Polyethylene lining increases water injection line life

In 1997, after 27 years of steady production, the Rio Neuquén oil field in southern Argentina began to show its age. When Perez Companc S.A. took over field management in 1994, it was only producing 1,600 bopd. With a heavy investment, the operator increased oil production to more than 6,000 bopd; and similar increases in gas production have been realized. At that time, it was decided that a network of high-pressure water injection wells could increase production and greatly extend field life.

The first phase of the plan called for three high-pressure trunk lines which would carry water from a treatment plant to up to 19 injection wells. Each of these lines would start as 8-in, pipe at the plant and step down to 6 in., then to either 3 in. or 4 m. at wellheads, Fig. 1. There would be 3,300 m (10,820 ft) of 8 in., 7,000 m (22,960 ft) of 6 in., 2,000 m (6,560 ft) of 4 in., and 5,000 m (16,400 ft) of 3 in., for a total 17,300 m (56,700 ft) of pipe.

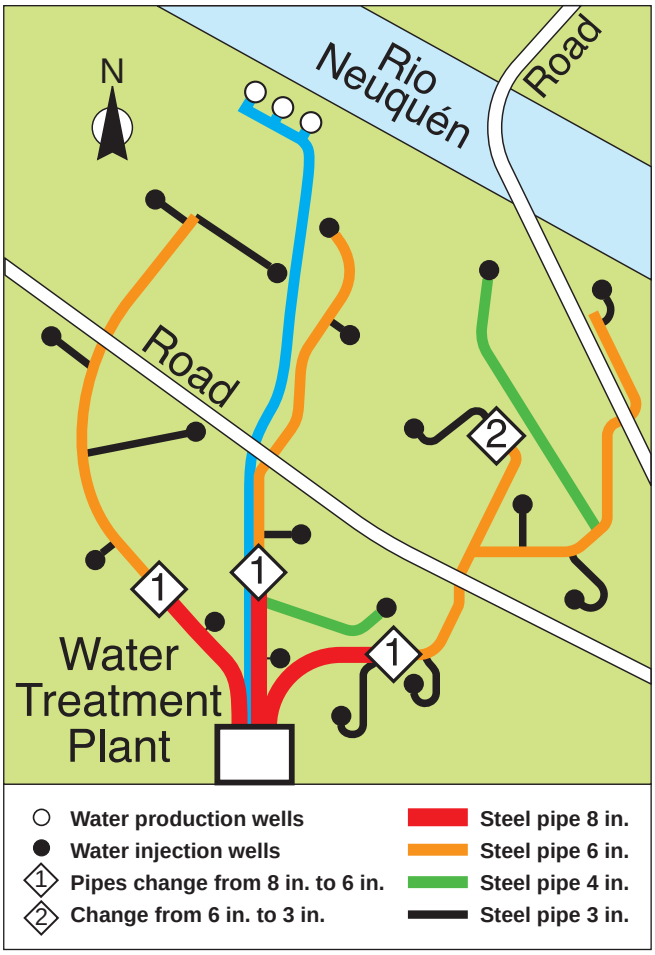

Fig. 1. Layout of Rio Neuquén high pressure water injection system

Design options. Perez was concerned about the safety of this high-pressure distribuion system because it would be installed under some of the most productive fruit plantations in Argentina. The injection water would be extremely aggressive to steel pipes, and an underground leak could damage the fruit trees and the surrounding environment.

The operator has long maintained a progressive policy for environmental improvement. In fact, Rio Neuquén field was recently audited by the international firm of DNV (Det Norske Veritas Quality Assurance) to obtain certification that its enviromnental management system conforms to the ISO 14001 standard. Therefore, it was natural that the engineers from Perez and SADE, an engineering /construction subsidiary, should conduct extensive research to find the safest, most cost-effective design.

Epoxy-coated carbon steel, heavy-walled fiberglass, stainless steel and polyethylene-lined carbon steel pipe were among the solutions considered. Perez had experienced failures with epoxy-coated pipes after only five years in some fields they operate. Heavy- walled fiberglass pipe is expensive, and engineers were concerned about reliability and jointing. Stainless would certainly meet the challenges, but it would have been "extremely" expensive. Thus, the designers discovered that their objectives could be met by the Swagelining process developed by BG plc (formerly British Gas).

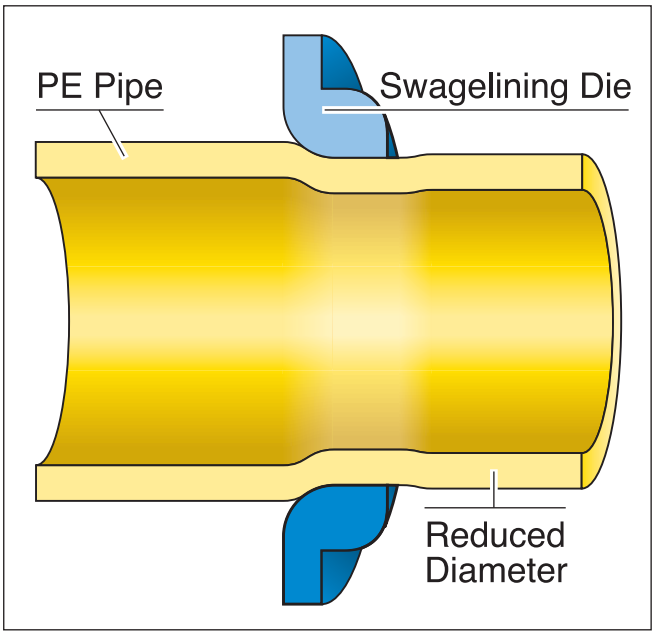

Fig. 2. Polyethylene lining OD is reduced by swaging through die before pulling through pipeline section.

Lining process description. The Swagelining process allows an existing pipe to be lined with an extremely tight-fitting polyethylene (PE) pipe. In addition, it is the only PE lining process with the technology to allow sections to be welded into a continuous pipeline. With the process, it would not be necessary to include flanged joints in the system.

The technique was developed by BG as a rehabilitation process for its own gas lines. However, because of its uniqueness, it has been used successfully to protect more than 500 mi (800 kin) of pipe ranging from 3 in. to 36 in. (75 mm to 900 mm) in diameter. This protection includes gas, oil, water, forced sewer and a wide range of

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industrial production lines all over the world, both on- and offshore.

The process uses PE pipe with an outside diameter slightly larger than the inside diameter of the pipe to be lined. During installation, this pipe is pulled through a die to temporarily reduce its outside diameter, Fig. 2. This reduction allows the PE to be easily pulled through the outer pipe. When the pulling force has been disconnected, the liner begins to return to its original diameter; and within hours, it will be pressing tightly against the ID of the outer pipe.

For couplings, at Rio Neuquen, the patented technology called for a short section of specially adapted duplex stainless pipe to be welded to each end of each section of the X85 carbon steel pipeline before it was lined with the medium density polyethylene (MDPE) pipe, Fig. 3A. After being pulled through the carbon steel pipeline and allowed to relax, the MDPE lining would be cut off inside the stainless steel section. A stainless steel compression ring would then be inserted inside the PE pipe to create a seal which could withstand the 3,000-psi pressure of the water injection system. This would allow consecutive sections of lined pipe to be welded together without leaving any of the X85 material exposed to the aggressive effluent which the line would carry, Fig. 3B.

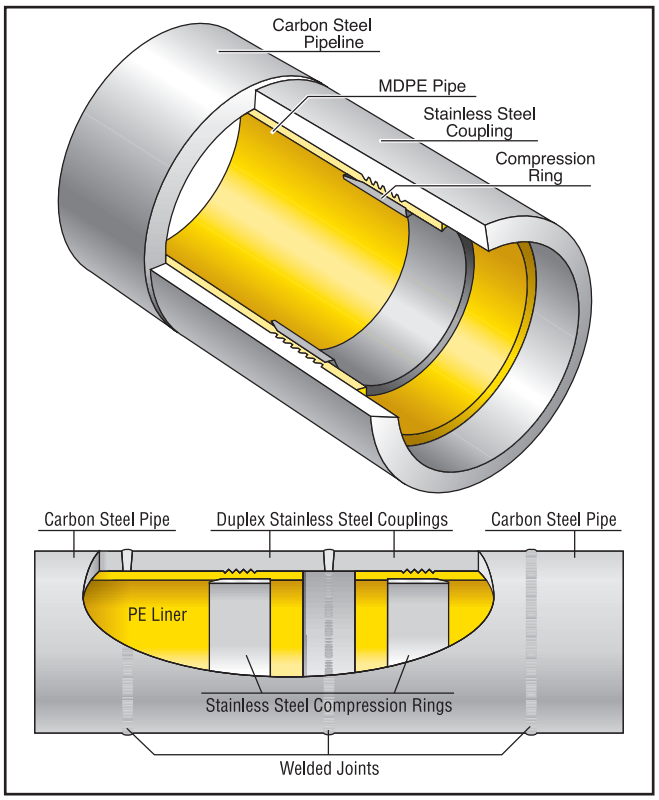

Fig. 3. End of pipeline after short stainless section is welded on, and PE liner and compression ring seal are installed (A). Stainless sections are then welded together to complete the pipeline connection (B).

The tight-fitting PE pipes used in the Swagelining process are manufactured to ISO, AGA. ASTM and API standards, so the linings have known physical properties and an established service life. For the Rio Neuquén injection lines, the engineers selected a MDPE pipe manufactured by Uponor, one of the largest PE pipe manufacturers. This company is headquartered in Finland, but has several plants around the world, including one in Argentina. Lining for the 3-in. and 4-in, steel pipes would have a wall thickness of 5 mm; for 6 in. and 8 in., WT would be 7 nun.

An important factor in the decision to use the swaging process was the fact that Nortek, the Buenos Aires licensee who would line the steel pipes, would guarantee the lining for 25 years. This unusual guarantee was made possible by the combination of the inherent characteristics of PE pipe, the patented process, and the unique coupling technology developed by BG and proven in BP's Foinaven oil field in the Atlantic Ocean.

Field installation. Another company involved in the operation was Avon Lippiatt Hobbs Contracting Ltd. (ALHCO), a process licensee headquartered in the UK. ALHCO became involved in the project through BG, and sent a representative to Argentina to assist Nortek with what would become the first Swagelining installation in that country.

The whole of the steel network was laid in-ground and backfilled. Bend diameters were kept to a minimum, and installers were careful to adhere to the welding spec of API-1104, so the root weld would not penetrate too deeply inside the pipe.

After the entire piping system was installed, Nortek went back and installed the MDPE lining. Between 40 and 50 separate insertions were made. And because the operation was conducted in an open area with no paved roads, the insertion points could be placed wherever they were needed.

After SADE excavated an insertion pit, they removed a section of the steel pipe equal to the length of two stainless steel couplings. They then lifted the ends of the pipe with shear legs or jacks so couplings could be welded on and the sections lined up. When the polyethylene pipe had relaxed inside the steel pipes, the ends were trimmed and the compression rings were inserted. The ends of the steel pipe were then lowered and the couplers were welded together.

The installer said the project was a little slow, initially, but "after we were up and running, we maximized the lengths we could pull, achieving 750-m pulls in the 4 in. and even longer pulls in the larger diameters." The project was judged to be successful; it has been tested and inspected in every way, and no problems have been found.

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