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Problem Solvers

Working in the bayou

Completing a difficult junction box rehabilitation on a tight schedule

Problem: Microbiologically induced corrosion severely damaged a critical concrete junction box.
Solution: Repairing and replacing the degraded concrete using specially formulated concrete and an antimicrobial solution to inhibit future microbial corrosion.

Repairing and relining large sewer lines is always a serious undertaking, especially when the lines in question run underneath a Texas bayou.

A national cured-in-place pipe (CIPP) contractor in Texas was working on such a project when the company ran into a serious snag: After designing and installing a temporary bypass system involving six high-volume diesel pumps and four temporary lines, system engineers were surprised to discover that a critical concrete junction box was badly decomposed by microbiologically induced corrosion (MIC) and in danger of failing structurally. To keep this project on track, the box needed to be cleaned and rehabilitated in a very short time frame, while CIPP work continued.

The contractor called on T.V. Diversified (Lake Worth, Fla.), a trenchless rehabilitation contractor, to complete the difficult project under extreme time pressure.

Working under pressure

MIC is a familiar evil to public works departments. Warm temperatures, turbulence, organic waste, and low oxygen levels commonly found in wastewater systems can make the system a near-perfect incubator for *thiobacillus* bacteria and the formation of hydrogen sulfide gas. *Thiobacillus* feeds on the sulfur in the gas, and converts it to sulfuric acid; some *thiobacillus* colonies can thrive in 7% acid solutions. The sulfuric acid attacks concrete and turns it into rotten, spongy calcium sulfate. Depending on the concrete's condition, significant deterioration can take place in just a few months.

In Houston, the very large junction box — 6-m (20-ft) wide × 10-m (32-ft) long × 6-m (20-ft) deep — was surprisingly close to total destruction even though it had been protected by a polyvinyl chloride (PVC) liner.

"It was pretty bad," said Tom Vitale Jr., owner of T.V. Diversified. "About 8 in. to a foot [200 to 300 mm] of the inner surface was completely corroded and eaten away … and the walls were only 18 in. [460 mm] to begin with, so structural integrity was compromised. And the PVC liner was falling off in sheets, because the corroded concrete just wouldn't hold it up anymore."

PVC lining is installed in many wastewater systems as an MIC-prevention measure — the lining is intended to keep sulfuric acids away from concrete. PVC lining can work well in some situations, but it depends on meticulous application and absolute structural integrity. Even a tiny hole can allow *thiobacillus* to set up colonies between the PVC and concrete walls. When that happens, the lining actually hides the corrosion, and operators may not notice MIC until serious damage has been done.

Vitale is an expert at rehabilitating MIC-damaged structures, but even he was surprised by the size, severity, and urgency of this project. "We got the call in Florida, and 4 days later we were onsite in Texas," Vitale said.

Rebuilding and protecting in one pass

Given the size of the chamber, Vitale needed scaffolding. Rather than rent, he purchased scaffolding on eBay from a seller in Texas. With the scaffolding in place, he and his crew got to work with 34,500-kPa (5000-lb/in.^{2}) pressure washers, thoroughly cleaning the concrete walls and removing all PVC lining and corroded concrete.

The cleaned walls were then rinsed with a 10% solution of Con^{mic}Shield®, an antimicrobial product made by ConShield Technologies (Atlanta). The antimicrobial product is not toxic to humans or animals, but creates an environment that permanently inhibits *thiobacillus* growth. It either can be used as a rinse, or mixed with concrete and applied structurally because the additive bonds with the concrete matrix and creates a permanent barrier.

After the antimicrobial rinse, Vitale used AP/M Permaform's (Johnston, Iowa) Permacast® MS-10,000 to fill the voids caused by corrosion and to rebuild the junction box walls. Voids deeper than 130 mm (5 in.) first were filled with MS-10,000 UL, a fast setting underlayment. Both products are silica-modified Portland cement; the strong corrosion-resistant cement is designed to strengthen and repair concrete structures. Vitale applied the new concrete with low-pressure rotor-stator pumps to minimize backsplash and improve adhesion. The City of Houston performed visual inspections as work progressed.

For the top inch of concrete resurfacing, Vitale continued to use MS-10,000, but added Con^{mic}Shield® to the mix.

"You don't need the antimicrobial protection in the deeper layers," Vitale explained, "so to save money we just use it on the surface, which creates a barrier that protects the entire structure."

Vitale used a thickness gauge to ensure even coverage. By using silica-modified cement and antimicrobial product together, Vitale was able to repair the junction box as well as permanently protect it without the expense or complication of additional PVC or epoxy linings.

T.V. Diversified spent 2 weeks onsite with an accelerated schedule. But the project would have gone even faster except for a massive rainstorm over the bayou.

"Some pump stations couldn't handle the extra flow and backed up, so we were kept out of the box for a couple of days," Vitale said. "It was just Mother Nature acting up — not much you can do about it, except clean up the mess and get started again."

Finding breathing room

New aeration/mixing system manages tight nutrient limits, tight footprint

Problem: Not enough capacity and an inability to meet stringent effluent limits for phosphorus.
Solution: Installing a combined mixing and aeration technology, as well as an automated control system.

The City of Heyburn (Idaho) Wastewater Treatment Plant started experiencing increased flows that it did not have the capacity to handle. In addition to reaching hydraulic capacity, in 2008 the plant also was facing a tough new phosphorus limit — less than 2.3 kg (5 lb) total phosphorus per day. The plant's existing two single-ring oxidation ditches were not adequate to handle the incoming flows nor provide the biological nutrient removal (BNR) needed to meet the new standards.

The plant was constrained both by a tight budget and a limited amount of land for construction of the additional BNR basins that would be needed. If the city did not meet the new effluent permit within the time frame allotted by its regulatory agency, it would face continuous fines until the problem was solved.

Heyburn hired a consultant, Forsgren Associates Inc. (Salt Lake City), to evaluate potential solutions. The evaluation revealed that fine-bubble aeration "would require a new blower building" and surface aerators would require "a new concrete deck," said Travis Higby, project engineer. "Furthermore, the fine-bubble capital cost was about 50% higher, and the surface aerators were cost-prohibitive by 30%."

Instead, the city chose to install the Tri-Oval® oxidation ditch system, manufactured by Aeration Industries International (Chaska, Minn.). The consultant also added the dNOx oxidation-reduction potential (ORP) control system, supplied by dTEC Systems (Seattle), to optimize nitrification/denitrification.

System operation

The Tri-Oval® system enabled the city to choose a size depending on land available and treatment requirements. The system relies on the Aire-O_2 Triton process aerator/mixer, which produces fine air bubbles and provides mixing as deep as 10 m (33 ft). This allows for a deeper oval with smaller footprint, while still treating the same volume of wastewater. In the system, aeration and mixing duties are divided between multiple aerator–mixers, providing inherent equipment redundancy and power distribution around the ditch. The plant has a spare aerator/mixer for additional redundancy.

The dual-mode operation of the aerator–mixers "allows for the creation of aerobic and anoxic zones in a single-ring oxidation ditch for cost-effective BNR operation," said Ayman Shawwa, technical director at Aeration Industries. "Furthermore, with the use of the dNOx ORP control system, the addition of oxygen can be tightly controlled to perform nitrification–denitrification in a single ring oxidation ditch," he said.

Accruing cost savings by space and energy efficiency

Heyburn was able to save substantially by not having to purchase additional equipment. Incorporating the ability to aerate and mix, or just mix, in a single device prevented the city from having to purchase additional mixers to supplement the aeration equipment. The Aire-O_2 Triton equipment also includes an onboard regenerative blower, so large blowers and blower buildings were not needed. Also, additional mixers for the anoxic zone and additional anoxic basins were not necessary because nitrification and denitrification are conducted in the same basin.

The city saved even more because only minimal structural modifications were required to convert the existing brush rotor basins. The existing splitter boxes and weirs also could be reused in the upgrade. And since the aerator–mixers are surface-mounted, the existing oxidation ditches did not have to be drained for the installation.

Savings continued to add up by using less energy. The ORP control system and dissolved oxygen (DO) control systems cycle the aerator–mixers' blowers on and off based on DO set points and nitrate depletion. Additionally, some aerator–mixers can be completely turned off during the anoxic, mixing-only cycles because only two mixers are required to completely mix each basin. Variable-frequency drives were installed on the blowers and were used to adjust the blowers when in DO-control mode, which also

added to energy efficiency.

Other benefits

In addition to energy and cost savings, the installation provides environmental and employee benefits. The aerators do not splash the wastewater into the air creating aerosols that may put pathogens and odors into the air. The aerators are quieter than large blower buildings. And since the brush rotors are covered, they do not create a mist that previously created health and safety issues when it led to icing on bridges. The covered rotors are also quieter than before. Because the plant is in a small neighborhood with homes near the plant's property line, the low noise levels are appreciated by the neighbors.

"Low maintenance also is a feature of the installation," said Ralph Martini, an operator at the Heyburn plant. Previously, the basins had to be drained to remove deposited sludge on a biannual basis. Taking down a basin reduced plant capacity, and sludge removal required the use of a truck and several days of labor by plant staff. The aerators are much more effective at mixing and eliminating sludge deposits, saving the time and costs previously spent on sludge removal.

Also, the process aerator requires only minimal maintenance due to the slow speed of the motor, few wearing parts, and a proprietary-engineered water-lubricated bearing. Simple maintenance can be done from the walkway without dewatering the tanks, and it does not require the assistance of cranes, or valve or gear reducers. The DO and ORP probes are inspected and cleaned if necessary every 90 days. The cap of the DO sensor, and the salt bridge and fill solution for the ORP probes are replaced once a year. The equipment also includes a 5-year warranty.

Providing a flexible, cost-saving increase to capacity that meets phosphorus limits

The installation met effluent requirements while staying within budget and fitting into the small area available for installation. The project also allowed the site to use existing aeration basins with minimal structural modifications and construction costs.

"The site is saving significantly in capital equipment and yearly maintenance costs," Shawwa said. "And installation was less costly than the other alternatives available to meet the necessary phosphorus limitation," he added.