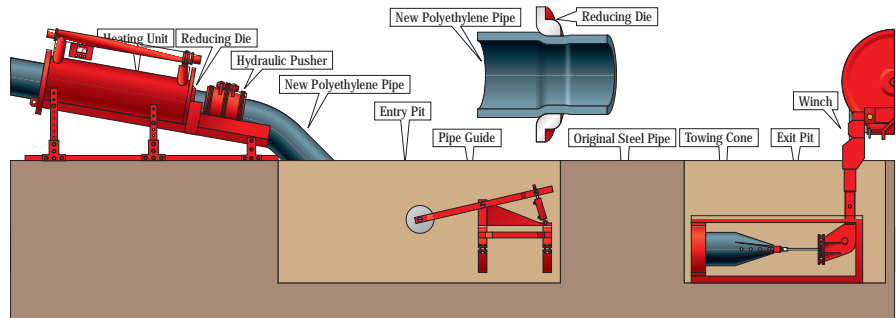


# HIGH PRESSURE SALTWATER PIPELINE REHABILITATION

In mid-1999, engineers at the Dow Chemical plant in Stade, Germany, decided to rehabilitate a mining-water pipeline which carried water 27 km (17 miles) at 40 bars (570 psi) from their plant to a salt mine operated by the company. The 400 mm-diameter (16") steel pipeline would be used to carry 7% saltwater for the mining activities. The engineers planned to line the steel pipeline to prevent corrosion and abrasion, and to prevent the saltwater solution from leaking into the environment.

The pipeline was important to Dow, both economically and environmentally. It would allow the company to recycle the salt in the effluent by returning it to the mine, and it would also reduce the quantity of treated wastewater emptied into the Elbe River.

The pipeline had been laid in 1971, in a right-of-way through public land. It passed under the Schwinge River as well as many main roads and railways. The estimated cost for excavation and total replacement of the pipeline was extremely high, and since much of the land is now classified as a nature reserve, obtaining permits would be complicated and slow. As a result, Dow engineers began to investigate trenchless rehabilitation technologies. After thoroughly researching the available technologies, the Swagelining process was selected.



*Cutaway illustration showing the installation process*

## SWAGELINING

The Swagelining process was developed by BG plc, formerly British Gas, as a rehabilitation process for its own gas lines, and is licensed by BG Technology. However, because of its uniqueness, the process has been used successfully to protect over 1000 km (600 miles) of pipe ranging from 75 mm (3") to 900 mm (36") in diameter. This protection includes water, forced sewer, gas, oil, and a wide range of industrial production lines all over the world.

The Swagelining process uses Polyethylene (PE) pipe which has an outside diameter slightly larger than the inside diameter of the pipe to be lined.

During the installation process, the PE pipe is pulled through a die to temporarily reduce its outside diameter. This reduction allows the PE pipe to be

easily pulled through the outer pipe. When the pulling force is disconnected, the PE pipe begins to return to its original diameter. However, just before the PE pipe relaxes completely, it presses tightly against the inside of the host pipe, eliminating all annular space while only reducing the inside diameter of the pipeline slightly. In fact, the reduction is so slight that the smoothness of the PE pipe usually results in additional flow capacity.

In cold weather, the PE pipe was preheated before it was reduced and pulled through the old steel pipeline. Preheating can be used in summer to speed the reduction process.

Although other tight-fitting liners were considered, the Swagelining process was selected because it offered the best combination of cost, tight fit, corrosion and abrasion resistance, ease of installation, and this method could be used in cold weather. The final cost of rehabilitating the entire pipeline using the Swagelining process was about 50% of the cost of total replacement. The process also minimized the impact on the environment and simplified permit procurement.

Because the strength of the old steel pipe had not been lessened, the PE liner could be relatively thin since it could depend upon the steel pipe for support. As a result, a high density polyethylene (HDPE) liner was selected. The SDR 17.6 HDPE has a wall thickness of 23.7 mm (0.95") and is rated at 10 bar (150 psig). However, the rating of the liner was not included



*Photo showing PE pipe exiting the heating unit and disappearing into the old pipeline. Special heaters warmed the PE liner before it was reduced and pulled through the old pipeline.*

in the pressure rating calculations of the total system.

## INSTALLATION

The installation contractors, Haustadt & Timmermann GmbH & Co. KG, headquartered in Duisburg, Germany, began the actual rehabilitation work in October, 1999. Since they planned to work through the cold winter, the ability to preheat the PE pipe was very important. Entry and exit pits were excavated at convenient locations along the old pipeline to provide access. However, since the pits were excavated only when needed, no more than two or three were open at any given time. Over the course of the project, 47 pits were used, resulting in an average of 550 m (1787') between pits, although one pull of 950 m (3166') was made.

Before the PE liner was installed, a television camera was used to inspect each section of the old pipe to locate any weld beads, protruding taps, bends, or other obstructions inside the pipeline. When the pipe was clear and reasonably clean, a cable was run through the pipeline to the entry pit from a 20-ton winch at the exit pit. The cable would pull the PE liner through the old pipe.

The PE pipe was delivered to the job site in 20 and 24 m (65' and 78') lengths and fused together into lengths sufficient for each pull. Each fused unit was leak-tested with air at 0.5 bar (7 psi) before being pulled into the steel pipe.

The beads left on the inside and outside of the PE by the fusing process were removed before the liner was installed. If beads had been left on the inside of the liner, turbulence would have resulted and pigging operations would have been hampered. If they had been left on the outside, they would have prevented the liner from being

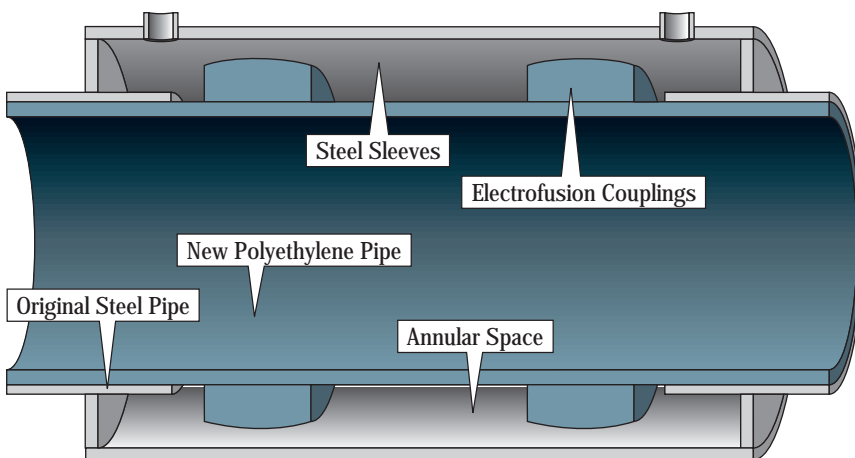


Illustration showing the connections in the pits.

pulled through the die.

The leading end of the PE pipe was notched and bent to form a cone before it was connected to the winch cable. As the winch began to move, it pulled the PE pipe through a specially-designed heat chamber, then through the reducing die and into the old pipeline. As the winch pulled the PE pipe, a special hydraulically-operated unit gripped the pipe and pushed it forward. The combined pushing and pulling forces moved the PE pipe forward at a rate of about one meter (3') per minute.

## RECONNECTION

As the rehabilitation project moved from one section to the next, the lined sections were joined together and tested. After completion, the entire line was pressure-tested with water at 60 bar (900 psi).

Electrofusion couplings were used to connect the PE pipe sections in each pit. A steel sleeve was put over the fused couplings and welded to the 400 mm (16") pipe. The cavity between the sleeve and the couplings was then filled with non-shrinking mortar, maintaining the pressure rating of the pipeline.

## COMPLETION

After the rehabilitation was complete, the liner was monolithic. It had no joints or seams in its entire 27 km (17-mile) length. The finished pipeline was pressure-tested, then inspected with the aid of a television camera to be sure it had been installed correctly.

The lining should last at least 30 years, but it may last much longer. If it is ever necessary to replace the PE liner, the current liner can be removed easily by pulling a 3-point splitter through the pipeline, then pulling the separate pieces of the PE liner out. At that point, a new liner can be inserted.

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