POLYFLOW

Installation Procedures for Pulling Thermoflex Through Existing Offshore Pipelines

Overview:

Below are the planning requirements, testing procedures and operating requirements for the design, installation and operation of Thermoflex® tubing pulled through existing steel pipe operating in offshore environments. The procedure is broken down into Pre-Planning, Project Planning, Installation and Post Installation.

Safety procedures of each individual company need to be incorporated into each project to assure safety standards are met each step of the way. In addition, certain procedures may have to be modified based upon the platform considerations, pipeline bends and tie-in requirements for each individual projects.

Pre-Planning:

Below is a list of data required to evaluate the suitability of the project, select the proper Thermoflex® tubing and determine the proper installation techniques. The data is for the existing pipeline.

- Line Length
- Riser type (radius of formed bend or elbow)
- Pipeline configuration (straight run, bends or turns, significant elevation changes etc.)
- Pipe diameter
- Termination flange type (RTG, grooved face, etc.)
- Underwater Tees or Connections
- Depth of Water
- Well Chemistry (Gas, Brine, Oil, Condensate, CO2, H2S, Sand, etc.)
- Operating Pressure
- Production Rates
- Wellhead temperatures
- Can the well be flooded with salt or fresh water for the pulling process

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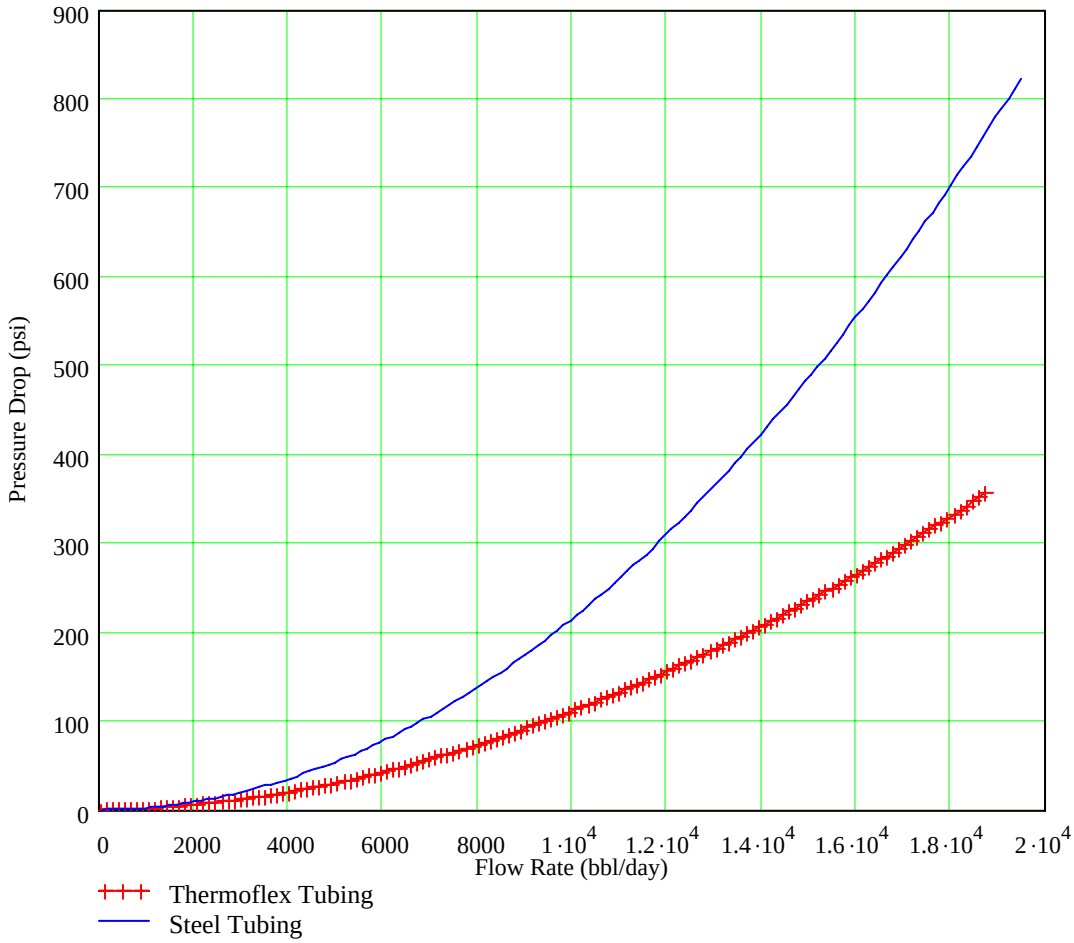
In addition to collecting the information above, it is highly recommended to run a sizing pig through the pipeline being evaluated for rehabilitation to make sure that the line is clear to accept a new pipeline. A foam pig should not be used because it needs to be determined there are any collapsed areas in the pipeline and the pig will determine the pipe integrity to handle the pushing of a pig through the line.

Using the data above, Polyflow will model the line to create options for the operator. The output of the model will select polymers suitable for the operating environment, MAOP pipe rating, pressure drops based on different pipe diameters, and temperature rating for the pipe. Polyflow will offer different options but it is the operator's decision to select a specific pipe type.

Thermoflex ID	Steel ID	
ID = 3.920in	id = 4.000in	
Length	Operating Pressure (Gage)	Operating Temp
L = 5904ft	P = 1400psi	T − 460°F = 176°F



Modeling Output

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The modeling will also determine the pull force requirements, the type of pulling cone, the ability to pull through the riser etc. The output of the model displays the pull force required for the model and the minimum bend radius the Thermoflex pipe can withstand for the pull through.

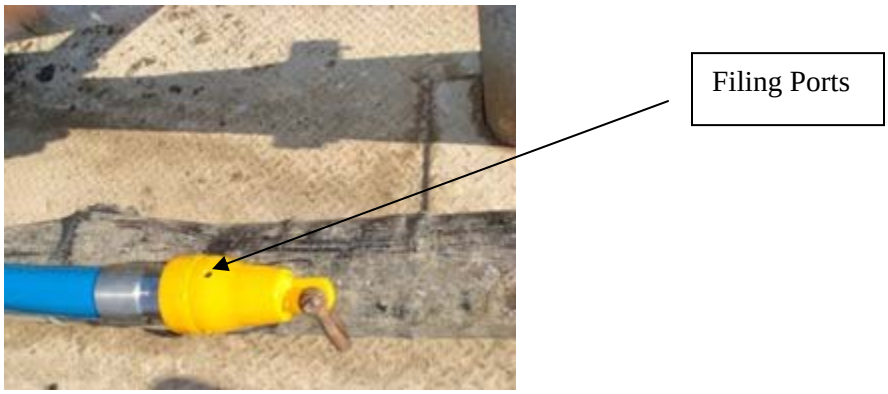
Sample Output of the Pulling Model

Total force required is based on the assumptions that all included angles occur at the end of the pull. This provides a worst case estimate for the total force required.

Total Force Required	$Ft = 3.43 \times 10^3 lbf$	
Minimum Bend Radius in System	$Rc = 4.405ft$	**No Factor of Safety Applied!**

One of the advantages is the density of the Thermoflex tubing is its density of the tubing is very close to that of brine. As a result, pulling through a line flooded with brine can lower the pull force required to pull Thermoflex through the line by 90%. For an example: The force required to pull 20,000ft (6,097meters) through two 45 degree bends without risers would require 20,930lbs of pull force in a dry pipeline. If the Thermoflex was pulled through brine filled pipeline would require only 2,408lbs of pull force.

The types of pulling cones are also selected at this time. To maximize the pulling lengths a termination coupling is required and a pulling cone can be threaded onto the termination coupling. The pulling cone must have holes or ports in it to allow for water ingress into the inside of the Thermoflex tubing for pulling through brine.



Pulling Cone Attached to a Thermoflex Termination Coupling

For pulls where the inside diameter of the existing steel line and the outside diameter of the Thermoflex line are very tight, pulling through with the cone is not feasible because the cone can get stuck on welds in the steel line. In these cases, a pulling cable is attached to the pipe with bolts that run through the pipe and are ground smooth to provide a zero profile while pulling

through the steel pipe. This dramatically reduces the pull length because all of the Aramid fibers in the pipe are assisting in withstanding the pull force. A picture of the procedure is listed below. Polyflow and the Operator can determine the proper pulling cone during the planning phase.

Pulling without a coupling or pulling cone

The type of pulling rope or cable must also be determined in the planning phase. The tensile load required is a function of the pull force necessary to pull the Thermoflex through the existing pipeline, the safety factor desired by the operator and the maximum stretch allowed for the line. In addition, the pressure capability of the existing line is very important in determining the pulling line type. If an existing steel line is severely corroded and the only low pressures can be used to pull the cable or rope through the pipeline with a pig, there may not be enough force for a pig to pull a heavy cable through the line and a synthetic rope may be the only alternative. Polyflow and the operator can determine which type of pulling line can be used based upon the operating pressure capabilities of the line.

Finally the winch type can be determined as a result of the pulling line selection. Safety factors, size, power types (electric, diesel etc) can be determined during planning depending upon platform size, power availability etc.

Operations Pre-planning:

There are multiple planning issues that have to be resolved prior to moving ahead with the project.

The proper sizing, scraping and pulling pigs vary by project. Pipe size, scale build up etc. all have an impact on the proper pig selection. Operators should consult local pig manufacturing representative to select the proper pigs.

If the risers have too tight a radius for the Thermoflex to pass through, the line may have to be lifted to the surface, the riser removed, and the termination of the pull ending at the start of the riser and flanged off to accept the riser. A new riser or a short Thermoflex section can be pulled through the riser. If the existing line has to be lifted and the riser removed, this is generally done

on a barge that is much lower to the water and the barge has more space for setting up the pulling winch or storage of the Thermoflex spools.

Removing the Riser and lifting the Existing Pipeline onto a Barge

The location of the pulling end of the line and the Thermoflex pipe entry end is determined by space. If the radii of the risers are sufficient to pull from platform to platform, the platform with the most space should be where the Thermoflex is pulled off while the second platform has the pulling winch. If there is not suitable space, or crane capacity up to five tons, a work barge may be required for storage and lifting of the spools. This is all determined on a case by case basis depending upon the layout of the specific platforms being evaluated.

If pulling through brine filled existing pipeline and the line has hydrocarbon contamination, Storage tanks may be required to capture the water as the Thermoflex line is pulled through the existing pipeline. If one or both platforms have oil water separators, the water can be put directly into the separators eliminating the need for the tanks. If only on platform has a separator, this may determine which platform to pull to.

The final issue is determining the end connections. Polyflow prefers to flange to the existing steel pipe flange terminating the existing steel pipe. Because Thermoflex is very flexible, terminating to a non rigid structure can cause some issues with excessive bending. Polyflow can machine any type of double faced flange face to seal off the annulus created with the existing steel pipe line as well as sealing to the existing flange on the platform.

RTG flange that will be pushed back and flanged off the existing pipe

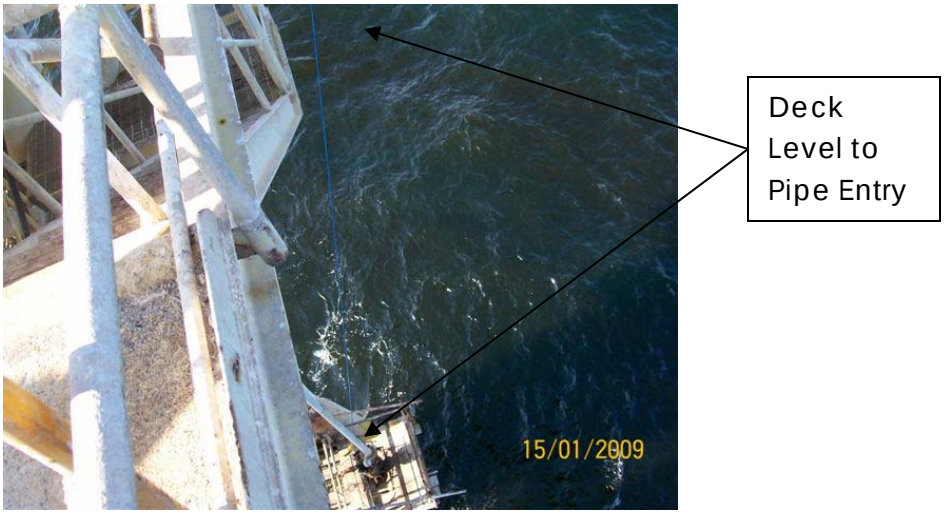
The Project:

Below are the general steps required to pull the Thermoflex through the existing pipeline. Many of the specific details are determined from the results of the pre-planning. An example of the steps required to pull Thermoflex pipe between platforms with the existing steel risers having suitable radius to pull the Thermoflex through is listed below.

Project Planning:

Schedule A is a project planning worksheet to make sure a solution is found for each step of the process. It is meant as a guide to make sure that a solution specific to project and operator is addressed.

There are a few requirements for set up to ease installation. First is it is preferred to have approximately 30ft from the unwind area to the opening of the pipeline the Thermoflex is being pulled through. This allows the Thermoflex pipe to pull into the existing steel pipe at a straight angle which prevents any hang ups.



Sample of distance between pipe entry and un-spooling level


Onshore to offshore straight length before entering existing pipe

It is highly suggested that a Polyflow representative be assist in the planning of the project.

Installation Steps:

The steps below are an overview of the necessary steps for a pull through. This is not intended to be the detail plan but provides the basic steps for installation. Please consult a representative of Polyflow to determine the details required for a specific project.

1. Pig the line to scrape the wall of the existing pipeline to clean, remove sharp edges and eliminate build up in the line. This could require 4 or more passes of the pig

2. Blow the cable/rope through the existing pipeline

3. Attach pulling cone to the cable/rope

4. Create a straight area of approximately thirty feet from the un-spooling station to the entry of the existing pipeline. Centralizers can be used to assure the Thermoflex pipe enters the existing pipe without scraping the edges. It may be required to hand feed the beginning of the Thermoflex tubing into the entry of the existing pipe

5. Pull back at no more than 20ft per minute. Make sure there is radio contact between platforms to manage the pulling process and stop pulling if a problem arises.

6. As on spool is completely unwound, stop the pull, remove the existing empty spool and replace it with a new spool in the unwinding station, attach splice coupling to join the two pipe sections and continue spooling.

7. Pull past the exit of the existing pipe to inspect the Thermoflex tubing for any gouges, excessive scrapes, or other damage.

8. Clamp off the pipe, cut the pipe back to the proper length, and couple the termination coupling

9. Bolt the termination flange to the existing steel flange.

10. Tie in the surface connection.

11. Hydro test the line

Hydro Testing:

The hydro testing procedures and hold times are the decision of the operator. However, there are a few requirements from Polyflow.

1. Pressures testing should by done with liquid

2. The Thermoflex line should be increased in 500PSI increments and held for 20 minutes before increasing pressure. There is some stretching of the line and pressure drops can occur during the pressurization of the line.

3. Once the final pressure is achieved, there may be a few recharges required during the pipe relaxation before the pressure test hold procedures begin.

4. The pressure profile curve is asymptotic, so there may be a slight pressure decay for several hours before the pressure stabilizes

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