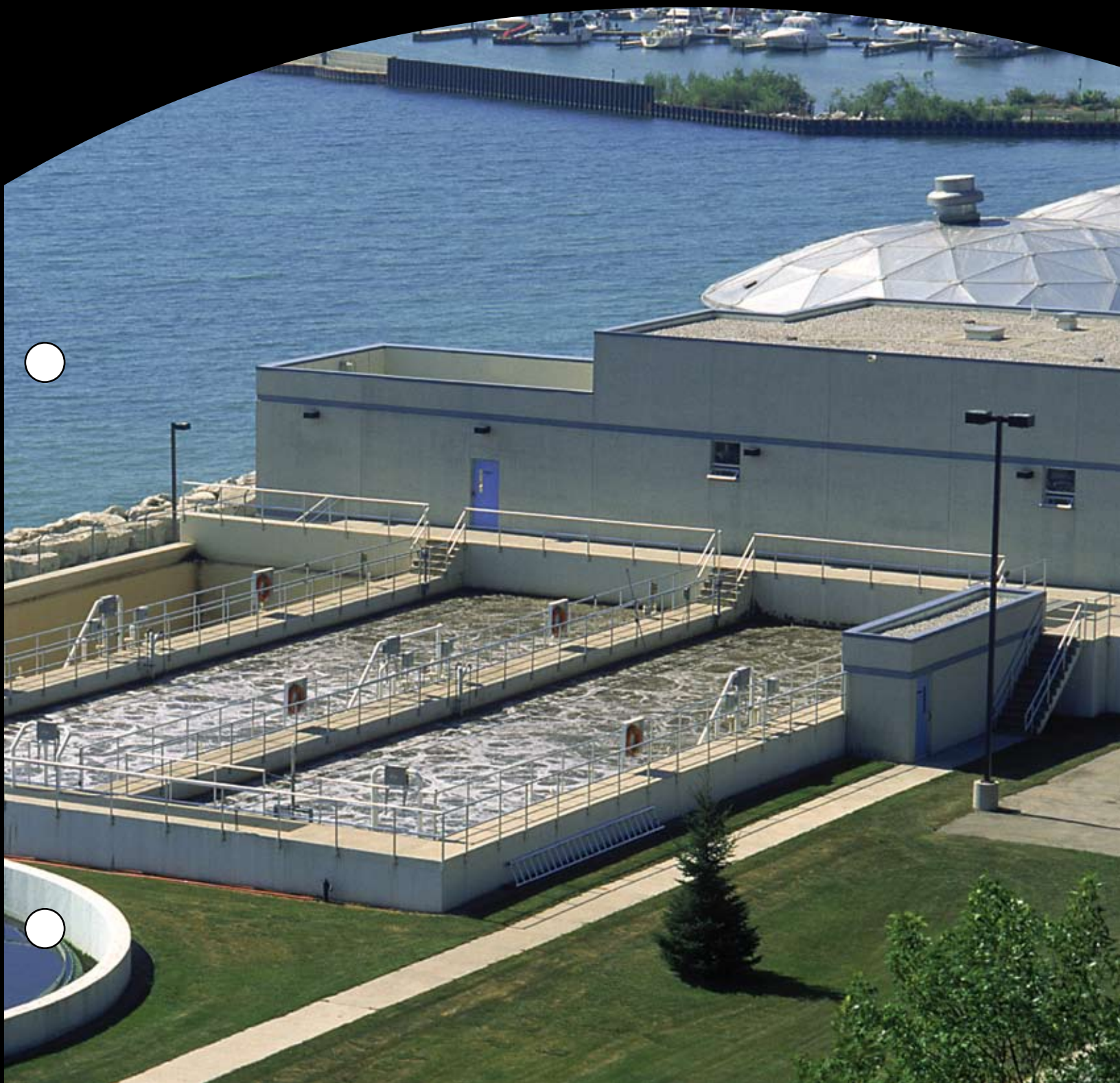
TNEMEC®

THE ULTIMATE SHIELD AGAINST WASTEWATER CORROSION

TNEMEC PROVIDES PROTECTION FOR WASTEWATER FACILITIES.



TNEMEC'S PERMA-SHIELD SYSTEM

SHIELDS CONCRETE FROM DESTRUCTIVE WASTEWATER ELEMENTS AND PROVIDES LONG-LASTING CORROSION PROTECTION.

THE BENEFITS

- H_2S permeation resistant
- Sulfuric acid resistant
- Abrasion resistant
- Increased film thickness
- Rapid return to service
- Withstands thermal cycling

COMMON USES

The Perma-Shield products offer the ultimate in corrosion protection for the following wastewater components:

- **COLLECTION**
  - Sewer interceptors
  - Lift stations
  - Manholes
- **HEADWORKS**
  - Screening structures
  - Lift structures
  - Grit chambers
  - Influent channels
  - Flow measurement facilities
  - Equalization tanks
- **PRIMARY TREATMENT**
  - Covered clarifier
  - Anoxic basins
- **SLUDGE TREATMENT**
  - Dewatering
  - Sludge holding
  - Digesters

THE NATURE OF CORROSION

This lift station at a Texas wastewater facility illustrates corrosion at its worst. Moderate levels of hydrogen sulfide gas advance the deterioration of the lift station's protective coating, destroying its concrete. Due to biogenic sulfide corrosion activity, this structure will face costly renovations and downtime.

Corrosive elements such as hydrogen sulfide (H_2S) gas, sulfuric acid, industrial waste and abrasion have been a constant threat to wastewater facilities for decades by causing concrete to deteriorate and completely fail over time.

Due to legislation passed over the last 30 years, corrosion has risen to extreme levels within wastewater facilities. The Clean Air Act of 1970 mandated the sealing of open wastewater tanks, which trapped H_2S within the tanks and increased sulfuric acid. Corrosion intensified when the Clean Water Act of 1980 demanded industrial pretreatment to abolish harmful heavy metals from wastewater discharges. While beneficial for health purposes, this legislation caused an unexpected side effect within wastewater facilities. Removing the metals from the wastewater system allows bacteria to flourish and causes H_2S levels to drastically increase. Due to the turbulence throughout the system, the dissolved H_2S is stripped from the solution, producing H_2S gas. The H_2S then condenses on the surface and is oxidized by sulfur-oxidizing bacteria, creating sulfuric acid and advancing the process commonly referred to as biogenic sulfide corrosion, or Microbiologically Induced Corrosion (MIC).

Today, wastewater facilities are struggling with corrosion more than ever. To help control maintenance costs, many cities and metropolitan areas are consolidating their wastewater to larger regional treatment plants. Because of this diversion, wastewater travels greater distances and is retained longer within the collection system, increasing dissolved H_2S levels. With the boom of regionalization in today's industry, H_2S levels in large domestic wastewater plants have skyrocketed, in some cases resulting in unprotected concrete deterioration beyond 1.0 inch per year.

Stronger, more harmful treatment chemicals in this environment are also playing a major role in the heightened level of corrosion today. The coating technology of yesterday cannot protect against new coagulants and disinfectants currently being used. Facilities are left defenseless.

This severe increase in corrosion levels led the U.S. Environmental Protection Agency (EPA) to release a report stating that a funding problem will develop if the challenges of aging wastewater infrastructures are ignored. An approximation tool (Figure 1) that is currently being used to assess the useful life of wastewater structures shows that components within these structures should last anywhere from 50-100 years. Without appropriate action, unchecked wastewater facility corrosion will cause a drastic increase of future spending, in addition to greater taxpayer cost.

(Figure 1)

LIFE EXPECTANCY	COMPONENT
50 years	Grit Chambers
50 years	Treatment Plants – Concrete Structures
50 years	Lift Structures
50 years	Pumping Stations – Concrete Structures
80-100 years	Manholes
90-100 years	Sewer Interceptors

Source: U.S. Environmental Protection Agency

Fortunately, Tnemec — the recognized leader in the wastewater industry for more than 50 years — took the initiative to research and develop new coatings for wastewater protection. After screening hundreds of formulations and testing the superior ones, Tnemec created the Perma-Shield product line — the ultimate in fluid-applied wastewater protection.

The Perma-Shield product line offers solutions for each of your wastewater protection needs. Series 434 Perma-Shield H_2S® is an aggregate-reinforced epoxy mortar. Series 435 Perma-Glaze® is a multi-purpose thick film epoxy liner and chemical and permeation resistant glaze coat. Series 436 Perma-Shield® FR is a spray-applied epoxy liner with fiberglass reinforcement. Series 446 Perma-Shield® MCU is a hydrophobic polyurethane. When you choose these products, you not only protect your facility against corrosion, you also extend its life and decrease your future spending.

TESTING METHODS

In order to be called the ultimate in wastewater protection, Series 434 Perma-Shield H_2S, Series 435 Perma-Glaze, Series 436 Perma-Shield FR and Series 446 Perma-Shield MCU underwent the Severe Wastewater Analysis Test (S.W.A.T.). Developed by Tnemec in conjunction with leading engineers, municipal owners and a state-of-the-art testing laboratory, this accelerated wastewater corrosion testing program simulates a severe wastewater environment and evaluates coating performance with regard to permeation resistance, chemical exposure, adhesion, substrate deterioration and long-term performance.

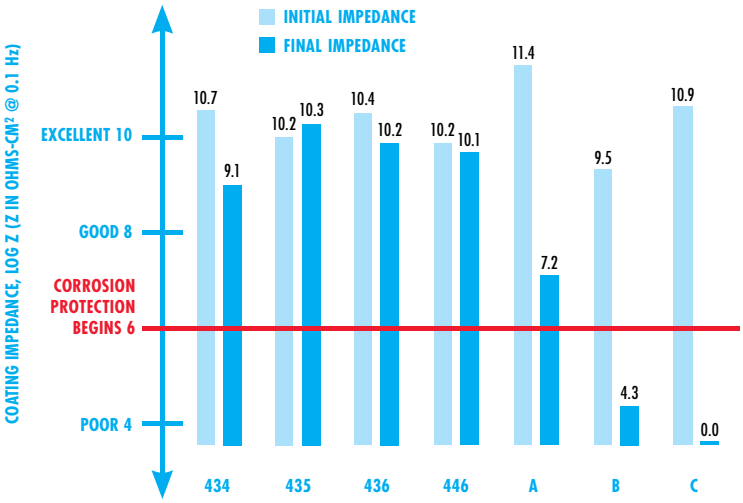
A unique aspect of the test was the examination of wastewater coatings using Electrochemical Impedance Spectroscopy (EIS), a proven laboratory method that uses electrical current to determine the level of coating degradation after exposure to a testing environment. Measuring a coating's resistance as impedance to an electrical current provides a correlation to its overall performance. A coating in good condition resists penetration, or electrical current, as opposed to a coating that has degraded. The higher the resistance of a coating, the lower its permeability to H_2S, chemicals, ions, water and gases, and the more protection it offers.

An independent laboratory tested Series 434 Perma-Shield H_2S, Series 435 Perma-Glaze, Series 436 Perma-Shield FR and Series 446 Perma-Shield MCU along with a multitude of other widely used protective coatings and linings. The products were applied to steel panels, then EIS was administered and the initial impedance of the coatings was determined.

The coated steel panels were then exposed in a control chamber that simulated a wastewater headspace environment (Figure 3). After the 28-day accelerated test was completed, the results of the coated steel revealed that the products showing high initial and retained impedance, as well as resistance to H_2S and sulfuric acid, are Tnemec coatings (Figure 2). Series 434 Perma-Shield H_2S, Series 435 Perma-Glaze, Series 436 Perma-Shield FR and Series 446 Perma-Shield MCU all exhibited excellent adhesion and showed no blistering (Figure 4).

(Figure 2)

EIS IMPEDANCE OF CYCLIC IMMERSION TEST COATINGS



For complete testing results, contact your local Tnemec representative.

(Figure 3)

SEVERE WASTEWATER ANALYSIS TEST – S.W.A.T. (ACCELERATED TEST CONDITIONS)

Aqueous solution: 10% sulfuric acid, brine (saltwater) containing 4000 ppm NaCl

Purge gas: 500 ppm H_2S

Temperature: 150°F (65°C)

Total elapsed test time: 30 days

Time under test conditions: 28 days with 60 immersion cycles

Immersion schedule: The test panels were immersed in the sulfuric acid solution for 15 minutes, three times each working day, Monday through Friday. At all other times, the test panels were positioned in the gas space above the sulfuric acid solution.

These coatings were also applied to concrete cores and exposed once again in the chamber for an assessment on permeability, resistance to blistering, adhesion and visual inspection. The test results were then used to evaluate coating permeation resistance, which is crucial in the prevention of concrete corrosion (Figure 5). Having tested excellent for permeation resistance, adhesion and other testing criteria, Tnemec's products surpassed all other fluid-applied coatings and rivaled the performance of PVC liners.

(Figure 4)

TNEMEC SERIES 434
This epoxy mortar had excellent adhesion, no blistering and retained impedance of 86.6% after 28 days of exposure.

TNEMEC SERIES 435
This thick film epoxy had excellent adhesion, no blistering and retained impedance of 100% after 28 days of exposure.

TNEMEC SERIES 436
This fiber-reinforced epoxy had excellent adhesion, no blistering and retained impedance of 98% after 28 days of exposure.

TNEMEC SERIES 446
This moisture-cured hydrophobic polyurethane had excellent adhesion, no blistering and retained impedance of 99% after 28 days of exposure.

ALTERNATIVE A
This thick film amine-cured epoxy mortar had excellent adhesion, no blistering and retained impedance of 63% after 28 days of exposure. Its perpetual drop in impedance throughout the testing signifies that eventually it will lose its ability to shield against corrosion.

ALTERNATIVE B
The performance of this typical multi-purpose industrial epoxy was poor, based on severe blistering and impedance retention of 44%. Its results were well below the protection level needed to provide long-term H_2S resistance.

ALTERNATIVE C
Although this coal tar epoxy had good initial impedance, severe blistering developed after 10 days of exposure, and retained impedance fell to 0% after 20 days.

THE BEST PROTECTION

Tested and specifically designed to resist MIC, Series 434 Perma-Shield H_2S, Series 435 Perma-Glaze, Series 436 Perma-Shield FR and Series 446 Perma-Shield MCU are the industry's best protection against biogenic sulfide corrosion.

SERIES 434 PERMA-SHIELD H_2S is an aggregate-reinforced mortar designed to reduce permeability and provide an impenetrable system to H_2S gas. Because it has been specifically formulated to withstand harsh wastewater environments, its resistance to thermal cycling and impact allows facilities to not only last longer but perform better and avoid costly downtime as well. Series 434 is especially useful on rehab projects where substantial substrate deterioration has occurred.

SERIES 435 PERMA-GLAZE is an epoxy coating that can be used alone as a spray-applied, high-build protective liner, a thin-film coating or as the chemical- and permeation-resistant glaze coat over Series 434 Perma-Shield H_2S or Series 436 Perma-Shield FR.

SERIES 436 PERMA-SHIELD FR is a spray-applied liner with fiberglass reinforcement, which accounts for thermal cycling and allows for higher film build. It's ideal for protection against corrosion in new construction and concrete rehabilitation projects. The reinforcing fiberglass also dissipates curing and impact stresses that typically develop in high-build liners, leading to better integrity and longer service life.

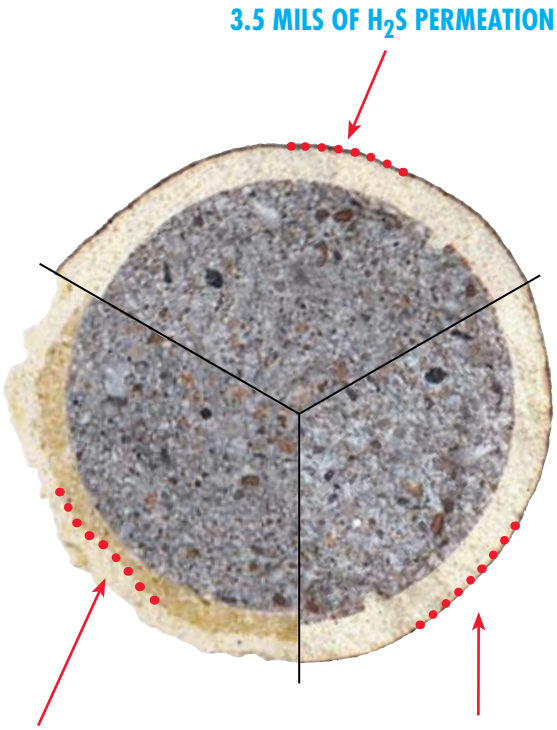
SERIES 446 PERMA-SHIELD MCU is a moisture-cured hydrophobic polyurethane that offers rapid return to service, which keeps facility downtime to a minimum. A user-friendly product, it offers superior performance to coal tar — and other thin film — epoxies.

When your facility uses Series 434 Perma-Shield H_2S, Series 435 Perma-Glaze, Series 436 Perma-Shield FR and/or Series 446 Perma-Shield MCU, it's armed with the industry's premier protection innovation — Tnemec's Perma-Shield System.

Contact your Tnemec representative for detailed product information.

(Figure 5)

Concrete coated with the Series 434/435 Perma-Shield System: When used as a coating system, Series 434/435 offers more advantages than Series 434 used alone. In addition to increasing permeation resistance and chemical resistance, Series 435 reduces the coefficient of friction of the coating by providing a smoother surface that results in better flow and reduced slime buildup.



50 MILS OF H_2S PERMEATION

Concrete treated with Alternative B's thick film epoxy mortar: This coating will allow sulfuric acid and hydrogen sulfide gas, the by-products of bacteria which aid in the process of MIC, to permeate the substrate and corrode the concrete surface.

7 MILS OF H_2S PERMEATION

Concrete treated with Series 434 Perma-Shield H_2S: This protective coating provides a barrier between the substrate and the destructive bacteria by-products, shielding the concrete from corrosion.

For additional information, refer to Tnemec Technical Bulletin No. 03-41.

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