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CASE HISTORY

Pipeline Restoration at a Generating Station Using Chemical Grout

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A gravity-flow water inlet line had developed many ruptures and cracks, leading to appreciable groundwater inflow. Contaminants brought in by the groundwater increased the cost of treating the water for station use. The problem was solved by injecting chemical grout to the exterior side of the pipe.

The sheer size of the infrastructure at any power plant is impressive. Chimneys, cooling towers, scrubber modules, coal silos, and a network of flue gas ducts are obvious at a glance. These are the structures that most likely come to mind when considering plant maintenance at a coal-burning power generation facility. There is, however, a great deal of buried infrastructure equally essential to plant operation and safety. This article describes the repair of a 75-ft (23-m) deep, gravity-flow water inlet pipeline to stem the inflow of groundwater into the pipe.

A Costly Water Leak

All of these infrastructure components exist at Allegheny Energy's Albright Power Station near Albright, West Virginia (Figure 1). In January 2008, a major restoration project was undertaken in a part of the plant that is generally inaccessible and easy to overlook. Deep beneath ground level, the plant's water delivery system had been compromised by a series of ruptures in the walls of a 40-in (~1-m) diameter reinforced concrete pipe. These ruptures allowed groundwater to leak into the pipe at a rate of 60 gal/min (227 L/min).

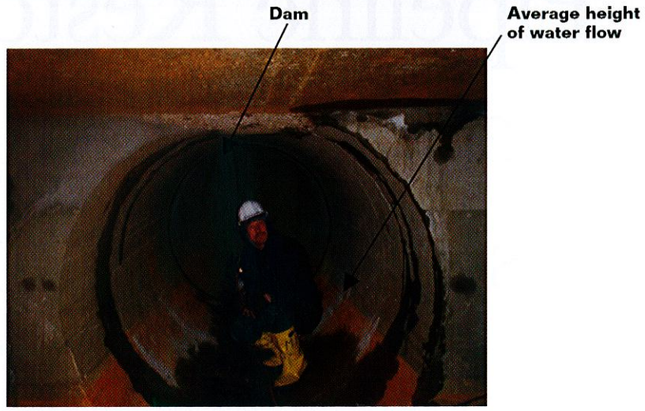
Water from the Cheat River is pumped up ~50 ft (15 m) to a cistern. From there it flows by gravity underground through the pipeline to another cistern under the station, from which it is pumped up to the station water treatment plant.

Engineers from URS/Washington Group worked with station engineers to develop a solution. Repairs were needed and time was of the essence because contaminants brought in by the groundwater increased the cost of treating the water for use in the station. Since the pipe lay 75 ft underground, excavation and replacement wasn't a viable option. The prospect of "slip lining" the pipe with a cured-in-place pipe wasn't economically attractive either, since such methodology is generally applied to pipes of a much smaller diameter.

FIGURE 1

The Albright Power Station on the Cheat River in West Virginia.

FIGURE 2



The interior of the 40-in water delivery pipe at the intake cistern, just downstream of the dam installed to shut off the water flow.

Seeking a Repair Method

The search for a solution focused on materials that could be applied to localized areas on the exterior of the pipe where the pipe was ruptured or cracked. This approach had its own challenges too. First, there would be the need to locate all of the ruptures and cracks in the pipe. Second, any repair material would need to be applied in the presence of water or at least be able to bond to a wet surface. Sauereisen, Inc. (Pittsburgh, Pennsylvania) was asked to recommend and supply the proper material and to advise on methods of installation.

Sealing the Leak with Chemical Grout

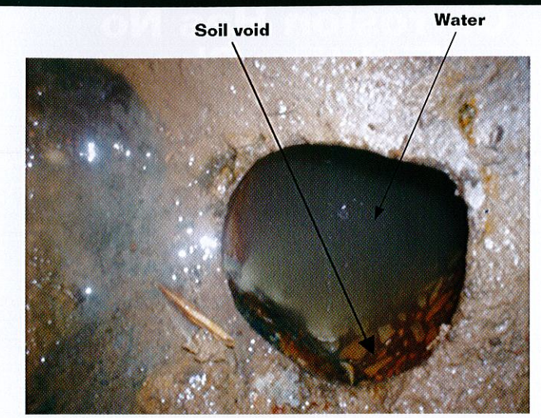
The material search focused on a chemical grout that might effectively seal the pipe to prevent groundwater inflow. Chemical grouts function by filling voids behind a surface. They typically exhibit a viscosity that allows them to penetrate cracks as well. The repair material selected was a hydroactive polyurethane grout, supplier's No. F-370†. The basis of selection included three primary factors: aggressive expansion properties, high density, and necessary strength. This product can expand 20 times its original volume when it encounters water. This provided confidence that whatever soil void existed outside of the pipe ruptures and cracks would be effectively filled and sealed and the inflow of groundwater stopped.

For a foam-like product, the grout selected exhibits a relatively high density at just over 2 lb/ft^3 (32 kg/m^3). Its non-shrink performance was critical to the success of the project. No shrinkage could be tolerated, since that would provide a gap and permited groundwater inflow to resume. The grout's relatively high density posed an advantage in this respect.

Finally, the potential of shifts in the surrounding soil and the dynamic forces applied along the cracks of the pipe wall meant that the grout needed to withstand a reasonable level of shear. Based on ASTM test method C273,[1] the grout exhibits a shear modulus of 117 lb/in^2 and shear strength of 14.5 lb/in^2. Combined with an elongation just under 10%, the urethane material was deemed to have the necessary strength.

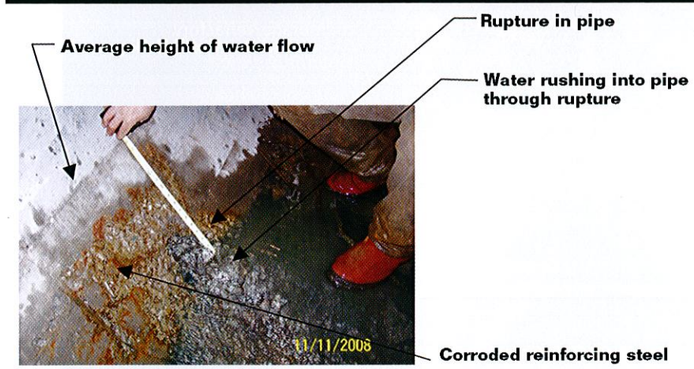
†Trade name.

FIGURE 3



Looking down on a core cut in the bottom of the pipe, showing soil void nearly filled with water.

FIGURE 4



Typical conditions within pipe.

Installation Challenges

R.G. Friday Construction Co. installed the chemical grout. Winter weather conditions posed a potential threat to a smooth installation. The installation crew set to work by staging materials in a manner that the extreme cold and foot of snow on the ground would not prevent activation of the chemical grout. Generally, the standard resin-to-catalyst ratio functions properly when the material temperature is >65 °F (18 °C) and the air temperature is at least 40 °F (4 °C). In this case, the temperature was below these limits, so additional catalyst was used to achieve the quick set times needed.

After temporarily damming the pipe to shut off the water flow (Figure 2), workers went through the interior of the pipe and identified primary rupture and crack locations (Figure 3). They then drilled 1 1/2-in (38-mm) injection ports alongside any identifiable crack or rupture (Figure 4). These ports would be the entry points for placing the grout from within the pipe. Mixing and pumping of the grout proceeded rapidly since even atmospheric moisture can cause the grout to foam. The crew made arrangements to use extra catalyst provided by the manufacturer that proved to be necessary for the most actively leaking areas.

Typical viscosity of the grout is ~500 centipoise. It flows into place readily and then sets up quickly. Upon setting, the grout maintains a tenacious bond, even in applications under standing water. Polyurethane-formulated grout has a water absorption property of <1%, and is much more impermeable than cement-based sealants. Such is the nature of a hydrophobic material; it is resistant to water intrusion and therefore repels water, in contrast to a hydrophilic material that absorbs water to keep it firm if conditions dry out.

Conclusions

Sealing of this major artery in the water system of the Albright Station enabled the owner to prevent the inflow of over 86,400 gal (326,963 L) of water per day, along with all the contaminants brought in by the groundwater inflow. The elimination of these contaminants also lowered the cost of treating the water for station use.

This project was just a portion of a large water system improvement completed at the station in the first quarter of 2009. The owner is happy to report compliance with the latest water quality standards and to be a good neighbor to others in the Cheat River Valley of West Virginia.

Reference

1 ASTM C2733, "Standard Test Method for Shear Properties of Sandwich Core Materials" (West Conshohocken, PA: ASTM).

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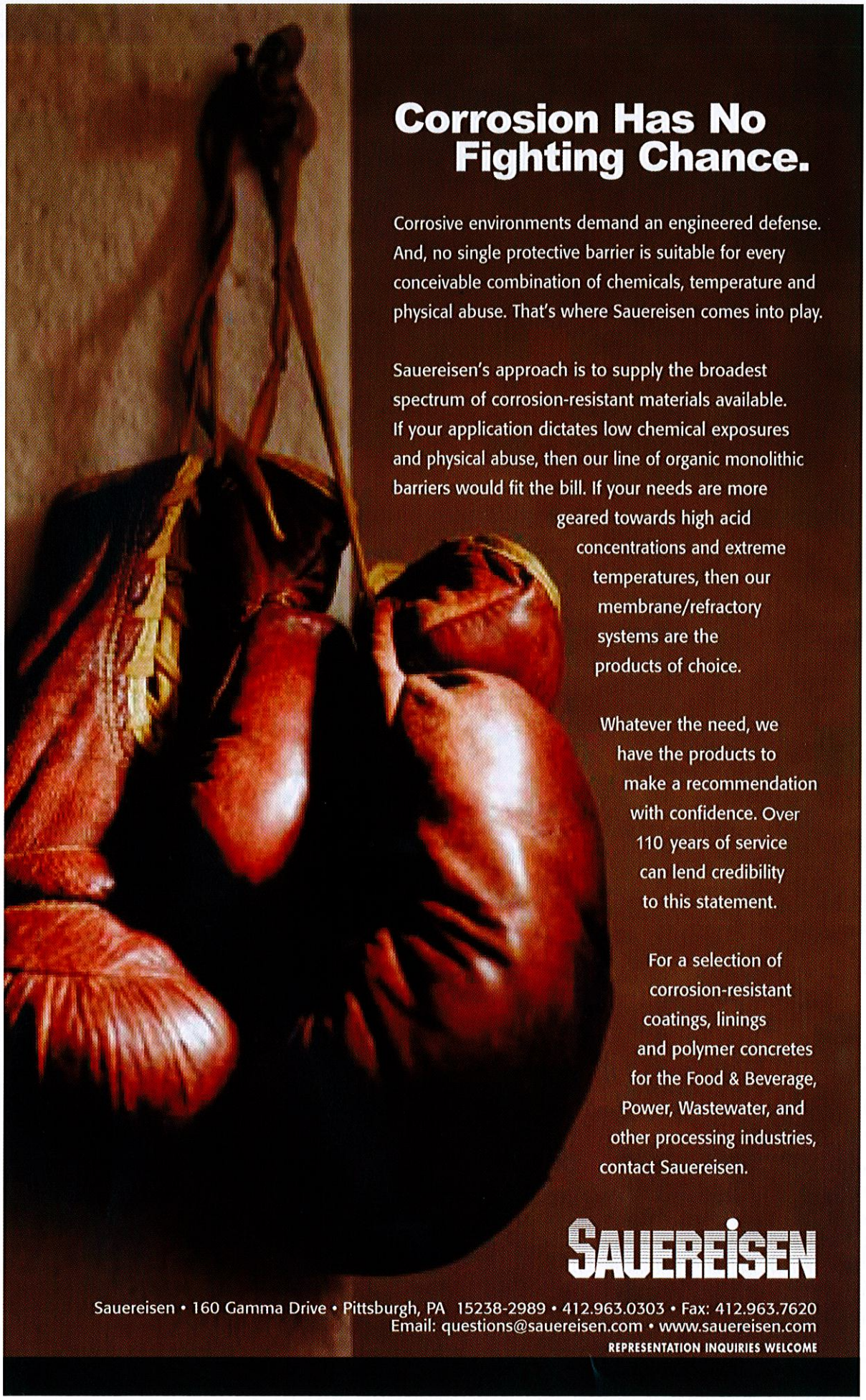
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