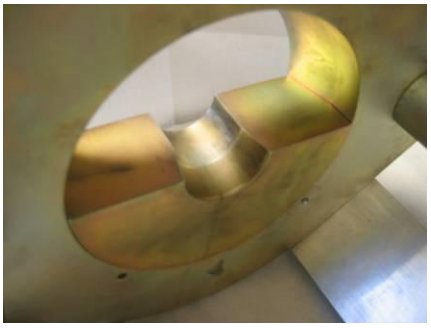
6.) Screw the ferrule onto the stem to assemble the coupling. This should be hand tight to prevent turning during the coupling operation

7.) If ambient temperature is below 32°F:
   a. Place end of pipe into hot water to warm the tubing and ease the coupling process.
   b. At least 6'' of pipe should be immersed in the hot water.
   c. The end of the pipe should be immersed for at least 2 minutes.
   d. After immersion, proceed quickly through steps 8 to 19.

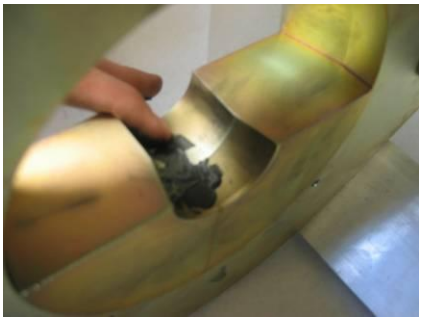
8.) Using your hands, place the assembled coupling onto the end of the pipe.

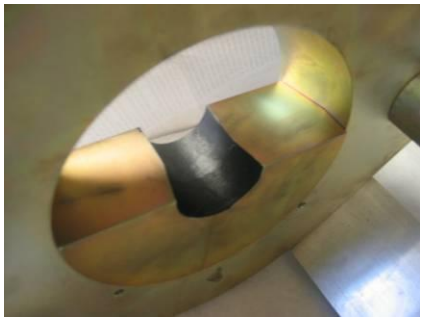
9.) Make sure the back edge of the ferrule aligns with the pen-mark on the pipe. If not, use hammer or rubber mallet to tap the coupling into place. If a steel hammer is the only option, threads should be shielded from direct blows; use a piece of wood or adapter fitting to protect the threads.

10.) Install lower half of the swaging die into the hydraulic swaging machine

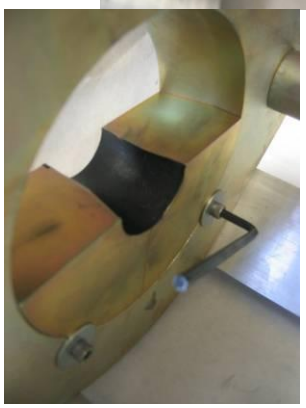


11.) Place a small dab of Molybdenum Disulfide on the tip of your finger and rub it around the inside top half of the die. One application should suffice for several coupling installations.

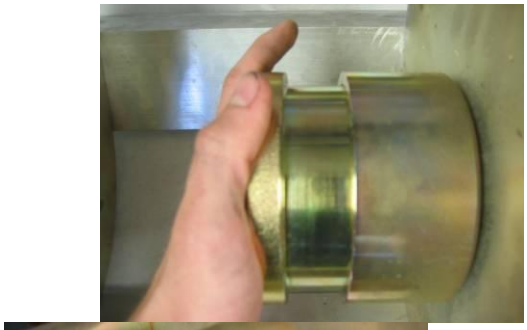




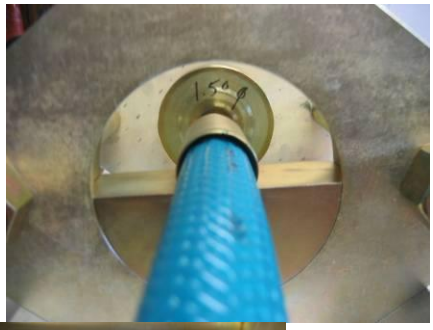
12.) Secure the lower half of the swedging die with an Allen key.



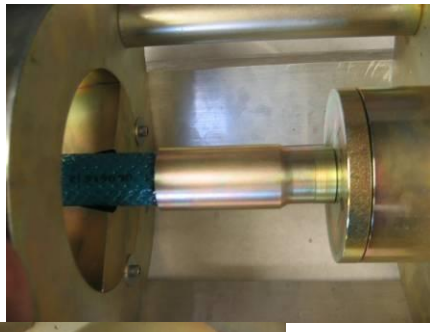
13.) Install thread protection on the coupling, if necessary
14.) Install the hydraulic ram adapter plate.

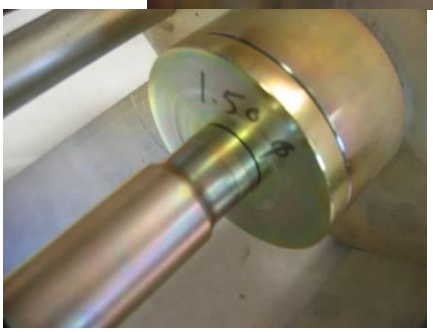


15.) Feed the pipe and coupling through the yoke of the hydraulic swaging machine.

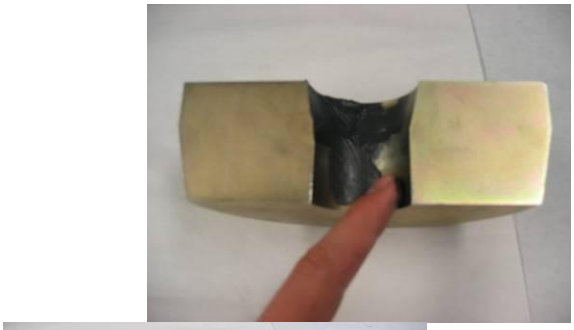


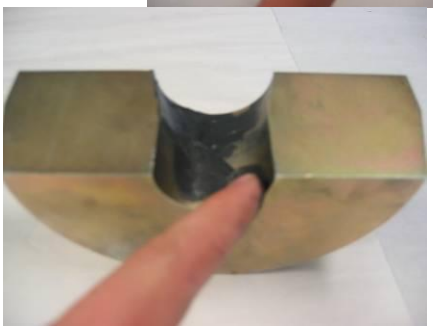
16.) Coupling should be seated firmly in the hydraulic ram adapter plate.



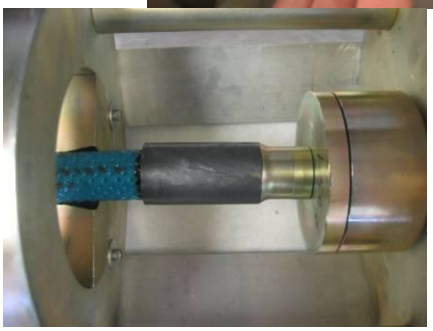


17.) Repeat step 11 for top half of the swaging die.



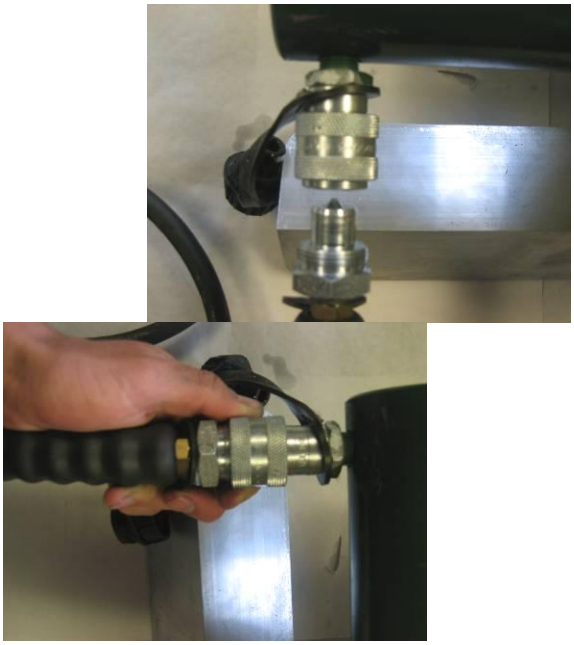


18.) Cover the exposed ferrule with Molybdenum Disulfide.



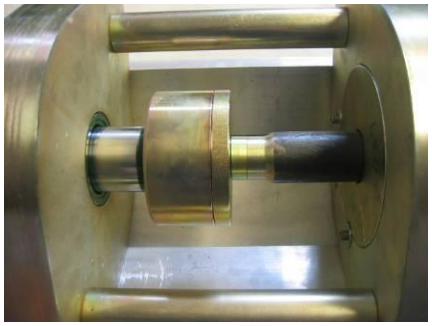
19.) Slip the top half of swaging die into place. Make sure it is flush with the bottom half.

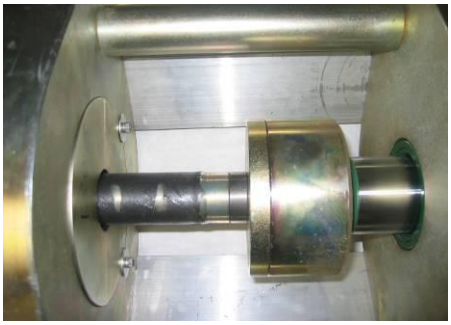
20.) Screw the end of the hand pump's hose into the receiver on the swaging machine.



21.) Tighten the knob on the side of the hand pump to apply pressure to the hose.

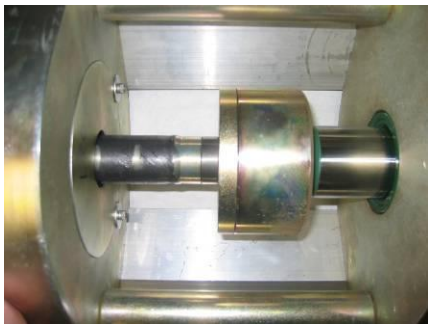
22.) With the hand pump, run the ram until the ferrule reaches the die.

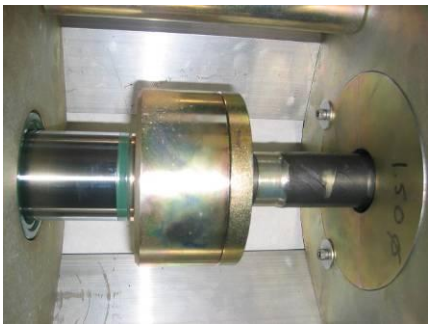




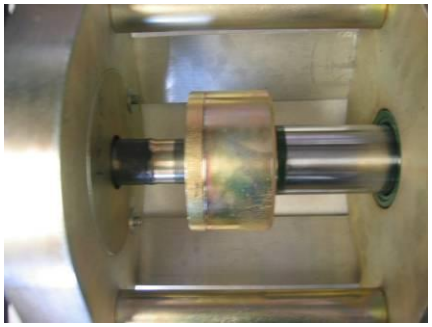
23.) Loosen the knob on the side of the hand pump and jiggle the pipe to relieve pressure on the coupling. This will ensure the coupling is centered in the ram. Make sure the coupling completely entered the die before proceeding.

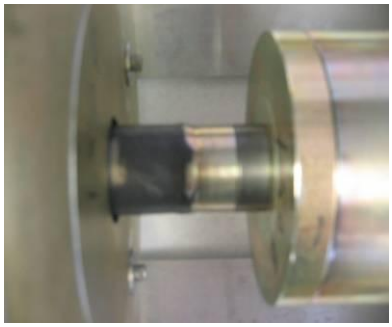
24.) Tighten the knob again and run ⅓ of the length of the ferrule (as shown in the notches in the Molybdenum Disulfide) through the die, and then stop.





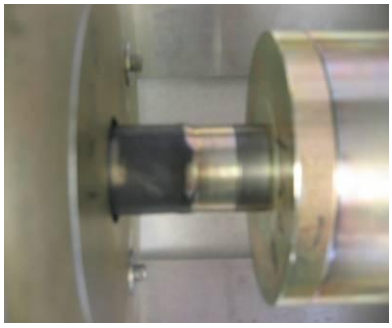
25.) Repeat step 23.
26.) Tighten the knob again and run another ⅓ of the length of the ferrule through the die.





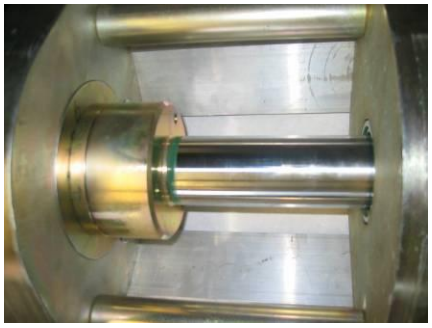
27.) Repeat step 23.
28.) Tighten the knob on the hand pump and run the coupling all the way through the die.

29.) Tighten the knob again and run another ⅓ of the length of the ferrule through the die.



30.) Repeat step 23.

31.) Tighten the knob on the hand pump and run the coupling all the way through the die.



32.) Loosen the knob on the hand pump to reverse the ram all the way back so that it comes to rest at the other end.

33.) Remove the coupled pipe and inspect the coupling for any abnormalities. Ideally there should be 3 rings in the ferrule and no bulges.

34.) Wipe off excess grease and the coupling is compete

35.) For connection of splice couplings to join two pieces of Thermoflex® Tubing, the same procedures apply except that a splice style coupling machine must be utilized. The picture below describes the splice coupling machine.

Final Hook Up:

There are three options for terminating the tubing.

1. Welding to Steel
2. Flange
3. Threaded Unions

The style of termination is the responsibility of the operator. This is dependent upon company and local government regulations regarding underground connections.

When welding the Thermoflex® terminations to steel, care must be taken not to overheat the coupling and melt the tubing. Using a wet rag rapped around the ferule of the termination coupling serves as an adequate heat sink. Any coatings or wraps used to protect steel should be applied to the weld area. Please refer to the Polyflow weld procedures for further detail.

Using a Wet Rag for a Heat Sink

Final Assembly to a Riser

For insertion of the tubing inside of existing pipe, please contact a Polyflow Representative.

Equipment Required:

Tools Required:

1. Polyflow coupling swaging machine (end termination or splice style)
2. Appropriate sized swaging dies for the coupling machine
3. Molybdenum Disulfide high pressure grease
4. Hack saw /pipe cutting tool
5. Grease pencil
6. Tape Measure
7. Oilfield hand tools to tie lines into the well or existing flow lines

Service Equipment Requirements:

1. Trenching equipment for direct bury of tubing or pig and wireline for pulling through existing pipe.
2. Backfilling tampers as required

Product Requirements:

1. Thermoflex® tubing of sufficient length
2. Termination couplings. Either splice, threaded, weld style or flanged
3. Steel pipe fitting to mate with the Thermoflex® tubing terminations

PolyFlow Inc.®
Technology for Fluid Transport

WARRANTY

Polyflow, Inc. warrants the products delivered to be free from defects in materials and workmanship for a period of one (1) year from the date of shipment from Polyflow's facilities. Any claim must be submitted by the buyer to Polyflow, Inc. within five business days of the discovery of the claimed defect, but in no event after the expiration of one (1) year. Failure by the buyer to notify Polyflow of claimed defects within the above time periods shall bar the buyer from any remedies under this warranty

If the products are not as warranted during the warranty period, Polyflow, Inc. will, in its sole discretion, either (i) repair the products, (ii) furnish equivalent replacement products at the site where they are installed, or (iii) reimburse the purchase price of the products furnished to the Customer. The Customer's remedies herein shall apply only after Polyflow, Inc. has been given the opportunity to inspect the site where the products are installed.

THESE WARRANTIES AND LIMITATIONS ARE CUSTOMER'S EXCLUSIVE WARRANTIES AND SOLE REMEDIES AND REPLACE ALL OTHER WARRANTIES OR CONDITIONS. EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE

In no event shall Polyflow, Inc. or its agents or suppliers be liable to buyer for more than the amount of any actual direct damages up to the sales price of the products, which are the subject of the claim by the buyer, including delivery charges, regardless of the cause and whether arising in contract, tort (including negligence) or otherwise. IN NO EVENT SHALL POLYFLOW, INC. OR ITS AGENTS OR SUPPLIERS BE LIABLE FOR ANY OF THE FOLLOWING: a) DAMAGES BASED ON ANY THIRD PARTY CLAIM EXCEPT AS EXPRESSLY PROVIDED HEREIN; OR b) INDIRECT, SPECIAL, INCIDENTAL, PUNITIVE OR CONSEQUENTIAL DAMAGES (INCLUDING LOST PROFITS OR SAVINGS), EVEN IF POLYFLOW, INC. IS INFORMED OF THEIR POSSIBILITY.

This warranty shall not apply to goods or products, which have been repaired or altered by other than authorized representatives of Polyflow, Inc. or to damage or defects caused by accident, vandalism, Acts of God erosion, normal wear and tear, improper selection by the buyer or others, and other causes beyond Polyflow Inc's control. This warranty shall not apply to the misapplication, improper installation, or misuse of the goods caused by variations in environment, the inappropriate extrapolation of data provided, the failure of the buyer or others to adhere to pertinent specifications or industry practices, or otherwise.

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