TNEMETECH

SUBJECT

Series 431 Perma-Shield PL as a superior technology for lining ductile iron and steel sewer pipe

PURPOSE

To show how Series 431 Perma-Shield PL (pipe liner) for sewer pipe, a derivative of the successful Perma-Shield technology, far surpasses the performance of pipe linings utilizing older technology currently used on most ductile iron pipe today.

GENERAL

For nearly 30 years, the prevalent coating technology for ductile iron pipe (DIP) for gravity sewers or force mains has been a coal tar-modified novolac epoxy. In that same period of time, the U.S. wastewater infrastructure has changed radically with increased domestic sewage detention times and distance to treatment facilities. As a result, the sewerage environments have become increasingly corrosive, with more aggressive gases (H_2S, CO_2, CH_4) forming in the headspace and more abrasive materials attacking the lining.

Although cementitious mortar linings are sometimes used in DIP for non-severe service, the leading competitive coating technology for severe wastewater has for decades been a "ceramic" modified coal tar novolac epoxy. (The ceramic ingredient is purportedly fly ash, a by product of coat combustion which technically qualifies as a ceramic material.) Similar to the introduction of the Perma-Shield line in wastewater treatment plants, Tnemec anticipated a need to develop and introduce a more advanced coatings technology into the ductile iron and steel pipe market where only older, less advanced products are currently available.

Series 431 Perma-Shield PL is based on the same technology which made Perma-Shield a standard of quality for severe wastewater coatings. It is a 100% solids polyamine ceramic epoxy containing 20% ceramic microspheres by weight for added abrasion resistance. Series 431 was formulated to address the three main evils which plague protective coatings systems in domestic sewerage systems (in order of importance): 1) Permeation to H_2S and other sewer gases; 2) Abrasion; 3) Chemical attack.

Comparative Testing:

To compare the performance of Series 431 with a widely-used ceramic novolac epoxy pipe liner, Tnemec subjected both materials to a myriad of tests. Both Series 431 and the competitor's material were submitted for S.W.A.T. analysis. Tnemec also purchased several production-lined 8" diameter (DN 200) ductile iron pipes with the ceramic novolac epoxy and conducted in-house evaluations side-by-side with Series 431 ductile iron pipes of the same size. The results for each coating were compared to determine not only the gap in performance between the Perma-Shield technology and older technology, but the gap between the competitor's published data and Tnemec's internal test results.

Permeation Resistance

Both Series 431 Perma-Shield PL and the competitor's ceramic novolac epoxy began S.W.A.T. testing with a baseline reading of Log Z 11.2. However, after 28 days, the accelerated S.W.A.T. environment attacked the competitor coating, dropping it to a final impedance of Log Z 5.7, below the point of corrosion protection. Series 431 fared much better, ending up with a still "excellent" Log Z 10.7. In other words, Brand X lost 49% of its ability to resist permeation, while Series 431 lost less than 0.5%. Clearly, Series 431 provides a permeation resistance superior to that of the competitor's ceramic epoxy.

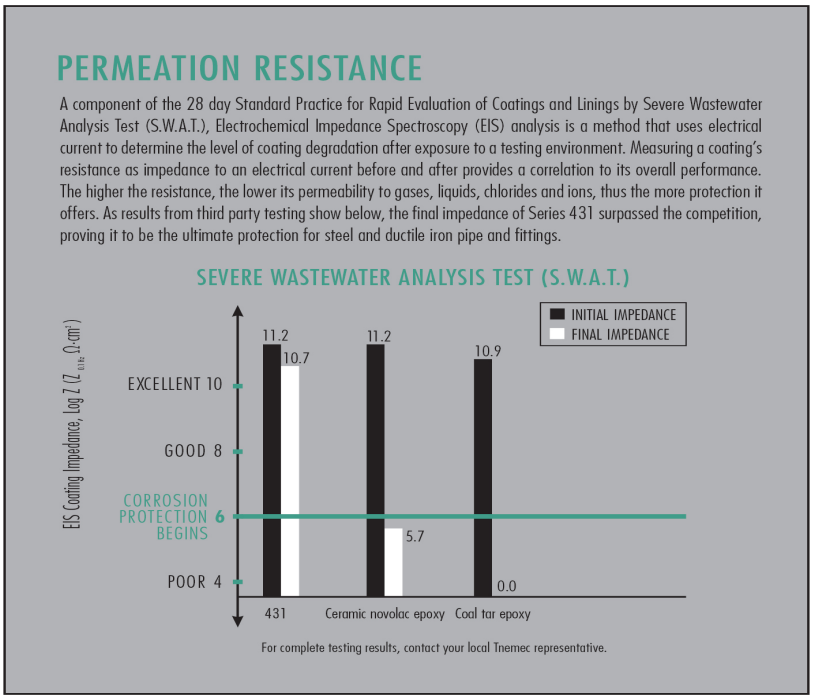

Figure 1: S.W.A.T. comparison of Series 431, the competitor's ceramic novolac epoxy and a standard coal-tar epoxy

Abrasion

To measure the abrasion resistance of the linings, Tnemec tested an 8" diameter (DN 200) pipe lined with Series 431 Perma-Shield PL as well as a production-lined pipe of the same size with a ceramic novolac epoxy in accordance with the latest version of the British Standard BS EN 598 for ductile iron pipes and linings. This test is also known as the "rocking abrasion" test because it employs a mixture of water and gravel inside a capped pipe that is rocked back and forth by a machine for a set number of cycles. To determine average film loss, the DFT is

measured along 15 determined points in the bottom of the pipe (invert) before and after testing. The standard BS EN 598 only requires 50,000 cycles, but because the competitor publishes data for 1 million cycles, Tnemec ran the test out to 1 million cycles for both pipes.

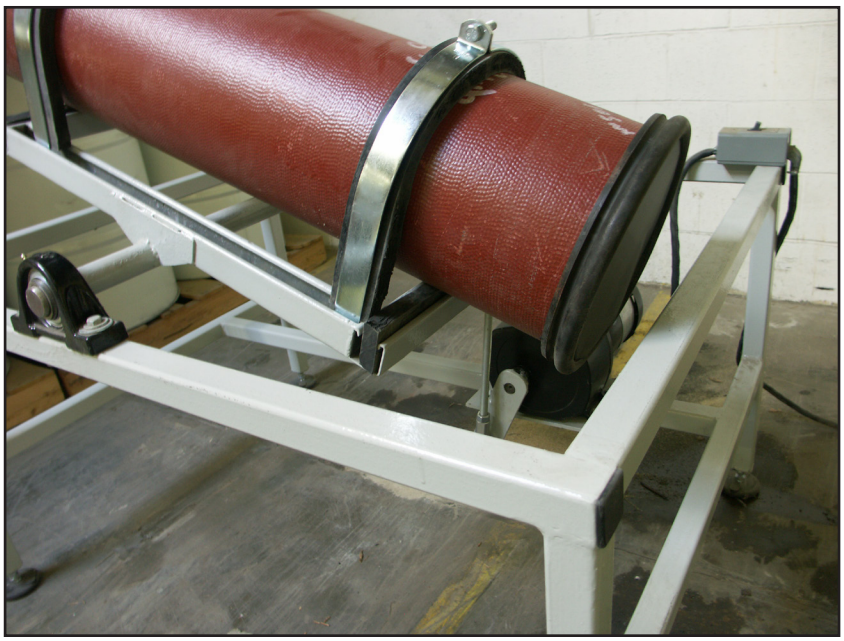

Figure 2: BS EN 598 Rocking Abrasion apparatus with lined pipe installed

The competitor's ceramic novolac epoxy lost 21.4 mils average after 1 million cycles. In some places along the invert, the coating had almost worn through to the substrate. Elsewhere, the film loss was visible to the naked eye. Series 431 fared much better, losing only 5.5 mils average after 1 million cycles and showing no visible change in the coating along the invert of the pipe.

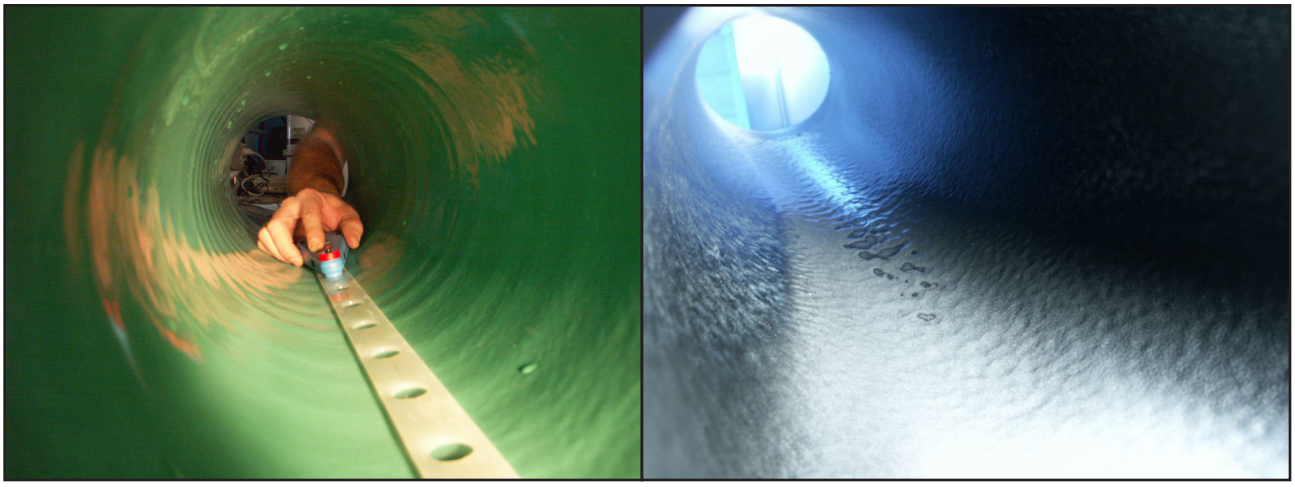

Figure 3: Comparison of Series 431 and competitor ceramic novolac epoxy after 1 million rocking abrasion cycles

Chemical Attack

For the chemical test Tnemec used the same type of pipe, one lined with Series 431 and the other production-lined with a ceramic novolac epoxy. The pipes were filled halfway with a static solution of 20% sulfuric acid (H_2SO_4), capped on each end, and left in a horizontal position for a 30 day immersion test. After the exposure, the linings were evaluated visually.

In Tnemec's internal test the coating blistered and cracked all along the pipe invert in 30 days. The Series 431 Perma-Shield PL was discolored by the chemical immersion, but did not blister or crack.

Figure 4: Comparison of Series 431 and ceramic novolac epoxy after 30 day pipe acid immersion test

Other Evaluations

Perma-Shield PL and the competitor's ceramic novolac epoxy were also evaluated for 5% ring deflection, which is the maximum allowed deflection for ductile iron pipes lined with flexible linings according to the Ductile Iron Pipe Research Association (DIPRA). A 4" ring was cut from a Series 431 lined pipe and a production-lined pipe coated with the competitor's material. The linings were tested for holidays using a high-voltage holiday detector to make sure they were in good condition before the test. Both rings were then pressed 5% of their total 8" (DN 200) diameter and the linings were evaluated for holidays once again. The Series 431 lining had no failures or visible defects, while the competitor's ceramic novolac epoxy had some visible cracks in the crown, or uppermost part of the pipe interior. When tested using a high-voltage holiday detector, Series 431 had no holidays, while the competitor's material had numerous holidays in the film.

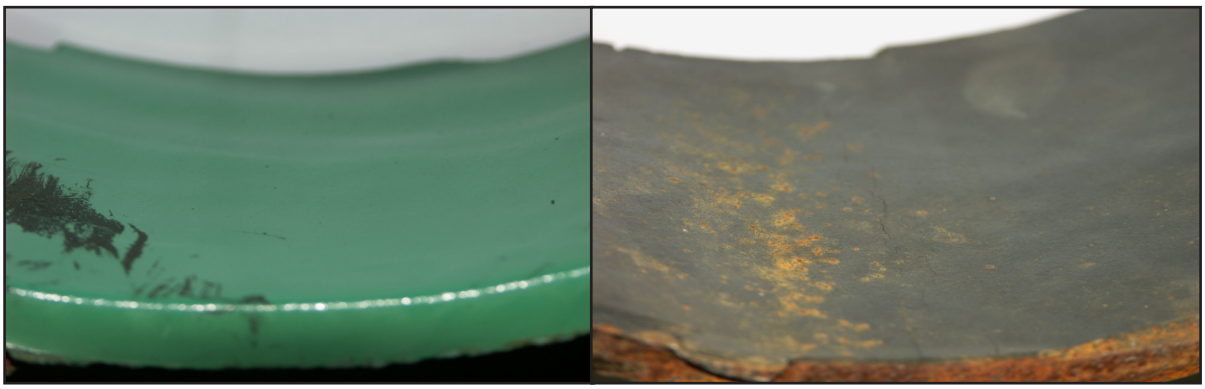

Figure 5: Comparison of Series 431 and ceramic novolac epoxy after 5% ring deflection

Conclusion

The EPA's new "Clean Water and Drinking Water Infrastructure Sustainability Policy" (announced 10/4/10) addresses the issues facing our aging sewerage systems and emphasizes building new systems with the future in mind. The purpose of the policy is to "Develop guidance, provide technical assistance, and target federal SRF capitalization assistance to support increasing the sustainability of water infrastructure in the U.S." [1]

It's obvious that investment in water and wastewater transmission systems is going to be a key issue as the nation moves further into the 21st century. Even the New York Times has picked up on the story, publishing two water infrastructure articles in the past year. Both stories focus on the need for the American people to invest in their water systems. Properly-functioning water and wastewater infrastructure is often taken for granted since it is only noticed when something goes wrong. Bob Herbert writes, "The truth is that the nation's water systems are in sorry shape—deteriorating even as the population grows and demand increases." [2]

Much has changed since the building of most wastewater infrastructure. Sewerage systems have become more severe, while municipal owners and engineers are expecting lasting performance. Quality manufacturers understand the challenge ahead and are developing new products to meet those increased expectations. If owners wish to address severe wastewater corrosion and design sewerage systems with sustainability in mind, they should be looking towards new technologies with proven performance in today's severe environments.

Series 431 Perma-Shield PL, a high-performance pipe liner, is an extension of the successful Perma-Shield line of coatings for severe environments in wastewater treatment plants. Treatment plants may be more visible, but they are only a part of the wastewater infrastructure. The piping that transmits sewage from domestic users, through lift stations, and eventually to treatment plants is exposed to the same kinds of severe environments as the plants themselves. As piping becomes a bigger issue with the aging of the water infrastructure, the need for high-performance pipe liners will become more apparent. Series 431 Perma-Shield PL exhibits superior performance to existing pipe liners, providing the same kind of protection for ductile iron sewer pipe that the rest of the Perma-Shield line provides to wastewater treatment plants.

CP

1. United States Environmental Protection Agency. *Clean Water and Drinking Water Infrastructure Sustainability Policy.* 2010. Online. <http://water.epa.gov/aboutow/upload/Sustainability-Policy.pdf>
2. Herbert, Bob. "The Corrosion of America" New York Times Online. October 27, 2010. <http://www.nytimes.com/2010/10/26/opinion/26herbert.html?_r=1&src=me&ref=homepage>