TransCanada of Calgary Succeeds with Field Test on Composite Reinforced Line Pipe

A recent field test by TransCanada of Calgary, Canada established the practicality of installing composite reinforced line pipe (CRLP™)[1] on a commercial scale. NCF Industries, Inc., TransCanada and CRC-Evans Pipeline International, successfully joined seven sections of a 40-foot long CRLP on the 15-mile Saratoga section of the Western Alberta system mainline expansion.

Using relatively simple equipment and assisted by the pipeline contractor, Marine Pipeline Construction, two technicians composite-coated six weld area joints of the 48-inch diameter, 0.461-inch-thick, X-70 steel pipe reinforced with an outer wrap of isopolyester resin–glass fiber composite. The installed pipe is now part of a natural gas pipeline operating at 960 psi with future capability to operate at 1260 psi.

The success of the installation helps to demonstrate that CRLP is a viable solution in real-world applications. As an alternative to more expensive solutions for high pressure, high throughput pipelines— such as thicker walled X-100 steel pipe—the benefits of CRLP add up quickly: lower material costs, lower transportation costs, increased corrosion resistance, and reduced risk of propagating failures.

There has been a general trend in the natural gas pipeline transmission industry toward high-pressure pipelines using higher strength steels. However, as the strength has been increased, so have issues of weldability and fracture control. TransCanada has been developing and testing a hybrid product since 1996 called Composite Reinforced Line Pipe (CRLP™) to address these issues. This is a patented technology developed by NCF Industries, Inc. and licensed in Canada to TransCanada. CRLP is composed of high performance, composite material reinforcing a proven high-strength, low alloy steel pipe.

From the Beginning

Preparation for the field test actually started in California at NCF Industries, the company that licenses the technology to TransCanada. NCF received the seven sections of IPSCO-made steel pipe in its winding facility and wrapped each with an isopolyester resin–glass fiber composite. Six inches of steel at the ends of each pipe remained exposed so that the sections could be welded together in the field.

The composite used to coat the steel pipe is the result of teamwork and collaboration among NCF Industries, TransCanada, AOC, BP, PPG and Composites One. AOC supplies the heat-activated thermoset resin, made with purified isophthalic acid from BP. Designed specifically for TransCanada by AOC, with technical support from BP, the isopolyester resin offers high mechanical and corrosion-resistance properties and resists distortion under high temperatures.

The glass fiber from PPG is e-glass, originally developed for electrical insulators and capacitors and now widely used in composite applications. The tows, or bundles of e-glass fibers, have extremely high tensile strength, greatly enhanced with a surface sizing that coats and protects the individual fibers. PPG supplied the fiber to NCF as bundles of tows, called rovings.

To wrap steel pipe, NCF impregnates the glass fiber roving with the isopolyester resin and then winds this composite material around the pipe. A heat-activated process initiates the resin curing. Once cured, the composite wrapping will not distort, even under high temperatures. The glass fiber rovings, firmly set in the cured isopolyester, add hoop strength to the pipe.

NCF designed the wrapping process as a portable process, allowing it to be easily incorporated into any pipe coating facility in the world. Although the test sections were coated in California, the portability of the design can help minimize transportation costs from plant to field and make it possible to take advantage of locally produced steel.

The finished product is a conventional steel pipe reinforced with glass fiber rovings and isopolyester. The isopolyester is also an excellent protection against corrosion of the steel layer of the pipe.

From Weld to Wrap in No Time Flat
NCF shipped the seven pipe sections to Canada, along with glass fiber roving pre-impregnated with the isopolyester resin. The installation process involves first welding the exposed-steel ends of the pipe together and then field wrapping the exposed weld area with the “pre-preg” composite joint wrap. The result is a continuous composite-reinforced system. The joint wrap roving was supplied by Composites One and was preimpregnated with resin by NCF prior to shipment to the site. CRC-Evans Pipeline International of Tulsa manufactured the portable field-wrapping machine and supplied a technician to assist in the field application.

In less than 2 hours, NCF trained two technicians from TransCanada and CRC- Evans to use the proprietary wrapping process and the equipment provided. Using the wrapping equipment, they wound the pre-preg around the joint several times to a thickness of approximately one-and-one-half-inches. They followed this with a high strength plastic film to compress the composite. A dielectric heater built onto the equipment heated the wrapping to about 250°F, at which point the exothermic cure continues on its own to about 300°F. An insulating blanket can be used to hold the heat in under cold conditions and ensure that the cure is complete. The cure takes about 10 to 20 minutes.

For this first trial of a new process in the field, the joining of the sections—from the wrapping process through the cure—took an average 20 minutes per joint. With the improvements and modifications that come with the refinement of any new technique, this time is expected to drop even further.

Conventional steel pipelines are welded together, and then a corrosion coating is applied to the weld area. The use of CRLP eliminates the need for the corrosion coating at the weld area because the composite provides better corrosion and abrasion resistance. Once production models are produced and procedures modified, the CRLP joint wrapping process should take the same amount of time as the corrosion coating process that it replaces. Because CRLP uses less steel, there is up to a 40 per cent saving in welding reduction time.

In just a matter of hours, TransCanada and CRC-Evans technicians were ready to begin using the relatively simple machinery needed to composite coat the CRLP joints.

Adding Strength with a Multiple Material System
In its ongoing quest to improve the economics of gas transport over long distances, TransCanada has considered many alternatives. CRLP is proving to be ideally suited for the construction of high pressure, large diameter pipelines operating at as much as 3600 psi.

High strength X-100 steel, another alternative to conventional steel, although a more expensive material, offers the cost advantages that can accrue from thinner, lighter weight pipe sections. High strength steels often do not have the fracture control capability required for high-pressure pipelines and an option is to wrap these higher strength steels with CRLP to provide fracture control and crack arrest capability.

CRLP, a multiple material system, gives large diameter, conventional steel pipe the strength needed for higher-pressure pipeline applications. It is not damaged by denting and gouging under simulated service conditions that would severely damage unwrapped steel pipes. The layers of glass fibers in isopolyester resin has a tensile strength of 120,000 to 140,000 psi, making the composite layer about two times stronger than the underlying steel layer. The result is a stronger pipe without compromised corrosion resistance – and with the added corrosion protection of the composite layer.

A major priority for operators of high-pressure natural gas systems is safety and pipeline integrity. CRLP addresses these challenges. Time dependent failure modes such as general corrosion or stress corrosion cracking can result in a leak or rupture depending upon the size of the defect. CRLP provides a leak-without-burst mode of failure for these types of pipeline defects, which minimizes the probability of ignition, particularly for high-pressure large diameter pipelines. CRLP provides tremendous resistance to fracture propagation. NCF and TransCanada have conducted extensive tests demonstrating the ability to arrest propagating fracture velocities in excess of 1000 feet per second. CRLP has been designed with a minimum factor of safety of two times Maximum Allowable Operating Pressure (MAOP). Pipeline codes allow minimum safety factors of 2:1 MAOP.

Composite reinforcement allows the variables of pipe diameter, wall thickness, steel strength and line pressure to be balanced in the way most suitable for a given situation yet achieve a stronger, lighter, safer, more economical, more durable pipe for natural gas pipelines.

Although bending the pipe was not required on this test section, TransCanada successfully bent 10 to 15 CRLP joints in a 1.5-mile installation of 24-inch diameter CRLP that was installed in northern Alberta in minus 25°C temperatures in February of 2001.

A Joint Effort

NCF first took notice of isopolyester as a possible solution to the challenges of high-pressure pipelines when isopolyester became the standard for underground fuel storage tanks. Norman C. Fawley, president at NCF, noticed that even after 30 years, many of these tanks were still in service. Proof of isopolyester's superior corrosion resistance, strength and durability—along with a lower cost than alternative resin systems such as epoxy or vinyl ester—made CRLP an idea worth pursuing.

Presentations on the benefits of CRLP have been given to the U.S. Department of Transport – Office of Pipeline Safety, and in Canada to the National Energy Board and the Alberta Utilities Board which regulate pipelines. TransCanada has begun the regulatory process to have CRLP approved for use through the Canadian Standards Association (CSA) and expects approval late in 2004.

The Numbers Add Up

The savings in material costs alone with CRLP are significant. The material costs alone are 10 to 20 percent lower than for X-100 steel pipe of equal capacity. Additional financial benefits accrue from the lightweight, easy-to-join, and the fracture control and arrest capable reinforced pipe.

Each piece of composite reinforced pipe weighs approximately 10,000 pounds, making it about 30 to 40 percent lighter than steel pipe with the same pressure rating, reducing transportation costs. The reduced weight also reduces the need for heavy equipment typically used in traditional stringing practices.

The joining process takes 40 percent less time to weld joints due to reduction of steel thickness, reducing installation costs. With CRLP, only the steel liner is welded, so weld area is reduced by about 50 percent.

The durability of CRLP and its ability to prevent catastrophic failures offer the potential to avoid the overwhelming devastation and costs associated with bursts and propagating failures. Tests conducted by the National Bureau of Standards conclude that CRLP is 20 percent lower in cost and consumes 40 percent less energy than conventional steel line pipe.

For the TransCanada application, the numbers do indeed add up. TransCanada estimates that overall pipeline project costs can be reduced by 4 to 12 percent with the use of CRLP compared to all-steel pipelines. Another added benefit of using CRLP is that it is reinforced on the outside of the pipe so that the inside diameter is larger than the all-steel pipe size, providing up to 6 percent increase in volume throughput.

TransCanada sees CRLP as a potential North American solution for large diameter, high-pressure pipelines which are required to economically transport gas from Alaska and the Yukon. At present, only imported high strength steel pipe can provide the pressure and volume capability required for a large diameter pipeline. CRLP can provide North American mills the higher strength pipe capability to successfully supply these Northern pipelines.

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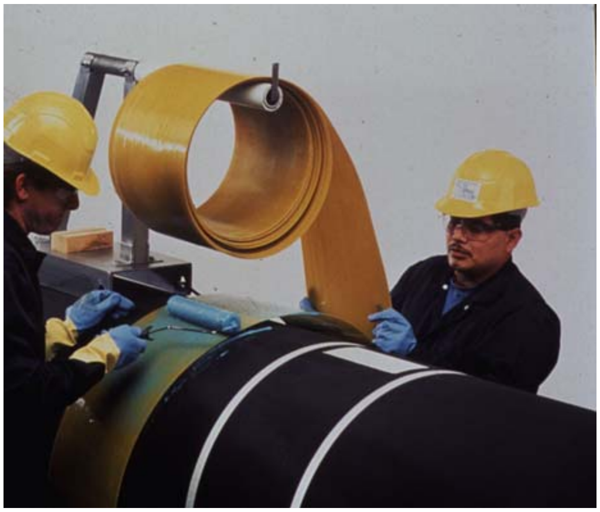
Same Technology, Different Application

A similar technology from NCF Industries has been simplifying repairs on existing pipelines for years. Clock Spring, a pre-cured composite wrap that looks like the coiled spring in wind-up watches, is used to repair pipe failures and to prevent crack propagation in deteriorating pipe. Because welding is not involved, the repair can be made while the pipeline continues to operate. The relatively lightweight coil can be hand-carried to the site and installed with an underside clearance of as little as 12 inches (30 centimeters).



More than 60,000 Clock Spring units have been installed in more than 50 countries around the world.

Contact Information

TransCanada

TransCanada is a leading North American energy company. It is focused on natural gas transmission and power generation complemented by employees who are expert in these businesses. The company’s 38,000 kilometers of pipeline links the Western Canada Sedimentary Basin to North America’s fastest-growing markets. TransCanada transports the majority of western Canada’s natural gas, with 60 percent of the company’s total volume delivered to the United States.

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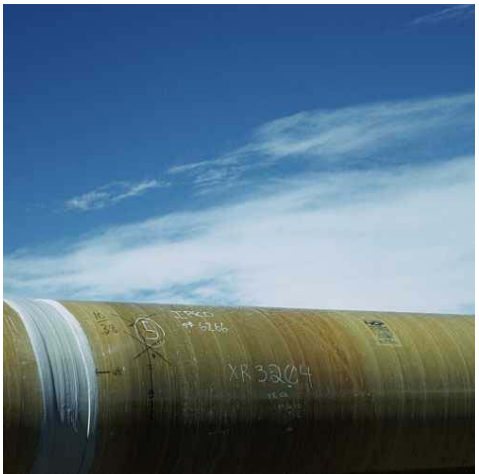
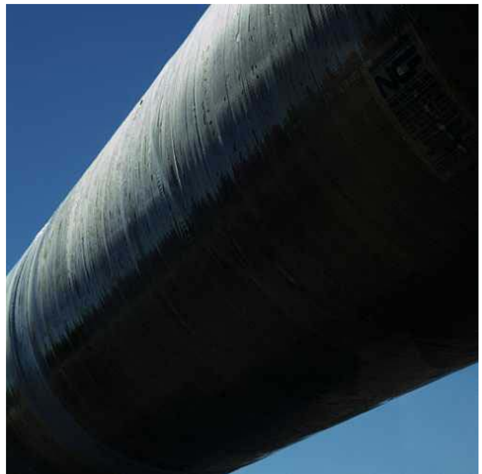
[1] CRLP™ is a trademark of NCF Industries, Inc. CRLP is manufactured under license from NCF Industries, Inc. U.S. and foreign patents have been issued and are pending.

Low-resolution .jpg's of site.

1- TransCanada and CRC-Evans technicians field-wrapped six CRLP joints.

2- Composite reinforcement makes it possible to increase the pressure of natural gas pipelines without increasing the thickness of the steel liner.





3- In just a matter of hours, TransCanada and CRC-Evans technicians were ready to begin using the relatively simple machinery needed to composite-coat the CRLP joints.