COMPANY SPOTLIGHT

Advanced Filtration Technology Required on Cameron Highway Oil Pipeline

When coupled to precise maneuvering and dynamic positioning, state-of-the-art filtration techniques add a new dimension to wet laying ocean pipelines

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Extending from terminals onshore in Port Neches and Texas City Texas, through High Island (63 feet in seawater, [fsw]) and then to offshore platforms in Garden Bank (525 fsw) and Ship Shoal (438 fsw), GulfTerra/Valero's 375 mile Cameron Highway Oil Pipeline System presented engineers and designers with a number of challenges. One important decision was to select a dry or wet lay for the 240 mile segment of 30-in. diameter pipe.

Wet laying a crude oil or natural gas ocean gathering system normally requires the existence of a water treatment plant that filters and treats the incoming seawater before introducing the liquid into the pipe as the pipe is being laid. This ingress of seawater overcomes the pipeline's buoyancy effect.

The treatment plant, often placed on an oceangoing barge, has an expensive daily rate and usually is required for the duration of the entire pipelaying operation.
Depending upon the amount and kinds of particulates being removed, operators may also face sludge disposal problems.

In-line, front-end filtration can alleviate the problems associated with traditional wet laying. Consequently, front-end filtration compares favorably with dry laying. Economic considerations/comparisons include:

- Weight and space requirements
- Number of pipe joints that will fit on the laying ship
- Concrete coating costs vs using standard pipe
- Water treatment costs
- Number of trips required between port and lay site.

For example, heavy concrete pipe affects the load out. That is, less joints can be loaded with concrete pipe given the same footprint. This equates to more trips
between port and the lay site. Generally, there is large footprint for shipboard handling and storage of large amounts of heavy concrete coated pipe. One must also consider overspray and other pipe coating operations when considering the size of the footprint needed on the laying vessel. To overcome buoyancy, concrete pipe is much heavier than standard pipe. This becomes an important design consideration in choosing the type of laying operation.

If a traditional wet laying could be simplified by using a front-end filtration system for the seawater, engineers could eliminate:

- the need for an expensive offshore water treatment plant
- delays in startup
- the requirement for water treatment during commissioning
- complicated seawater processing.

As a result a project would save time and money in the long run. Also, front-end filtration would ameliorate diver charges that, at target box depths for the system, can reach $30,000 per day.

Allseas, the contractor chosen to lay the 30" pipeline segment of the Cameron Highway system, selected a wet lay using front-end filtration. This lay method had never been done before. Indeed, an integral filtration system utilizing a filter in the start up head annulus is not common or standard industry practice. So, two questions had to be addressed: What was the risk? And, what was the savings?

Considering Pipeline Buoyancy

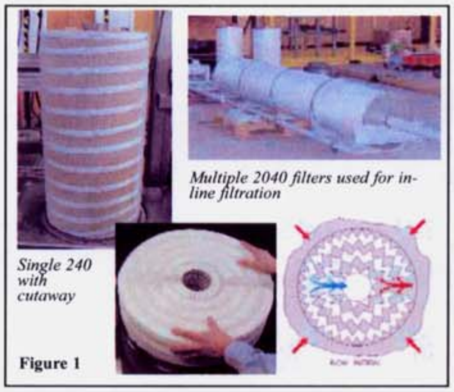
While wet laying eliminates the complexity of coating application, concrete pipe is heavy. It is not buoyant as it drops into place. Wet laying (filling the pipe with filtered seawater) also alleviates pipeline buoyancy.

So, if the correct diameter high flow rate cartridge filters were available that matched the diameter of the (uncoated) pipe, it would be possible not only to eliminate the need for concrete coating, but also eliminate the need for a costly offshore water treatment plant that is usually required during commissioning activities. Most contractors charge from $20,000 to $40,000 per day for a water treatment vessel with a 4-anchor spread, so savings could be significant. And, if treatment vessels are dynamically positioned, the cost can reach $70,000 per day.

Large, high capacity filters

Fortunately, large-scale seawater filtration had been the focus of a major research and development effort at FILTRATION TECHNOLOGY COMPANY. LTD (FTC), Houston, Texas. With an eye toward ocean pipeline operations, and the handling of produced water, FTC had successfully developed large diameter (See Figure 1) pleated filter cartridges whose flow rates and dimensions fit the needs of the project (See Table 1).

FTC obtained representative samples of the seawater from the start up location of High Island and Ship Shoal. A Gravimetric analysis of these samples provided the data nec-



Multiple 2040 filters used for in-line filtration

Single 240 with cutaway

Figure 1

essary for FTC to specify the quantity of filters required to handle the expected flow rate and solids loading while maintaining a minimal differential pressure (less than 22 PSID) across the filter system throughout the entire laying process.

Filtering seawater in wet laying is critical to the pipelaying operations in terms of maintaining ballast within the pipe, reducing buoyancy, alleviating the potential for corrosion and assuring seawater intake flow rates and the required temperature and pressure conditions. For the Cameron Highway, suspended material had to be removed by the filtration system where 99.98 % of all particulates that are 92 microns in diameter and larger had to be removed. If suspended material is pumped into the line due to faulty equipment or due to careless workmanship, many serious problems can result, particularly in respect to cleaning, gauging and pigging. Faulty filtration can require a complete line flush using clean water.

Pretesting the Filtration System

Pretesting the filter system was a key to selecting this cost-saving technology. Since this kind of pipeline-water-fill had never before been attempted, if the filter failed (plugged) prematurely, there would be additional costs because the unit was not diver accessible and thus there would be major delays.

A key component in the system was a set of relief valves that were installed to assure that proper pressure drop was maintained across the filter (two identical fully open relief valves provided redundancy).

FTC could not buy these valves, so they conceived the design and built them. The concept was unique because traditional valves to pressure drop across filters almost always operate at atmospheric pressure. These valves would be operating in deep water where the delta-P was far above atmospheric pressure. FTC built the valves, attached them in parallel to the filter system and tested the complete unit under actual operating, fail-safe condition,—.the same conditions that the filter would experience during the actual lay.

Initiating the Lay

With pretesting assuring functionality, engineers addressed the criteria of pipeline startup. Prior to flooding, the system was flanged and secured to the pipe using carbon steel strapping. Then, with the lay vessel positioned astride the lay route near the designated target box, the startup head was attached and readied for entry into the splash zone. The startup head, that was assembled onshore, contained the internal filtration system that was inserted into the pipe and held into place with a wafer plate that is sandwiched in between two flanges. (See Figure 2A and 2B).

The firing line is filled with pipe and the startup head (containing the filters) is connected to the lay cable that is guided out over the stinger. Two 3 1/2-inch flooding hoses are connected to the start-up head to allow for immediate

Table 1 - THE CAMERON HIGHWAY OIL PIPELINE SYSTEM

LOCATION	DESCRIPTION
Texas City Landing	49 miles 24 inch OD pipe/350 MBOPD
High Island	Water Depth 63 feet
Port Neches Landing	39 miles 24 inch OD pipe/350 MBOPD
Garden Banks	Water Depth 525 feet/ Pig unit
Ship Shoal	Water Depth 438 feet

Laying the CAMERON PIPELINE involved all aspects of preparatory work, transportation of materials, installation and burial. Effectively, the pipeline system initiates with a 30-inch diameter pipeline at a new facility at High Island (HIA5) in approximately 63 feet of seawater (fsw). This extends South-Easterly to an existing facility at Garden Banks (GB72, 525-fsw). The route length of this leg is approximately 126 miles. HIA5 will have pumping facility (each pump rated at 10,000 HP). Approximately 82 miles of this leg is less than 200-fsw and therefore requires burial by means of mechanical trenching.

From GB72, a 30-inch line extends Easterly to a new facility at Ship Shoal (SS332B), a platform in approximately 438-fsw, a distance of 113 miles. For the most part, the pipeline route parallels the existing Poseidon Pipeline System.

flooding upon the pipeline entering the water. Strainers are connected to the flooding hoses and are suspended by a buoy above the pipeline.

Figure 2A

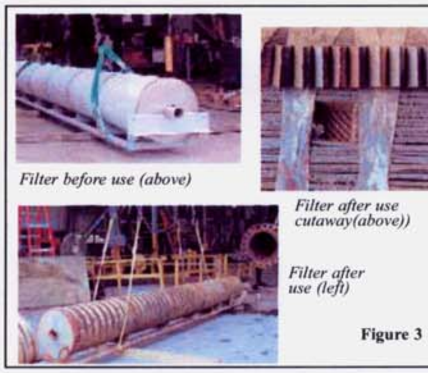
Figure 2B

With assistance from a support vessel, the flooding assembly is positioned and released, seawater begins to enter the filter assembly, and, with the lay vessel properly positioned (reacting to underwater transponders within the start-up assembly), the wet lay is initiated.

This process is continued until the full length of pipeline is laid. That period covered December 31, 2003 through April 7, 2004. The six filters, each with 900 square feet of surface area (total 5400 square feet of surface area) were able to achieve the necessary specified particulate removal rate as well as the required flow rate of 30 cubic meters per hour (132 gallons per minute) throughout the entire lay. Start up heads retrieved after the job was completed allowed comparison of used and unused filters. (See Figure 3).

Cost Considerations

As the lay rate of vessels is constantly increasing (now up to 1000 km of pipeline annually), and the depth of the lay is greater, dynamic positioning of the lay vessel becomes



Filter before use (above)

Filter after use cutaway(above))

Filter after use (left)

Figure 3

mandatory, and anchors become obsolete. This, when coupled to a new generation of high speed welding systems and advanced continuous-lay
technology, requires a detailed analysis in order to compare dry vs wet laying. The development of front end filtration dramatically changes the economics of wet laying, therefore the traditional comparisons are no longer valid. With front-end filtration, a wet lay creates synergy with a lay vessel's:

- Firing line length
- Pipe-carrying capability
- High transit speed.

In-line filtration has proven economically viable and synergistic with the above from both investment and operating viewpoints. Front-end filtration offers the flexibility of:

- Less interference with other platform activity
- Less space requirements
- Low risk/ extensive savings
- No per day expenses related to water treatment barges or vessels
- No discharge or disposal requirements
- Flexibility to match with both startup and laying rates
- Low initial costs/low operating costs
- No downtime
- Continuous filtration without the need of an operator.

For more information visit www.ftc-houston.com or call (713) 849-0849