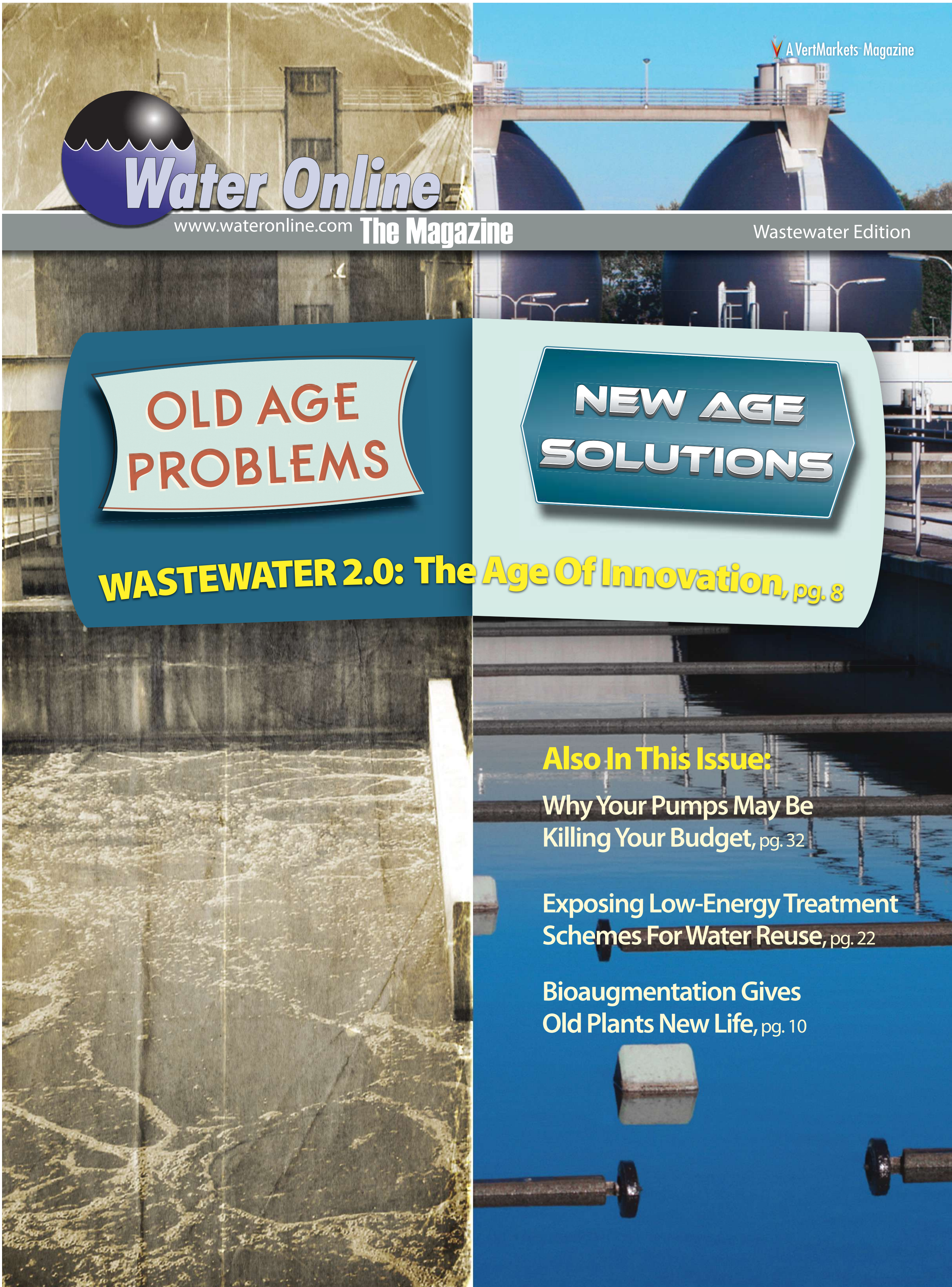
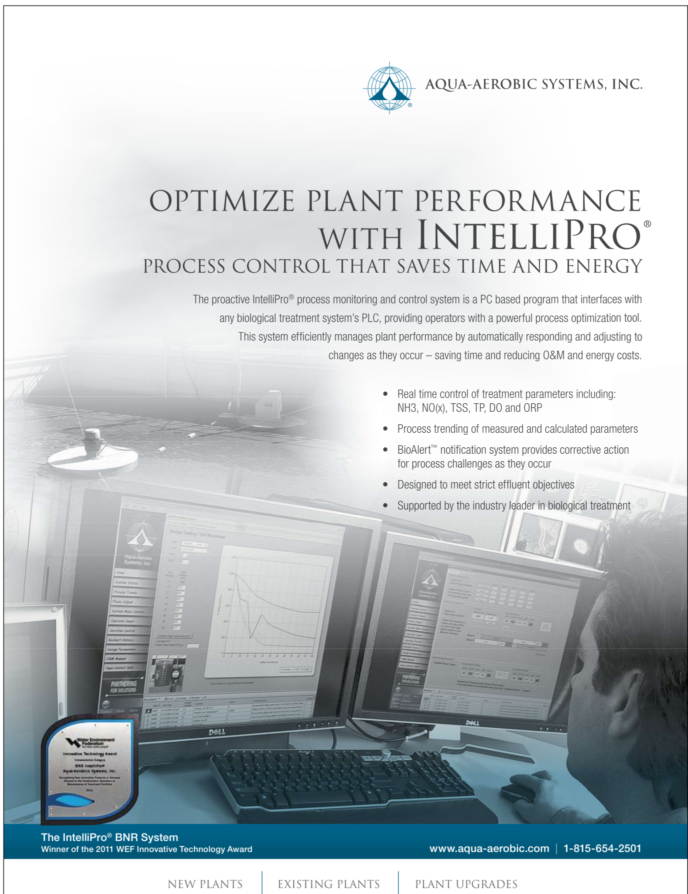
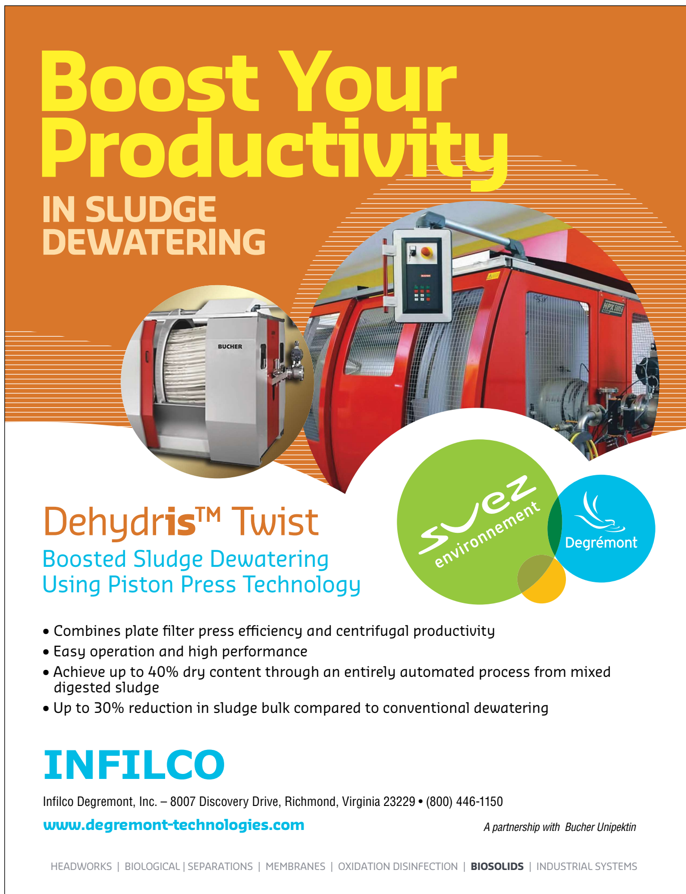

A VertMarkets Magazine
Water Online
www.wateronline.com
The Magazine
Wastewater Edition
OLD AGE PROBLEMS
NEW AGE SOLUTIONS
WASTEWATER 2.0: The Age Of Innovation, pg. 8
Also In This Issue:
Why Your Pumps May Be Killing Your Budget, pg. 32
Exposing Low-Energy Treatment Schemes For Water Reuse, pg. 22
Bioaugmentation Gives Old Plants New Life, pg. 10

FEATURED ADVERTISERS






Water Online
The How To Site for the Water Treatment Professional
www.wateronline.com
Water Online • 101 Gibraltar Road, Suite 100 • Horsham, PA 19044 • Phone: 215-675-1800 • Fax: 215-675-4880 • info@wateronline.com

A VertMarkets Magazine

Water Online

www.waternline.com The Magazine

Wastewater Edition

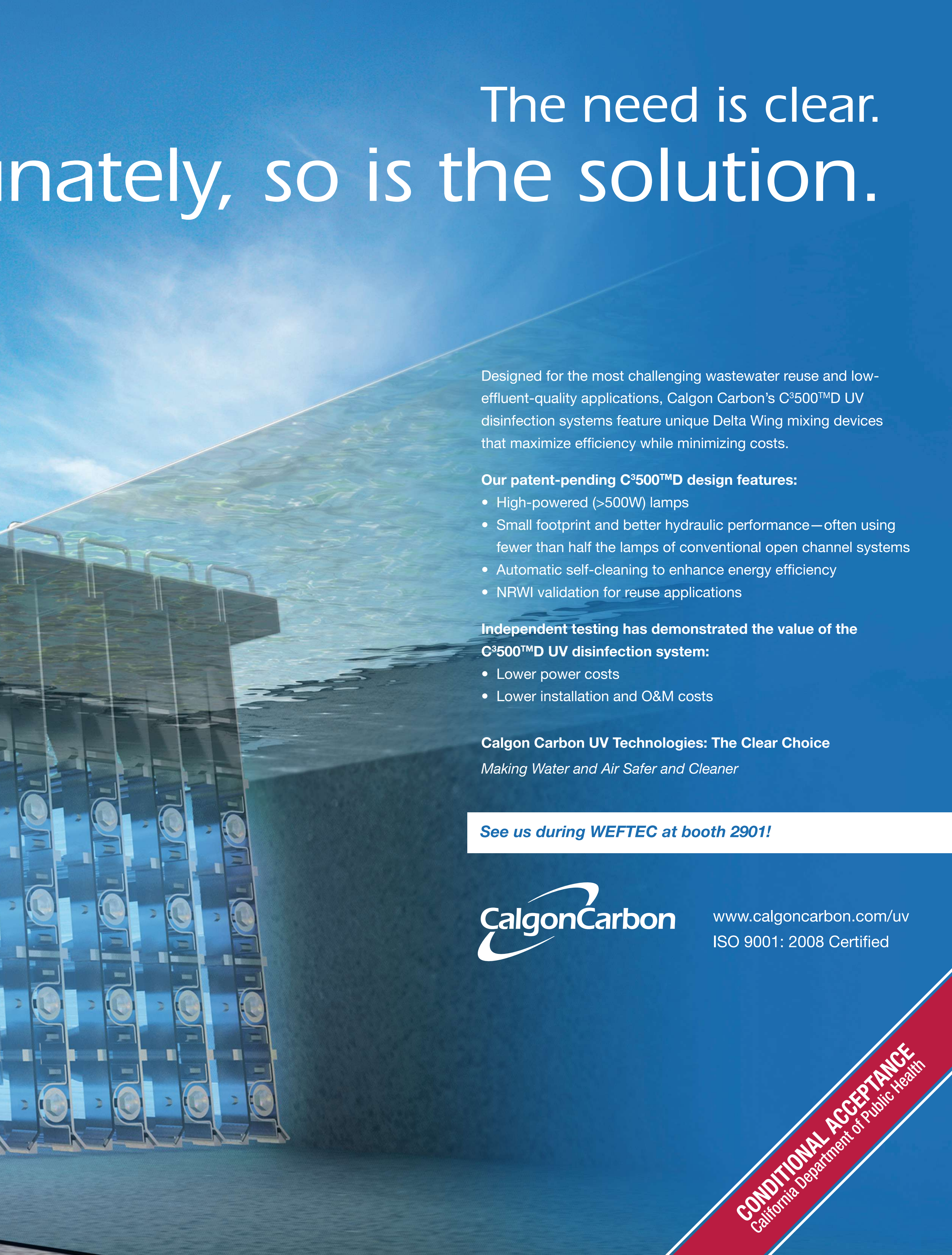
OLD AGE PROBLEMS

NEW AGE SOLUTIONS

WASTEWATER 2.0: The Age Of Innovation, pg. 8

Also In This Issue:


Fortu
CalgonCarbon


The need is clear.
nately, so is the solution.
Designed for the most challenging wastewater reuse and low-effluent-quality applications, Calgon Carbon's C³500™D UV disinfection systems feature unique Delta Wing mixing devices that maximize efficiency while minimizing costs.
Our patent-pending C³500™D design features:
• High-powered (>500W) lamps
• Small footprint and better hydraulic performance—often using fewer than half the lamps of conventional open channel systems
• Automatic self-cleaning to enhance energy efficiency
• NRWI validation for reuse applications
Independent testing has demonstrated the value of the C³500™D UV disinfection system:
• Lower power costs
• Lower installation and O&M costs
Calgon Carbon UV Technologies: The Clear Choice
Making Water and Air Safer and Cleaner
See us during WEFTEC at booth 2901!
CalgonCarbon
www.calgoncarbon.com/uv
ISO 9001: 2008 Certified
CONDITIONAL ACCEPTANCE
California Department of Public Health

Leaks eventually tell you where they are...

but can you afford to wait?

A geyser caused by the rupture of a water main is a big, expensive problem to fix. Find leaks before they erupt with Aclara's STAR® ZoneScan leak-detection solution. Jointly developed by Aclara and Zurich-based Gutermann International, the STAR ZoneScan locates leaks while they are still underground. The solution employs data loggers placed on gate or hydrant valves to sample the sound waves generated by leaks along the main, and automatically sends this data to the utility over the Aclara STAR® Network. There, the system's software correlates the data, pinpointing any leaks to within a few feet.

The STAR ZoneScan solution saves time by automating the process of collecting and transmitting data about the water system. It also encourages practical water conservation by helping utilities identify and fix leaks before they become costly, water-wasting emergencies. **For more information, please contact us at STARZoneScan@aclara.com or visit us at bit.ly/STARZoneScan.**

ACLARA®
Aclara Technologies of ESCO

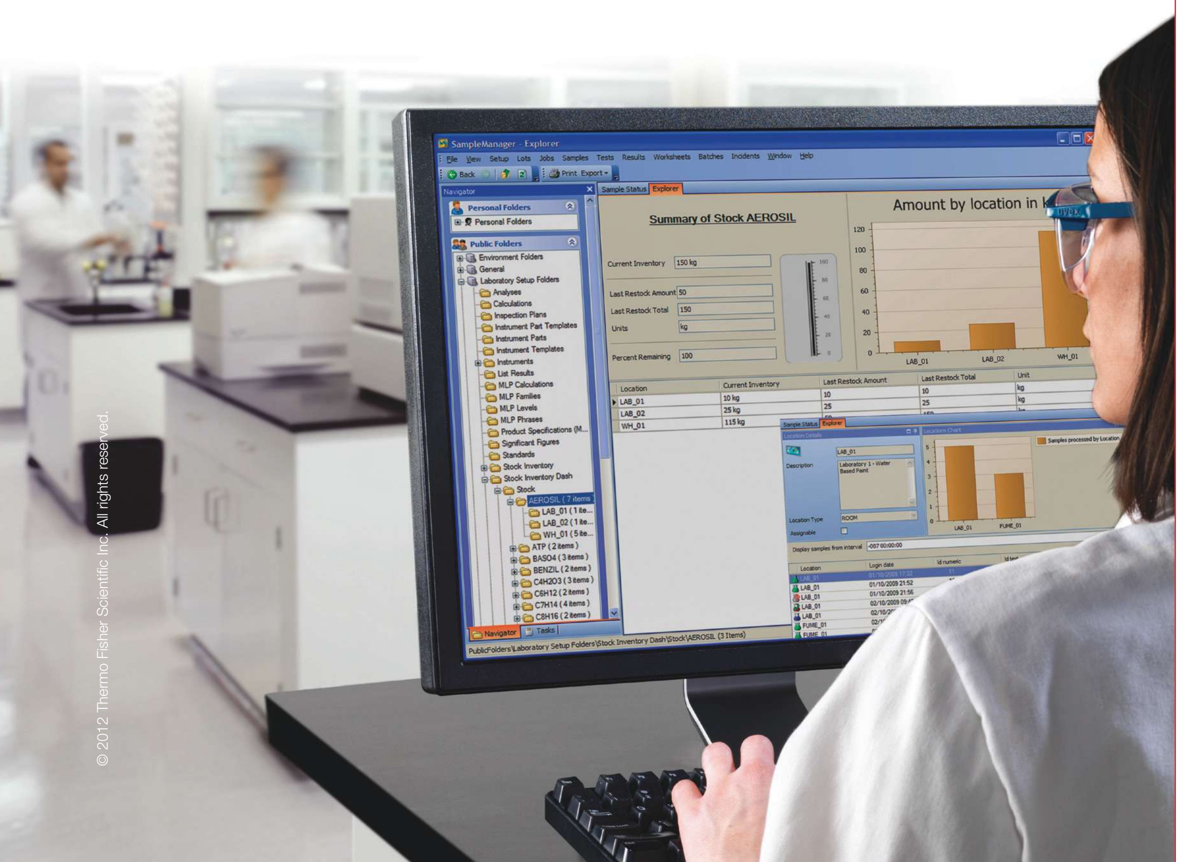
Thermo
SCIENTIFIC

You are compliant

Information is demanding. It has to be accurate and easy to share across your lab, or across the globe. To flow seamlessly into reports that ensure product safety, productivity, and compliance. In over 25 years of work with regulated industries, we've learned what you face today, and what's on the horizon. This is where you'll find sustainable, integrated **purpose-built LIMS** that withstand the test of time.

with informatics solutions ready for the future

• thermoscientific.com/informatics



Laboratory Information Management Systems
Designed to meet the flexibility demanded by today's laboratories

Chromatography Data Systems
Enterprise-level for global deployment and maximium instrument functionality

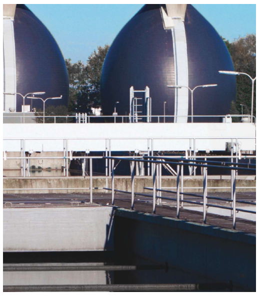
Document Management Systems
Compliant document management for mission critical information

Electronic Laboratory Notebooks
Secure documentation, enable collaboration and ensure traceability

Spectroscopy Software
Industry-leading solutions to visualize, process and manage data

TABLE OF CONTENTS

DEPARTMENTS



Advertiser Index

The Future Is Now For Wastewater Technology

"To raise new questions ... to regard old problems from a new angle, requires creative imagination and marks real advance in science."
— Albert Einstein

Einstein may as well have been speaking directly to today's wastewater professionals, because if there's one thing the industry has in spades, it's "old" problems — not only traditional, age-old problems, but also old-age problems. For many municipalities, the infrastructure is old, the technology is old, and even the workforce is... well, let's say retiring.

So how do we contend with these "old" issues? Taking a cue from Einstein, we decided in this edition of *Water Online The Magazine* to look at them from a new angle — to embrace wastewater treatment techniques that are smarter and more efficient than their predecessors. Traditional methods may still fit the bill for some, but most municipal budgets today demand that we actually cut the bill, to do more with less. In such cases, a more forward-thinking approach should be seriously considered.

There are a host of emerging technologies, for instance, to treat reclaimed water in an energy-efficient, cost-effective manner. To help you wade through the uneasiness and uncertainty of selecting an alternative technique, Carollo Engineers evaluates these technologies for effectiveness and market-readiness on page 22.

While it is acknowledged that there is some risk involved in stepping away from old, "tried and true" methods, new approaches often pay big dividends. Consider the case of the Roseburg Urban Sanitary Authority (pg. 16), which utilized 340 acres of nearby ranchland to receive treated wastewater and get in compliance with U.S. EPA nutrient mandates.

A far more conventional destination for wastewater is the man-made lagoon, but even this age-old technique can benefit from modern technology. Find out how on page 40.

To be sure, our society's scientific and technological evolution has afforded us the ability to tackle these old problems in new ways. Our deeper understanding of microbiology, for example, has enhanced our ability to treat wastewater (pg. 10), as well as prevent corrosion to infrastructure (pg. 46).

Stepping away from the microscope, there is a more patently obvious component to every wastewater system that nevertheless requires a close look — the pumps. On page 32, discover just how much outdated and inefficient pumps can cost facilities in maintenance, man-hours, and energy consumption.

The monitoring and analysis of your systems is indeed essential to realize your operational efficiency, or lack thereof. Visibility facilitates optimization, cost savings, and also compliance with ever-stricter regulations. Internet-hosted SCADA, presented on page 38, provides this vital oversight for your plant, while a laboratory information management system (pg. 52) does the same in a water-testing environment.

"Out with the old and in with the new" may not be a panacea, but innovation and technology is proving to be the answer for many age-old and old-age problems in the wastewater industry. And while some bemoan the loss of a rapidly retiring workforce as "brain drain" for the water community, there are plenty of inventive minds currently working on tomorrow's breakthroughs — as evidenced by the gathering wave of innovation I write about on page 8.

Raising new questions, pursuing new angles, using creative imagination. Einstein would be proud of today's wastewater industry.

Kevin Westerling
Editor
editor@wateronline.com

Water Online The Magazine

101 Gilbraltar Road, Suite 100
Horsham, PA 19044
PH: (215) 675-1800
FX: (215) 675-4880
Email: info@wateronline.com
Website: www.wateronline.com

DIRECTOR OF SALES
Travis Kennedy
(215) 675-1800 ext. 122
tkennedy@vertmarkets.com

CUSTOMER RELATIONSHIP MANAGER
Chuck Allen
(215) 675-1800 ext. 126
callen@vertmarkets.com

CUSTOMER RELATIONSHIP MANAGER
Patrick Gallagher
(215) 675-1800 ext. 129
pgallagher@vertmarkets.com

CUSTOMER RELATIONSHIP MANAGER
Scott Setzman
(215) 675-1800 ext. 134
ssetzman@vertmarkets.com

MANAGING EDITOR
Michael Thiemann
(814) 897-9000, Ext. 340
michael.thiemann@jamesonpublishing.com

PRODUCTION DIRECTOR
Dianna Gross
(814) 897-9000, Ext. 255
dianna.gross@jamesonpublishing.com

DIRECTOR OF AUDIENCE DEVELOPMENT
Martin Zapolski
(814) 897-7700, Ext. 337
martinz@jamesonpublishing.com

DIRECTOR Of ONLINE DEVELOPMENT
Art Glenn
art.glenn@jamesonpublishing.com

Reprints, Eprints, and NXTprints
The YGS Group (800) 290-5460
VertMarketsReprints@theYGSgroup.com
www.theYGSgroup.com

ADDRESS CORRECTIONS
Send to Water Online at above address, or email circ@vertmarkets.com. Please give old and new address, and enclose or reference your latest mailing label.

Plan to meet us at
WEFTEC 2012
Booth 7539

Learn more at
huberforum.net/transform
704.990.2055 · solutions@hhusa.net

SOLUTIONS FOR:


SCREENING


GRIT


SLUDGE

Wastewater 2.0: The Age Of Innovation

Thanks to some forward-thinking pioneers and early adopters committed to innovation, the wastewater industry is on the precipice of radical change.

by Kevin Westerling

For many municipalities, old treatment methods and practices are still in play because they are comfortable and predictable, but we are coming to a point where that rationale will no longer hold water — or wastewater, in this case. When confronted with technology that is clearly superior — more effective, economical, energy-efficient, and sustainable — there is little choice but to advance and upgrade. This is especially true when government regulations, community obligations, and shrinking budgets demand improved performance. Because of these forces, a sea change in the industry is imminent, and ready to forever change the course of wastewater treatment.

Hubs Of Innovation

The groundswell for this transformative innovation has actually been building for years, and in some very specific places. Boston, for instance, boasts more than 30 water startup companies, in addition to established companies such as Siemens and CDM Smith. Furthermore, the city recently hosted the inaugural *Symposium on Water Innovation in Massachusetts* to discuss how the region could become a global innovation leader in the water industry. Boston has all the key ingredients in place to fulfill such promise: large purchasers in the area, namely utilities and big corporations; access to R&D through its many startups and universities; and, finally, a wealth of local capital.

One of Beantown's many bright spots is Oasys Water, which uses forward osmosis technology to treat high-salinity water for reuse, specifically for hydraulic fracturing in the oil and gas industry. Whereas reverse osmosis requires high pressure and substantially more power, forward osmosis — utilizing reengineered membranes — works at lower pressures with less energy. By lowering the cost of desalination, this technique has the potential to be a game-changer for both wastewater and drinking water applications.

Boston's West Coast counterpart is the Central Valley of California, where more than 120 water, energy, and agriculture technology companies have taken root. Home to a huge agriculture industry, worth about $19 billion in exports per year, water is in high demand but scarce in the dry Central Valley, making it an ideal testing ground — and, ultimately, proving ground — for water and energy innovation.

In particular, the BlueTechValley initiative — a collaboration of industries, universities, and non-government organizations (NGOs) — has set out to transform the Central Valley into "the Silicon Valley of water" by focusing on high-tech water and wastewater solutions. One such example of cutting-edge technology is the use of ultrasound and reusable ion exchange resins to remove contaminants from industrial wastewater. The potentially groundbreaking development comes from the Water and Environmental Technology (WET) Center, which is part of BlueTechValley.

"If a treatment process doesn't work, municipalities may face fines and other financial repercussions…"

These hubs of innovation, and others like them, have introduced many technologies that can serve utilities and their customers *right now*, but there is a stumbling block to grand-scale implementation — trust. If a treatment process doesn't work, municipalities may face fines and other financial repercussions, and — much worse — public health could be compromised. It is no wonder, then, that utilities are cautious about going from traditional, proven methods to something new. Only after a bold and progressive utility validates a technology will others follow suit, making these early adopters vitally integral in the evolution of innovation.

Trailblazing Municipalities

In 2009, the Durham Advanced Wastewater Treatment Facility in suburban Portland stepped forward and became the first commercial facility in the United States to recycle phosphorus and other nutrients from wastewater into a commercial fertilizer. Using a unique, proprietary system developed by Ostara Nutrient Recovery Technologies Inc., Durham not only generates revenue through fertilizer sales, it has increased plant capacity and realized enough operational cost savings to provide a projected five-year return on its $2.5 million capital cost investment. Following Durham's lead, six other U.S. municipalities have entered into public-private partnerships with Ostara for nutrient recovery facilities.

The District of Columbia Water and Sewer Authority (DC Water) is also a trailblazer, having invested $433 million to build the largest thermal hydrolysis plant in the world, as well as the first in North America for wastewater treatment. The

Blue Plains Wastewater Treatment Plant, set for completion in 2014, will generate heat and power by "pressure-cooking" biosolids left over from the wastewater treatment process. Through the use of four anaerobic digesters, DC Water predicts it will produce enough biogas to cut its electricity consumption by a third, while also saving $10 million annually in trucking costs by cutting the amount of solids at the end of the process in half.

The San Francisco Public Utilities Commission (SFPUC) is another utility looking to draw energy from the waste stream, using a system developed by BlackGold Biofuels that turns fats, oils, and grease (FOG) into biodiesel fuel for use in city agency vehicles. The 300-gallon/day demonstration project is the first large-scale brown grease recycling project in the United States and, if proven successful, would serve as a prototype for municipalities nationwide. The technology could potentially solve two common issues for wastewater utilities and municipalities: It reduces high energy spending, and it disposes of problematic FOG. According to SFPUC, grease-clogged sewer pipes cost the city over $3.5 million each year to clean out.

Get On Board, Or Get Left Behind

The common obstacles besetting municipalities — particularly aging infrastructure and high energy costs — are becoming so acute that cold feet nor political agendas will be able to slow the march of progress. The inevitable tipping point, according to Paul O'Callaghan, CEO of BlueTech Research, will be here within the decade, and perhaps much sooner.

"Every technology goes through an innovation cycle periodically," said O'Callaghan, whose firm provides market intelligence on innovative water technologies and companies. "Telecommunications had one about 10 or 15 years ago, and water hasn't had one for about 100 to 150 years. The water industry is ripe for innovation, because it's been static for a quite a long time."

O'Callaghan points to other signs that innovation is ready to bubble over, including annual growth rates of 30% for water R&D, a stark rise in patents filed for water technologies, and the proliferation of conferences dedicated exclusively to water research and technology.

Indeed, the writing on the wall suggests that the wastewater technology revolution is on its way, and with it comes the choice to either get on board or play catch-up. With solutions designed specifically for what ails the industry, it is a wise move to investigate every alternative to the declining status quo — and the sooner, the better. ■

Microbiology: The Key To Wastewater Treatment

Using a novel sewer collection bioaugmentation process, wastewater goes from liability to asset.

by Bulbul Ahmed, Andrew Newbold, and Rich Schici

The biological treatment of wastewater relies mainly on a consortium of heterotrophic and autotrophic bacteria. The fecal bacteria that are constantly introduced into the collection system are not the optimal bacteria for degrading the contaminants present in wastewaters. The soil bacteria that are introduced through inflow and infiltration are more effective at degrading the wastes and can contribute to stabilizing the downstream wastewater treatment process; however, the flux of these organisms into the sewer system is not enough to contribute to significant degradation in the sewer system under normal conditions. Collection system bioaugmentation aims to introduce high concentrations of specific soil bacteria into the outer reaches of the sewer system and amplify the beneficial effects of soil bacteria in the collection system. The downstream impact of this treatment serves to improve the condition of the collection system by reducing odor and degrading fats, oils, grease (FOG), as well as reducing organic loadings to waste water treatment plants (WWTPs) and increasing the efficiency and effectiveness of the wastewater treatment process.

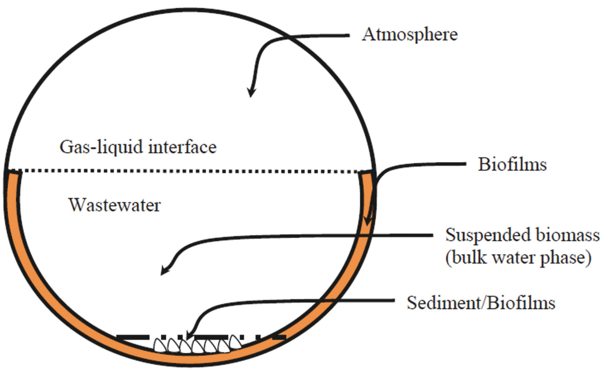


Figure 1: The environment in the sewer line.

Background

Direct releases of domestic, municipal, or industrial wastewater into surface waters degrade the condition of the natural aquatic environment and can pose serious threats to human health. Biological treatment processes are still the mainstay for degrading most of wastewater contaminants after pretreatment (e.g., screening and settling) since it is the most effective process in contaminant degradation, cost effective, and it is eco-friendly compared to the physiochemical processes. Advanced chemical and/or biological treatments, such as chemical precipitation or tertiary filtration are often required before reuse or discharge into ecologically sensitive waters. In a biological process, indigenous microorganisms (mainly bacteria) are the key to removing contaminants such as organics (chemical oxygen demand [COD]), and nutrients (nitrogen/phosphorous) from wastewater.

Wastewater Bacteria And Their Metabolisms

Fecal heterotrophic and natural autotrophic bacteria are the indigenous microorganisms introduced into the biological wastewater treatment processes. Heterotrophic bacteria degrade readily biodegradable COD (rbCOD) in wastewater by using it as an electron donor for respiration. They respire using oxygen, nitrate, or sulfate, as an electron acceptor under aerobic, anoxic, or anaerobic conditions, respectively. The main respiration products are carbon dioxide, nitrogen gas, sulfide, and biomass. Heterotrophic bacteria also degrade rbCOD through the fermentation processes under anaerobic conditions and generate the fermentation products of carbon dioxide and biomass. Autotrophic nitrifiers oxidize ammonia to nitrate or nitrite for energy and use alkalinity as a carbon source. Anaerobic respiration using sulfate is undesirable in a wastewater treatment process since the respiration product sulfide creates nuisance odors and is also toxic to human health. Furthermore, the sulfide oxidation in the sewer atmosphere generates sulfuric acid, which is corrosive to the sewer infrastructure. In addition, heterotrophic bacteria secrete enzymes to hydrolyze hydrolysable particulate COD to rbCOD, which then can be used as an electron donor for cellular metabolism.

Current Microbiology And Wastewater Treatment

Approximately 99.9% of fecal bacteria are strict anaerobes and the rest are either aerobes or facultative anaerobes. Fecal bacteria are more susceptible to the changes in wastewater characteristics and environmental conditions such as temperature, pH, chemistry, etc. Heterotrophic and autotrophic bacteria are the main contributors in wastewater treatment.

Nitrification by autotrophic bacteria requires more expensive operating strategies in a WWTP since nitrifying bacteria are slow growing and have lower oxygen utilization kinetics than aerobic heterotrophs. Therefore, traditional activated sludge process operations usually run with longer retention time, intense aeration, and lower COD to keep nitrifying bacteria active, or activated sludge processes are replaced with advanced biological processes such as sequencing oxic-anoxic batch reactors. However, achieving the performance by changing processes or operations still relies on the activity of indigenous nitrifying microbiology. Indigenous heterotrophic bacteria are capable of degrading the rbCOD, but are less efficient at converting less biodegradable and slowly hydrolysable COD to rbCOD which requires various enzymes. Due to the lower hydrolysis rate, non-biologically degraded COD ultimately yields more biosolids per pound of COD, which requires additional treatment and disposal cost. In addition, increased aeration energy is required to treat wastewater due to the presence the other non-beneficial microbiology.

The Significance Of Biochemical Processes In Wastewater Collection System

Figure 1 (prior page) illustrates the environment in the sewer line, which is simplified as the bulk water phase, the biofilm phase, the biofilm/sediment phase, and the sewer atmosphere. Biochemical processes take place in each phase of the sewer. The sewer atmosphere is the only source of the oxygen (O2) that dissolves into the wastewater in the sewer except the dissolved oxygen (DO) coming in with the influent wastewater. The hydrogen sulfide gas (H2S) and other odor causing volatile organic compounds (VOCs) emit from the bulk liquid phase to the sewer atmosphere based on the respective Henry's constant for each compound and the characteristics of the wastewater. The biochemical transformations in the bulk liquid phase, the biofilm phase or in the biofilm/sediment phase of the sewer network are initiated by microorganisms (mainly dominated by the large population of heterotrophic bacteria). The most important processes are the hydrolysis of hydrolysable COD and the utilization of rbCOD. Heterotrophic bacteria can improve the influent wastewater quality by changing the ratio of hydrolysable COD to rbCOD, and can reduce the influent loads to the WWTP though microbial metabolisms described earlier. This increase in the rbCOD fraction can further enhance the nitrogen (N) and the phosphorus (P) removal in the WWTP.

Sewer Collection System Bioaugmentation

The existing sewer system can be employed as a biological reactor to enhance the microbiology before entering to the WWTP through external bioaugmentation. It is demonstrated in previous studies that a 23.1 km gravity collection system contains as much as 9,500 m^2 (1.7×10^4 m^2/MGD) wetted biofilm surface area, which is equivalent to a 105 m^3 stone-filled trickling filter reactor. Also, since 99.9% of the fecal bacteria are strict anaerobes and possess slower metabolic activity, the improvement of the microbiology in the sewer can cause significant changes in the ratio of hydrolysable COD to rbCOD and the reduction of influent loads to the WWTP.

To enhance the microbial activity in the sewer collection system and to provide enhanced microbiology to the WWTP, In-Pipe Technology (IPT) employs the sewer collection system as an integral part of the wastewater treatment system and uses the collection system as a biological reactor. The IPT bioaugmentation process consists of the automatic continual addition (twenty-four hours per day, seven days per week) of high concentrations of naturally occurring, nonpathogenic, facultative *Bacillus* soil bacteria at multiple points (i.e., manholes, lift stations) within the collection system in order to:

- grow beneficial bacteria in the biofilm throughout the surface of the sewer pipes and thereby enhance the sewer biofilm activity with beneficial bacteria;
- improve the ability of the sewer biofilm and bulk phase bacteria to improve the wastewater quality through hydrolysis of the slowly biodegradable COD to rbCOD and/or reduce the load to the WWTP by consuming rbCOD through respiration or fermentation;
- take advantage of the retention time of the wastewater within the sewer pipes allowing the added bacteria additional time to degrade the waste;
- and continuously supply vegetative beneficial bacteria to the WWTP to improve operational efficiencies.

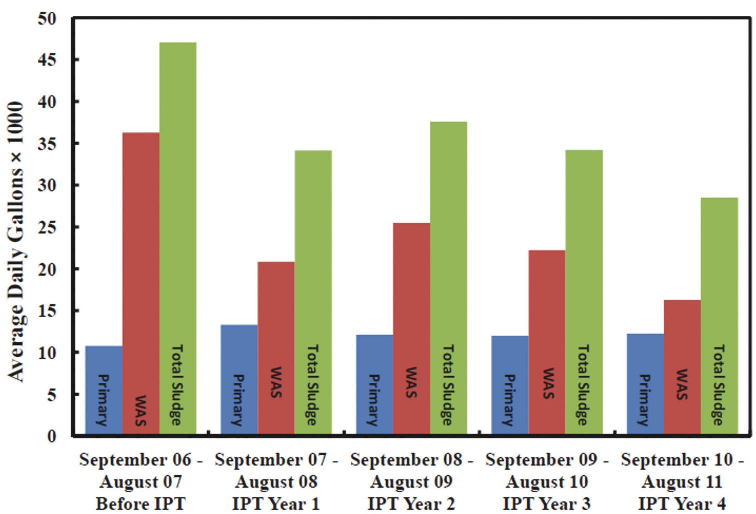


Figure 2: Production of primary sludge and WAS from the WWTP.

Collection System Bioaugmentation Case Study

Prior to 2007, The City of Crown Point, IN, was planning a $1.5 million expansion to add an anaerobic digester and expand the sludge residuals storage facility. The city selected a sewer collection system bioaugmentation to improve the WWTP operation efficiencies (i.e., reduce energy consumption, reduce chemical use, and reduce sludge production), enabling the City of Crown Point to forestall the $1.5 million in capital improvements required to increase sludge digestion and solids storage capacity. Additional city goals were to improve the condition of the collection system by eliminating FOG from the lift station wet wells and reduce system odors.

Approach

The City of Crown Point wastewater treatment process is an extended aeration activated sludge process with a rated capacity of 5.2 MGD and a peak flow capacity of more than 9 MGD. The wastewater average daily flow rate to the WWTP is ~4.0 MGD. The wastewater collection system in the city comprises gravity sewers, long gravity interceptors, and force mains feeding the WWTP. Twenty three G2 dosing units have been installed in the Crown Point sewer collection system at strategic locations. Each G2 panel holds a one liter replaceable reservoir with a 30-day supply of microbes. The G2 panel dispenses a preset volume of microbial formula per day on regular time intervals. The microbial formula contains the proper blend of *Bacillus* bacteria to establish a beneficial sewer biofilm, digest and remove FOG deposits, and inhibit sulfate reducing bacteria (SRB) in the collection system while improving treatment performance at the plant.

Performance Analysis With Collection System Bioaugmentation

Aeration Energy Savings — The average daily influent CBOD load to the WWTP reduced approximately 12% to 15% with treatment. The influent ammonia-nitrogen (NH3-N) load decreased by ~45% to 50%. The influent NH3-N and CBOD loadings to the WWTP determine the amount of air that must be delivered into the activated sludge system to facilitate oxidation of these two pollutants. The WWTP is running with a 50% reduction in aeration energy consumption since implementation began due to the reduction in influent CBOD and NH3-N loads and the presence of improved IPT microbiology in the biological processes. As a result, the WWTP is capable of running biological processes by turning off half of the blowers, which reduces the monthly aeration energy costs approximately $6,850.

Sludge Production — Figure 2 (prior page) shows the reductions in total sludge production (primary sludge + waste activated sludge [WAS]) in each year since beginning treatment.

The WWTP also produced less WAS with the bioaugmentation process. Prior to treatment, the WWTP produced ~595,000 dry pounds of WAS per year. During the same seasonal period, (September to August), the activated sludge system produced ~346,000 dry pounds of WAS per year. During the first 12 months, the activated sludge process produced ~42% less WAS. Similar reductions in WAS production for the years 2009, 2010, and 2011 were also observed with continued IPT treatment.

Other Operational Savings — Besides the reduction in costs associated with sludge and aeration energy, a reduction in the amount of manpower needed for operation and maintenance throughout the WWTP was observed. Specifically, the amount of manpower required for cleaning the overflow weirs and effluent channels in the clarifiers is reduced, along with the overtime labor that was required for operating the sludge press. Further, the stormwater pond cleanings (required after each storm event when they are utilized) has consistently taken fewer man hours to clean per year. The improvement in effluent TSS now allows the WWTP to utilize secondary effluent for non-potable utility water, saving 50,000 gallons per day of city water, totaling $60,720 annually. The collection system has been maintained in good condition with no odor complaints logged. Combined sewer overflows (CSOs) have been reduced 92% due to FOG elimination in the collection system. Return activated sludge (RAS) flow dropped by 29% saving $1,000/month. Additionally, the plant has maintained superior effluent water quality of 1.4 mg/L BOD, 1.5 mg/L TSS, and less than 1.0 mg/L ammonia.

Conclusion

Using sewer collection system bioaugmentation technology to enhance the microbial activity in the collection system and the WWTP is a proven technology to overcome the challenges associated with age-old biological treatment processes, and improve the performance of WWTPs without capital expansion. ■

Dr. Bulbul Ahmed serves In-Pipe Technology as research and development manager. His research interests include biofilms, biological wastewater treatment, waste to energy conversions, and bacterial metabolisms. Dr. Ahmed has authored one book chapter, peer reviewed journals, conference papers, and magazine articles. Dr. Ahmed is affiliated with WEF and CS-WEA professional organizations.

Andrew Newbold serves In-Pipe Technology as project engineer. With more than seven years experience in the water treatment industry, Mr. Newbold manages the application and implementation of In-Pipe's service, provides technical assistance, and provides application engineering and technical advice.

Rich Schici serves In-Pipe Technology as senior engineering manager. With more than 10 years experience in the wastewater and water sectors, including process modeling and treatment plant design, Mr. Schici is a high-level technical resource. He is affiliated with seven different environmental agencies including WEF, WERF, and Central States WEA.

Land Application Of Treated Wastewater Tackles Touchy Challenge

Total maximum daily load (TMDL) is solved with out-of-the-box (and off-site) thinking.

by Steve Werblow

Faced with drastic state-mandated cuts in the amount of phosphorus, nitrogen, and warm water that could be discharged into the southern Oregon's South Umpqua River, the Roseburg Urban Sanitary Authority (RUSA) decided to think big about how to modify its wastewater treatment plans — to the tune of 340 acres.

The South Umpqua flows through Roseburg, OR. It's a popular fly fishing river renowned for its salmon, steelhead, and trout. In fact, the Umpqua system is home to more wild coho salmon spawners than any other river system in Oregon — 15% of the coho salmon that spawn along the West Coast.

Jim Baird, RUSA's engineering and operations manager, inspects the pump station regularly.

That remarkable fishery put the South Umpqua squarely in the sights of state Department of Environmental Quality officials. Under the Clean Water Act, states are required to conduct water quality assessments of every water body within their borders. Those found to have excessive levels of pollutants — which could range from chemicals to bacteria, sediment, or temperatures high enough to interfere with fish reproduction and survival — must undergo the total maximum daily load (TMDL) writing process. Working with water quality data, a suite of best management practices, and negotiations involving the stakeholders within the watershed, the TMDL process assesses the pollution load and assigns the burdens of reducing it among the stakeholders.

In the reach of the South Umpqua that runs through Roseburg, the TMDL dictated reductions in phosphorus, temperature, and algae (which in turn is tied to target levels of dissolved oxygen, pH, and chlorophyll). The pollutants are tied together, as high levels of nutrients feed massive algal blooms, which play havoc with oxygen levels and biological oxygen demand (BOD) in the river as the algae thrive, respire, die, and decompose. Elevated water temperatures are also a danger to cold-water fish, whose spawning success and juvenile survival rate suffer as water temperatures rise.

In the case of the South Umpqua Basin, the U.S. Geological Survey and Douglas County determined that five wastewater treatment plants contribute less than 15% of the river's flow, but more than 90% of the nitrogen and phosphorus load during the low-streamflow months of summer. That meant that achieving target reductions would fall squarely on the shoulders of RUSA and neighboring wastewater treatment plants.

Expensive Proposition

To management at RUSA, bringing its 7.9 million gallon per day (MGD) wastewater treatment plant into compliance with the TMDL was shaping up to be an expensive proposition.

"There are a couple of different ways you could deal with it," notes Jim Baird, RUSA's engineering and operations manager. "A mechanical and filtration system are most common, but with both up-front costs and energy costs over time, it's expensive."

In fact, engineers at CH2M Hill evaluated a similar problem in Spokane, WA and estimated that upgrading to a membrane bioreactor system similar to the alternative Spokane selected would cost RUSA $80 to $100 million.

RUSA management and CH2M Hill took a look outside the box, beyond the footprint of the wastewater treatment plant. Keeping the water out of the South Umpqua promised to be cheaper than treating it thoroughly enough to discharge into the river. The team explored a wide variety of options to receive treated wastewater, including a golf course (which wouldn't have taken enough water), a poplar pulpwood plantation (which would have required too much land), and landscaping at highway interchanges.

It turns out the answer was just over the next hill.

Cost-Effective Solution

Back in the late 1990s and early 2000s, the utility had purchased 340 acres of ranchland in a canyon a little over a quarter mile from the wastewater treatment facility, figuring it could either serve someday as a place to spread treated biosolids, a site to receive treated wastewater, or a sound real estate investment whose sale could fund future plant improvements.

As it turns out, notes Mark Madison, CH2M Hill's senior principal technologist in natural treatment systems and agricultural sciences, the ranchland "has nearly perfect conditions" to receive treated wastewater and capture most of its nutrient load. Fertile topsoil is great for the plants that suck up about one-third of the water and consume most of the nitrogen, potassium, and micronutrients in the effluent, as well as a significant amount of phosphorus, he explains. Below that, a layer rich in clay bonds tightly with phosphorus at a molecular level, making it permanently insoluble. Deeper in the soil profile, weathered basalt ages into a constant supply of new phosphorus-binding clay. Farther down, just above bedrock, fractures in buried basalt form channels that draw water down into the canyon to feed wetlands, springs, and a stream called Sylman Creek, which in turn runs to the South Umpqua.

Heavy irrigation gives the plant community all the water it needs to thrive, and then pushes excess water into the soil and causes it to flow underground toward Sylman Creek. To farmers, it would be wasteful. To the ecosystem, it's luxurious.

"In rough numbers, one-third of the water flows through the soil, and then surfaces in springs that feed restored wetland plants before discharging to Sylman Creek," explains Baird. "One-third of the water will be used by plants, and one-third of the water over time will find its way to the creek and river in subsurface flow. At some rates, it will go into the ground this summer and go out next year."

That's a boon to the river, which runs low in the summer, notes Ron Thames, RUSA general manager.

"Normally, when you're taking your discharge out of the river, the river never gets it back," he points out. "We want to put as much polished water as we can back in to augment the river's low summer flows."

The combination of constructed wetlands, upland plantings, conveyance, and filtration and irrigation systems totaled $9 million — about one-tenth the cost of the mechanical treatment option. The operating expense is about $2 million per year, about one-third the projected cost of running a mechanical treatment system, says Thames.

RUSA drew from capital reserves and secured a 10-year loan from the state's Infrastructure Financing Authority to fund the project. Even after raising monthly sewer fees to $25 per single-family home to pay off the loan, RUSA is still the least expensive wastewater treatment provider in the area by nearly one-third, Thames notes proudly.

Integrated System

Between May 1 and October 31 — months of low streamflow in the river — RUSA is required to route its wastewater through its new system.

After two stages of clarification and chlorination, effluent is pumped to the canyon using 50- and 100-horsepower pumps with variable frequency drives. It emerges through an upwelling energy dissipater aeration fountain into a constructed wetland, where cattails, rushes, sedge, and algae begin drawing out phosphorus and nitrogen.

The water flows several hundred feet through dense stands of wetland plants that continue sucking out excess nutrients. A long, curved channel gently slopes around a pond large enough to hold up to two days' worth of treated water. The channel directs the flow to the far end of the complex, introducing it to the pond after it's had a chance to build up enough momentum to maintain a circular flow. That prevents stagnation and limits the buildup of algae on the pond surface, notes Baird.

As the irrigation system's 500-hp high-zone turbine or one of its 250-hp low-zone pumps kicks on, water is drawn through a coarse, steel intake screen to one of three Amiad EBS automatic self cleaning filters, each equipped with a 130-micron, stainless steel, weave-wire screen to protect the drip emitters and microsprinkler heads of the irrigation system from clogging.

When a target pressure differential is reached between the dirty and clean sides of the screen, the EBS's automatic self-cleaning cycle is engaged. An exhaust valve is opened to atmospheric pressure. Higher pressure inside the filter housing pulls water and filter cake — the dense mass of trapped solids — into a set of suction nozzles connected to the exhaust valve. The nozzles concentrate the high-velocity cleaning action on about one square inch of screen at a time, rotating on a scanning armature to clean the entire screen in a 35-second cycle without interrupting filtration.

A community of sedges, rushes, and cattails draws nutrients from treated effluent in RUSA's constructed wetland.

The suction scanning process minimizes back flush water, generally to less than one percent of total flow. Back flush water at the Roseburg project is piped back to the head of the constructed wetland for further treatment and settling.

One of the key benefits of the Amiad filters, notes Madison at CH2M Hill, is that they could be specified to perfectly match the flow capacity and level of filtration required for the program.

"We have spec'd Amiad filters on many other projects for drip irrigation and wastewater reuse," Madison adds. "The filters are rugged and reliable, and the support network of dealers and suppliers is vast and supportive, so a project that must perform every day is not waiting for parts and support."

Past the filters, the water tracks through a manifold system of 8, 10, 14 and 16-inch lines to feed the various irrigation zones throughout the canyon. Governed by a PLC SCADA network tied back to the plant by fiber optic cable, valves open slowly and pumps spin up deliberately to minimize hammer and pipe movement.

Water is delivered to the well-balanced mix of vegetation — and the soil beneath it — through drip emitters and microsprinklers. The plants are growing steadily, and by 2013, when they're considered large enough to be drawing their full share of phosphorus and nitrogen from the treated water, RUSA's system will be fully on-line. However, the vegetation got a great head start — even before the regulatory deadline, the natural treatment system was already treating water to a higher level than required.

Thames points out that the land-application system isn't about disposal — it's a fully functioning effluent polishing system.

"We're not putting bad stuff in the ground and hoping it goes away — we're adding nutrients to the soil, making it even better," he says. "We see this project as a win-win. We're letting Mother Nature help us out. We're providing soil amendments to nutrient-deficient ground, and we're putting polished water back into the river that's better than the river water itself."

Blazing A New Trail

The RUSA project blazed a new trail by combining mechanical treatment, land application, and constructed wetlands to address the South Umpqua TMDL. That made for some challenges in securing regulatory approvals, notes Madison.

"The regulators understand the technologies and have confidence in the treatment performance and wanted to allow the project to be built — it just didn't fit the process for permit writing," he explains. "With support from all levels of DEQ and other regulatory agencies, the innovative process finally got an innovative approval to proceed."

"The regulators now have some very successful examples to use as guidance to make permitting similar facilities quicker and easier," Madison adds.

That's good news for future projects like the RUSA one — a future Madison says is likely to include more of these systems that combine natural and mechanical treatment for both financial and public relations reasons.

"The initial capital cost and long-term maintenance cost of natural treatment systems can be much lower than a purely mechanical process," he points out. "The public is very supportive of green infrastructure and sustainability, which are the hallmarks of natural treatment."

No Blinders

"Probably what we're doing here doesn't fit everybody, but it fits us real well," Thames adds, noting that other wastewater utilities can seek a wide variety of solutions to address challenges — like TMDLs, which are being written for thousands of rivers, streams, and lakes across America. "The main thing is not to have blinders on. All sorts of things are possible. You just have to think 'what actually fits for the area?'"

"At the end of the day," he says, "we see this project as a win-win." ■

Steve Werblow is a freelance writer/photographer who covers water, agriculture, and industry from Ashland, OR. A graduate of the Cornell University College of Agriculture and Life Sciences, Steve has researched and shot articles on six continents. He worked with Amiad Water Systems to develop this article.

City of Centralia, WA

North Tahoe PUD, NV

Mabel Bassett Correctional, OK

ROTAMIX®

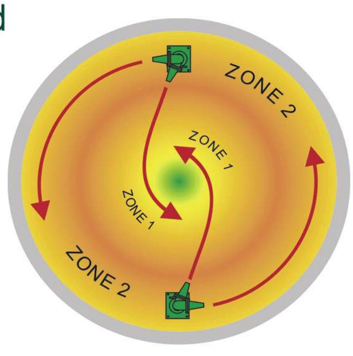
PROCESS MIXING SYSTEM

With over 750 worldwide installations Vaughan's Rotamix System is today's most cost effective means of mechanical hydraulic mixing, consisting of an engineered arrangement of floor mounted nozzles fed by a Vaughan Chopper Pump.

APPLICATIONS:

Anaerobic Digesters
Sludge Storage
Sludge Blend
TWAS
Biosolids
Anoxic Zones
Acid Phase
Equalization Basins
Influent Channels
Pump Stations
CSO Tunnels
FOG Reception
Septage Receiving

- Over 50 years of expertise in every pump
- Reliable chopping action reduces solid size
- Reduced power options available
- Oversized shafting and bearings extend pump life
- Conditioning of solids increases surface contact and enhances volatile solids destruction



Dual-rotational zone mixing

- Offered in single and double nozzle configurations
- Designed for permanent fixed installation (no moving parts in the tank)
- Glass lined nozzle barrels protect against effects of abrasion and corrosion
- Mixing assemblies include a 10 year full warranty

Vaughan®

QUALITY CHOPPER PUMPS SINCE 1960.

phone: (360) 249-4042 FAX: (360) 249-6155
email: info@chopperpumps.com web: www.chopperpumps.com

An Evaluation Of Low-Energy Treatment Schemes For Water Reuse

Carollo Engineers led a team of researchers to determine which of the latest technologies for reclaimed water is most effective and most ready for market.

by Erin Mackey and Andrew Salveson

The production of reclaimed water from municipal wastewater is now standard practice and almost universally accomplished using primary treatment (discretionary), secondary treatment with activated sludge, filtration, and disinfection with chlorine, sodium hypochlorite, or ultraviolet light (UV) disinfection. Sludge produced by liquid treatment is often stabilized with aerobic digestion. These conventional processes are energy-intensive. Lower-energy treatment alternatives exist in varying degrees of "market readiness." Collectively, these represent part of the future of wastewater and reclaimed water treatment.

There are a number of different process schemes and technologies that can meet the "lower-energy" reuse label, ranging from anaerobic membrane bioreactors to aerobic forward osmosis membrane bioreactors, to non-biological treatment and nutrient and energy-recovery systems, among many others. WateReuse Research Foundation (WRRF) project 10-06, cosponsored by the Water Environment Research Foundation (WERF), represents part of the initial effort (Phase I) to find and demonstrate the low energy treatment plant of the future.

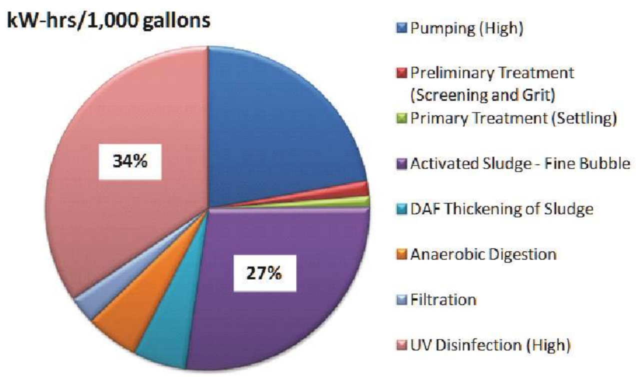


Figure 1. Relative energy use at a WWTP — Assumption of high energy use for pumping and disinfection (adapted from WEF 2009, EPRI 2002, and internal operational databases).

Project Objectives

WRRF 10-06 had two main objectives:

- Identify emerging low-energy treatment technologies, ranging from alternatives to existing treatment processes to innovations in energy recovery systems.
- Evaluate the market readiness of these new ideas and products to identify the most promising ideas to bring forward for Phase II testing. These ideas would have the highest potential to save energy and cost and would be close to being ready for use at full-scale.

Work Summary

Step 1: Establishing A Baseline — The first step identified an energy baseline against which new low-energy approaches could be compared. The baseline energy tabulations were segregated into wastewater treatment plants (WWTPs) with "high" and "low" relative energy use. The high power demand WWTPs saw the largest power uses for pumping, activated sludge aeration, and disinfection (16%, 27%, and 34%, respectively). See Figure 1 for more detail. The same was true for WWTPs with lower relative power demands (22%, 38%, and 25% for pumping, activated sludge aeration, and disinfection, respectively). In either situation, energy use at a WWTP is dominated by pumping, activated sludge aeration, and disinfection. Both ultraviolet light (UV) and sodium hypochlorite use a similar amount of energy once the energy required to generate sodium hypochlorite is accounted for (see Figure 2 on page 24). Pumping energy was not a focus of this project and so was not pursued further.

Since the largest energy use is in the secondary and disinfection processes, improvement of these processes would yield the largest gain in energy efficiency. This work focused on documenting ways to decrease energy use in the secondary and disinfection process and on ways to increase methane gas generation and thus increase energy recovery. Table 1 on page 24 summarizes these three key energy components for different wastewater qualities for a "benchmark"/"baseline" plant treating approximately 12 – 15 mgd.

Step 2: Identifying New Low-Energy Technologies — In advance of a workshop, project team members assembled a list of technologies to be reviewed and considered for the workshop. This list included both proprietary and nonproprietary technologies. Many of these technologies were well proven, while almost an equal number were in the early phases of development and without peer-reviewed data. Below is a description of the considered technologies. A few of the technologies are common and are not associated with a brand name, while other technologies have specific proprietary properties and are associated with a particular brand. Inclusion of brand names is not an endorsement.

Primary treatment technologies:
- M2 Renewables' MicroScreen
- Salsnes Filter
- Chemically enhanced primary treatment (CEPT)
- Veolia's Actiflo™ enhanced high rate clarification (EHRC)

Secondary treatment technologies:
- Shortcut nitrification denitrification (Severn Trent Services using its deep bed filter system)
- Severn Trent Services' TETRA Denite system
- Anaerobic ammonium oxidation (Anammox)
- Upflow Anaerobic Sludge Blanket (UASB)/Expanded Granular Sludge Bed (EGSB)
- Aerobic granular sludge (e.g., the Nereda Process)
- Biologically active filtration
- Anaerobic membrane bioreactor with and without granular activated carbon
- Grundfos' Biobooster (Ceramic MBR) — Low SRT MBR with physical membrane scouring
- Emefcy's Spiral Aerobic Bioreactor (SABRE)
- Emefcy's Electrogenic Bioreactor (EBR)
- High efficiency blowers (e.g., APG-Neuros's Turbo Blower).
- American Water's NPXPress.
- Noram Engineering's Vertreat Process

Tertiary filtration technologies:
- Water Tectonic's Electro-coagulation and Filtration
- Parkson DynaSand Ecowash
- Schreiber's Fuzzy Filter

Tertiary disinfection technologies
- Pasteurization Technology Group's Pasteurization System
- Aquionics/Dot Metrics LED UV disinfection

Energy recovery technologies
- M2 Renewables Ultra High Temperature Gasification
- OpenCel Focused-Pulsed Technology
- Thermal Hydrolysis (e.g., Cambi Process)
- Fuel Cell Energy's Fuel Cell.
- Supercritical wet oxidation (e.g., SCFI's AquaCritox)

Combined treatment trains
Several combined treatment trains were also considered. These systems were often propriety packaged systems or were closely linked and reliant upon each process.
- CEPT + microfiltration (MF) + BAF
- CEPT + IMANS
- Great Circle Industries' i50 non-biological satellite treatment.
- M2 Renewables — MicroScreen, BAF, filtration, disinfection.
- UASB, facultative ponds, nitrifying trickling filters, filtration, disinfection

Step 3: Recommendations — The technologies were sorted into three groups: established systems (proven and in practice), emerging systems (partially proven, limited full-scale application), and innovative concepts (new ideas that show promise). Key treatment technologies from the emerging treatment systems category recommended to be carried forward for Phase II research included: anaerobic MBR and full-stream anammox process. A few other processes were also recommended for testing. These processes are:

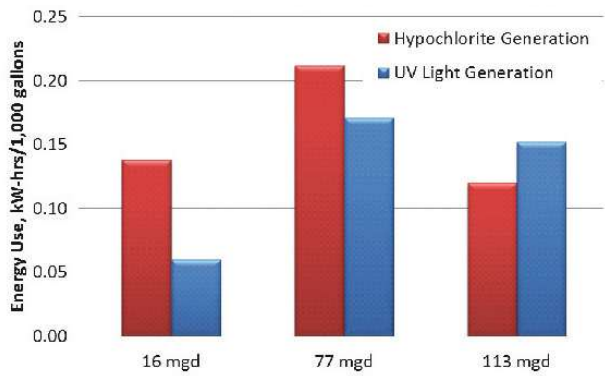


Figure 2. Planning-level comparison of energy use for UV disinfection compared to hypochlorite generation (Kansas City 2008, Dallas Water Utilities 2010). *[Note: This is a comparative figure only, as disinfection for these projects were not to reuse standards.]*

Anaerobic MBR

The anaerobic MBR has now been proven as an effective treatment process by different research groups and with variations of the MBR technology. Kim et al. (2011) used a fluidized bed MBR with GAC to produce a high quality effluent (5 mg/L BOD and zero TSS) with minimal membrane fouling. The same research estimated a decrease in secondary process energy use of ~50% and estimated an increase of methane production of 75%. While promising, this research was done on a very small scale, in a warm climate, used synthetic wastewater, and did not address long-term membrane fouling concerns.

Researchers at the University of Michigan[12] have been conducting anaerobic MBR research with the testing of a small-scale reactor (5L) on both synthetic wastewater and municipal wastewater at temperatures as low as 15°C. This work was done without the GAC scouring, instead relying upon biogas sparging to minimize membrane fouling. For the municipal wastewater work, effluent BOD of less than 30 mg/L was achieved for extended periods of time.

The proposed next step for the anaerobic MBR is to build on this research by designing and operating a larger-scale system to analyze the ability to meet stringent reclaimed water standards with subsequent disinfection. This larger system would be fully automated and use full-scale components.

Full-Stream Anammox

The anammox process is applied as a side-stream treatment system on digested sludge returns or waste streams with high ammonia and low carbon contents[3]. Since the anammox process requires approximately equal parts of ammonium and nitrite, it is often implemented as a nitritation-anammox, or deammonification, process in series to accumulate nitrite for use by the anammox bacteria as the electron acceptor[3]. If the anammox is preceded by nitrification, only part of the ammonia needs to be nitrified to nitrite, which helps to reduce cost compared to nitrifying all of the ammonia[6].

There are advantages to using the anammox process over conventional nitrification-denitrification processes for removal of nitrogen from high ammonium content waste streams. For one, nitritation-anammox requires 57% less oxygen and 86% less carbon than conventional nitrification-denitrification. In addition, it is completely autotrophic so nutrients and trace elements are not required. The low biomass yield means low sludge production. External carbon addition is not required and methanol is even toxic to the anammox bacteria. Energy costs are also low because oxygen is not required for the anammox process and only limited oxygen is required for the partial nitritation[3], i.e., aeration is not required. The anammox process also has disadvantages. A pre-partial nitritation is required for converting part of the ammonia stream into nitrite prior to the anammox process[1]. Anammox bacteria also have a slow growth rate with a doubling time of 11 days at 32-33°C[9]. This has the benefit of a low biomass yield but requires efficient sludge retention (long SRT) and means long start-up times to get sufficient biomass concentrations[4]. Conditions for anammox accumulation include long SRTs, stable operation, presence of nitrite, lack of oxygen, and lack of donors causing denitrification of nitrite[8]. The competition between anammox bacteria and other denitrifiers makes the start-up process difficult because denitrification is a faster process. This becomes a bigger problem when carbon is present[1].

The predominant application for anammox processes has been for treatment of digester reject water or industrial anaerobic wastewater treatment in streams that have limited organic carbon content[13]. However, the application could

Treatment Level	Energy (kW-hrs/1,000 gallons)		
	Secondary Process	UV	Energy Recovery
Activated Sludge	-0.50	-0.50	+0.72
Activated Sludge With Nitrification	-0.90	-0.26	+0.65
MBR With Nitrification	-1.20	-0.21	+0.60

Table 1. Approximate energy use/energy generation for select processes at a WWTP when treating a flow of 12-15 mgd. *[Notes: Energy use for UV is reduced compared to other secondary processes due to increase water quality and reduced regulated dose. Secondary Process: Energy values are strongly correlated to process SRT, aeration efficiency, and nutrient removal. Energy Recovery: Not normally done for plants smaller than 8-10 mgd because of economic considerations. The different energy recoveries shown for the listed treatment levels are due to different biodegradable fractions of the waste activated sludge resulting from different sludge ages.*

be extended to mainstream municipal sewage treatment if anammox can be applied at lower temperatures and lower nitrogen concentrations[4]. A recent laboratory-scal study[13] applies anammox bacteria in mainstream wastewater treatment. A granular sludge sequencing batch reactor (SBR) mixed ammonium and acetate at a COD:N ratio of 0.5 (so heterotrophs do not out compete the anammox bacteria) using nitrate from the previous SBR cycle at 18°C. The work from Winkler et al. and other results from current research conducted by Hampton Roads Sanitation District and DC Water can serve as the baseline for a Phase II anammox analysis. Because of the significant advantage of this process, it would bring major energy-savings benefits to the industry. The current plan is to implement anammox at demonstration-scale on the effluent of the anaerobic MBR.

Pasteurization

The pasteurization process is at demonstration scale (400 gpm) to disinfect filtered secondary effluent cost effectively to reclaimed water standards[10]. The unit is fully automated, with online monitoring of temperature, energy use, and control. The demonstration unit is anticipated to run into 2013.

Other Technologies

Several gasification processes are in operation nationally and internationally. These processes claim large net energy gains, though little to no peer-reviewed analysis has been conducted. Audits of one or more facilities is recommended.

The electrocoagulation process has the potential for energy efficient coagulation/filtration/disinfection to meet stringent reclaimed water standards. Limited bench scale testing of electrocoagulation of conventional secondary effluent and of anaerobic MBR and anammox effluent is recommended.

Aerobic biofilm reactors for secondary treatment show promise; the SABRE process will be installed at a demonstration-scale in late 2012 or early 2013. An audit of this facility is recommended. ■

Co-Principal Investigators
Julian Sandino, CH2MHill; Jean Debroux, Kennedy/Jenks Consultants

Contributing Parties
Nicola Fontaine, Carollo Engineers, Inc.; Rudy Killian, Carollo Engineers, Inc.; Rod Reardon, Carollo Engineers, Inc.; Perry McCarty, Consultant; Laura Shenkar, The Artemis Project; Paul O'Callaghan, O2 Environmental

Project Advisory Committee
Lauren Fillmore, Water Environment Research Foundation; Charles Bott, Hampton Roads Sanitation District; Miguel Rocha, United States Bureau of Reclamation; Paul Westerhoff, Arizona State University

References

1. Ahn, Y.-H. "Sustainable Nitrogen Elimination Biotechnologies: A Review." Process Biochemistry 2006, 41, 1709-1721. Electric Power Research Institute (EPRI). 2002. Water & Sustainability (Volume 4): U.S. Electricity Consumption for Water Supply & Treatment. Topical Report, 2002, 3-3 to 3-4.
2. Dallas Water Utilities Texas. Dallas Water Utilities Wastewater Treatment Facilities Strategic Plan, 2010.
3. Gustavsson, D. J. I. "Biological Sludge Liquor Treatment at Municipal Wastewater Treatment Plants - A Review." VATTEN 2010, 66, 179-192.
4. Jetten, M. S. M., Wagner, M., Fuerst, J., van Loosdrecht, M. C. M., Kuenen, J. G., and Strous, M. "Microbiology and Application of the Anaerobic Ammonium Oxidation ('ANAMMOX') Process." Current Opinion in Biotechnology 2001, 12(2), 283-288.
5. Kansas City, Missouri. Preliminary Technology Assessment for Effluent Disinfection for Six Kansas City WWTPs, 2008.
6. Khin, T., and Annachhatre, A. P. "Novel Microbial Nitrogen Removal Processes." Biotechnology Advances 2004, 22, 519-532.
7. Kim, J., Kim, K., Ye, H., Lee, E., Shin, C., McCarty, P., and Bae, J. Anaerobic Fluidized Bed Membrane Bioreactor for Wastewater Treatment. Envinron. Sci. Technol. 2011, 45, 576-581.
8. Rittmann, B. E., and McCarty, P. L. Environmental Biotechnology: Principles and Applications, McGraw-Hill, New York, 2001.
9. Strous, M., Heijnen, J. J., Kuenen, J. G., and Jetten, M. S. M. "The Sequencing Batch Reactor as a Powerful Tool for the Study of Slowly Growing Anaerobic Ammonium-Oxidizing Microorganisms." Applied Microbiology and Biotechnology 1998, 50(5), 589-596.
10. Salveson, A., Goel, N., & Ryan, G. Pasteurization, Not Just for Milk Anymore. Pasteurization for disinfection of wastewater and reclaimed water. Water Environment and Technology 2011, 23(3), 43-45.
11. WEF. Energy Conservation in Water and Wastewater Facilities. Water Environmment Federation: Richmond, 2009.
12. WERF. Anaerobic Membrane Bioreactors for Sustainable Wastewater Treatment. (WERF Project U4R08). Water Environmment Research Federation: Alexandria, VA, 2012.
13. Winkler, M.-K. H., Kleerebezem, R., and van Loosdrecht, M. C. M. "Integration of Anammox into the Aerobic Granular Sludge Process for Main Stream Wastewater Treatment at Ambient Temperatures." Water Research 2012, 46, 136-144.

Andrew Salveson is Carollo's Water Reuse Chief Technologist and an Associate Vice President. Mr. Salveson oversees advanced treatment technology planning, design, and research. Andrew was awarded the WateReuse Association's Person of the Year Award for 2007.

Erin Mackey is a lead technologist and project manager at Carollo. Dr. Mackey specializes in advanced treatment and regulatory compliance for drinking water and water reuse.

Trace Organic Compounds: What Goes In Must Come Out

Chemically enhanced high rate settling (CEHRS) shows promise in removing harmful compounds such as pharmaceuticals and consumer products from wastewater.

by Daniel Austria Jr.

A recent research project involved the pilot testing of a chemically enhanced high rate settling (CEHRS) process for removal of selected trace organic compounds (TOrCs). This article is a summary of those piloting efforts.

Increasing amounts of TOrCs at wastewater treatment plants (WWTPs) around the world is a phenomenon that has been occurring for some time now. Some examples of these compounds are consumer products (surfactants, caffeine), pharmaceuticals (drugs, hormones), pesticides (DEET), and volatile organics (flame retardants, household cleaning products). Many of these compounds are the result of every day human activities; this is especially true in developed consumer-based societies where environmentally conscious living has become secondary to keeping up with social status standards. These compounds can be harmful not only to humans but to the entire ecosystem. It is still not completely known how the compounds' presence will affect the environment long term, as current data is limited, but they are generally labeled a health risk by many experts. Research is continually being done to gauge the ability of water treatment technologies to remove such compounds from municipal water treatment plants (WTPs) and WWTPs.

Current literature demonstrates that generally the majority of TOrC removal at WWTPs can be attributed to the typical biological secondary treatment of an activated sludge process (ASP). With activated sludge, the WWTP can fine tune treatment by controlling the balance of new treatment organisms that grow to replace those that die and are wasted. A WWTP can operate a CEHRS process that utilizes "fresh" powdered activated carbon (PAC) and "used" PAC in a similar fashion. With proper PAC addition/recirculation/wasting, a WWTP can control the amount of time PAC is used/recycled to ensure full utilization of its adsorptive capacity. A system that can take full advantage of the inherent efficient adsorption capacity of PAC would potentially see significant removals of TOrCs.

Typical CEHRS Process Review

A general process overview of a CEHRS process (see Figure 1) is: raw water enters the CEHRS system in the first flash mix tank (coagulation tank). Here, chemical coagulant is added and thoroughly mixed to destabilize suspended solids and colloidal matter. The flow then enters the second tank (maturation tank) where flocculant aid polymer and microsand are added. In the maturation tank, relatively milder mixing provides ideal conditions for the formation of polymer bridges between the microsand and the destabilized suspended solids. The turbomix draft tube produces effective dynamic mixing to ensure that a very dense floc is formed; the fully formed ballasted flocs leave the maturation tank and enter the settling tank. It is here where ballasted flocs rapidly settle out and are collected to a center sludge pit. The sludge/microsand slurry is withdrawn from the collection pit using a centrifugal slurry pump where the slurry is then pumped to hydrocyclones for separation. The pumping energy is transferred from pump to hydrocyclone, which acts as a centrifuge causing chemical sludge to be separated from the higher density microsand. Once separated, the microsand is concentrated and discharged from the bottom of the

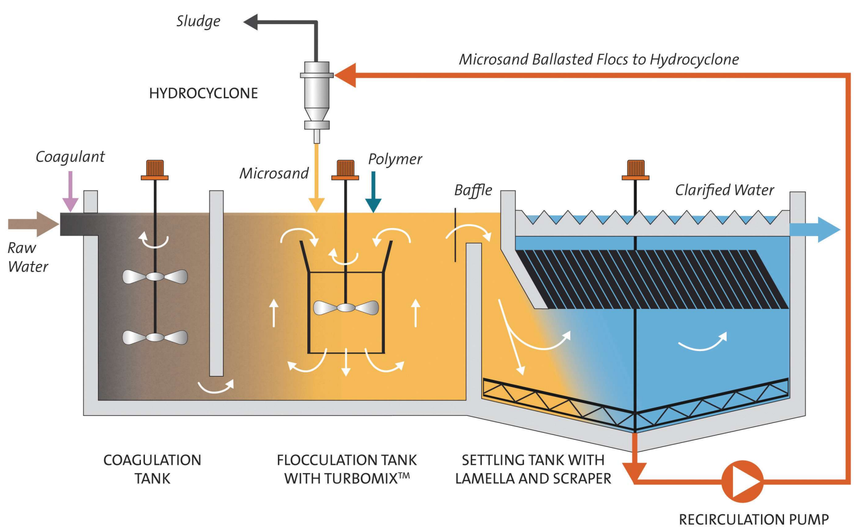


Figure 1: A CEHRS (ACTIFLO®) process schematic. (Image provided by Kruger Inc.)

hydrocyclone and re-injected into the CEHRC process for reuse. The lighter density sludge is discharged out of the top of the hydrocyclone.

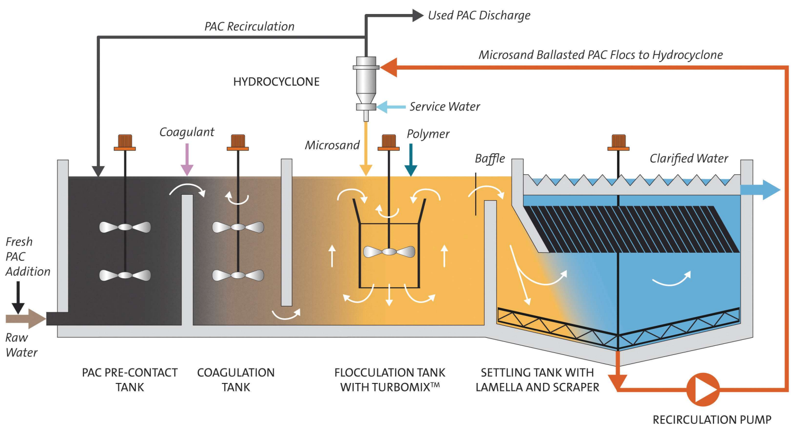


Figure 2: A CEHRS/PAC (ACTIFLO® CARB) process schematic. (Image provided by Kruger Inc.)

CEHRS + PAC Process Review

The CEHRS process can easily be combined with a PAC recycle/contact step to produce a process "offspring" that utilizes the high rate settling of the CEHRS process with the adsorption capabilities of PAC.

A general overview of this CEHRS/PAC process (see Figure 2) is: a PAC contact tank resides directly ahead of the CEHRS process. This tank allows for contact time of raw water with fresh and recycled PAC. A target solids concentration is maintained in this contact tank at a specific residence time. From here, the aforementioned CEHRS process steps occur; instead of the sludge/PAC slurry being wasted immediately, it is recycled back to the PAC contact tank. The PAC tank enables the process to exploit the well documented adsorption properties of PAC. Fresh PAC is added to the raw water stream as it flows into the contact tank with the recycled PAC/Sludge. Contact tank solids are wasted at a rate that keeps the entire solids balance within the CEHRS system in equilibrium and makes the most use of the PAC adsorption sites.

Pilot Program Review

Testing was completed in two phases to capture seasonal variations of test sites. Phase 1 occurred in April 2011 and Phase 2 during July/August 2011. A number of operating parameters were varied and monitored throughout the study although the most relevant parameters for discussion would be the fresh PAC doses and the removals of some TOrCs at those doses.

Wood-based PAC was used throughout the study after pre-pilot screening. The pre-screening demonstrated that the wood-based PAC provided for a good balance of performance and economic feasibility when compared to coconut-based PAC. Ten specific TOrCs were selected to be analyzed for removal efficiencies. These selected compounds in alpha order were: caffeine (stimulant/tracer), carbamazepine (anti-epileptic), diltiazem (anti-hypertensive), diphenhydramine (antihistamine), fluoxetine (antidepressant), naproxen (anti-inflammatory), ofloxacin (antibiotic), sulfamethoxazole (antibiotic), triclosan (biocide), trimethoprim (antibiotic).

Pilot Testing Results

The summary of results can be seen in Table 1-2. This is a general view of what type of removals were achieved with regard to the 10 selected compounds.

PARAMETER	RANGE	UNITS
Raw Water Flow	75 – 95	gpm
System Hydraulic Retention Time	27 – 34	min
Hydraulic Loading Rate	13 – 14	gpm/sf
Ferric Chloride Dose	1.5 – 5.7	mg/L as Fe
Flocculant Aid Polymer Dose (anionic type)	1.5 – 3.8	mg/L
Microsand Concentration in System	14 – 16	g/L

Table 1: CEHRS/PAC operational conditions. (Image provided by Kruger Inc.)

FRESH PAC DOSE	TRACE ORGANIC COMPOUND AVERAGE REMOVALS AT 10 & 20 mg/L PAC									
	Caffeine	Carbamazepine	Diltiazem	Diphenhydramine	Fluoxitine	Naproxen	Ofloxacin	Sulfamethoxazole	Triclosan	Trimethoprim
10 mg/L	44%	68%	89%	81%	52%	42%	69%	54%	90%	87%
20 mg/L	74%	88%	95%	92%	78%	67%	75%	75%	88%	97%

Table 2. CEHRS/PAC pilot TOrC average removals. (Image provided by Kruger Inc.)

Pilot Testing Conclusions

Overall, the average removal of all 10 compounds was nearly 70% at 10 mg/L fresh PAC dose and more than than 80% at 20 mg/L fresh PAC dose. These results generate a few conclusions from the testing:

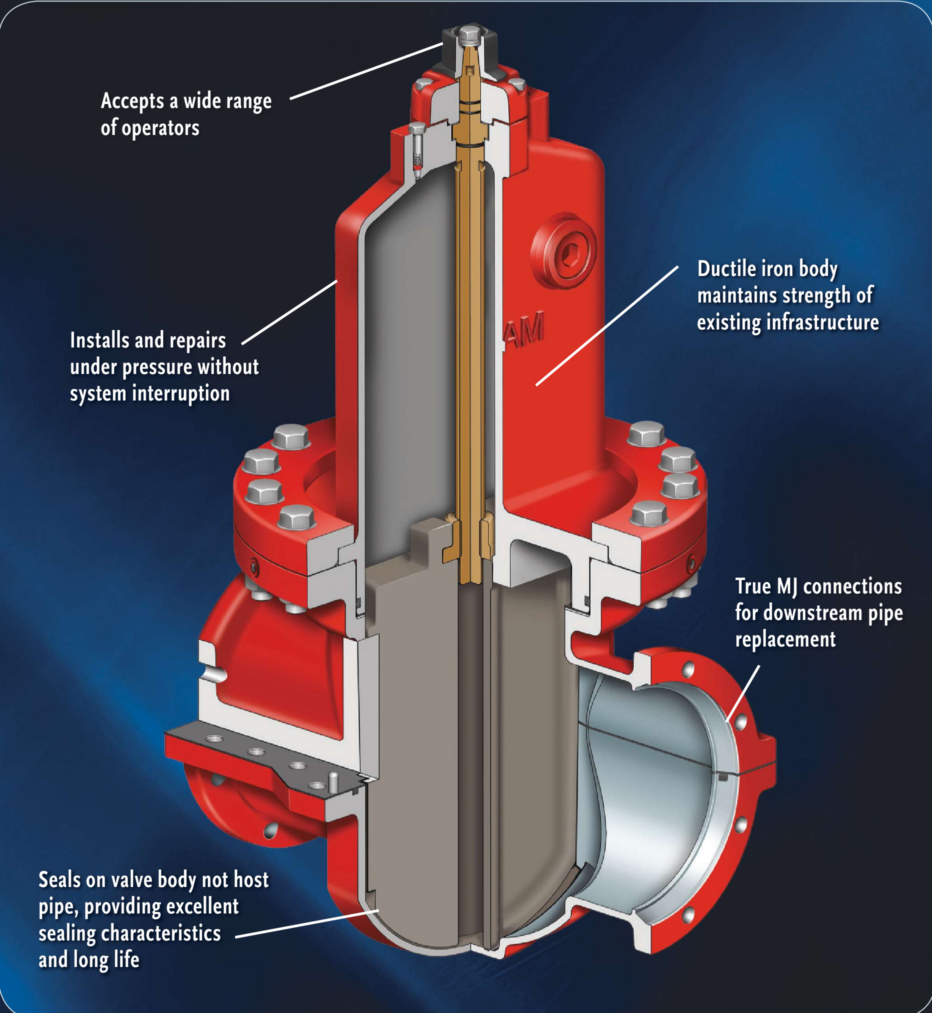
- A CEHRS/PAC process is capable of removing TOrCs from a typical municipal WWTP stream
- Generally, a higher fresh PAC dose resulted in higher removal
- PAC dose may be optimized at a full-scale plant to balance expected performance and operating costs based on the above
- Some compounds were more easily removed than others, which indicates a compound's molecular make-up may drive its capacity to be removed from the waste stream

The results of the piloting efforts that took place at the Milwaukee Metropolitan Sewerage District demonstrate that a CEHRS/PAC process provides municipal WWTPs with a viable option in removing TOrCs from their waste streams. This marks significant progress in the research to find economic ways to remove harmful compounds in public water/wastewater streams. Future research can now use the results from this pilot as a resource to make further gains in the TOrC removal arena. The health of the public and the overall ecosystem is at stake as more and more pollutants like TOrCs make their way into the human water supply. Knowing that resources to help eliminate the TOrC issue exist and will continue to grow, communities everywhere can now look to the future in a positive light. ■

Pilot Testing Team: Many thanks go to the pilot program team that executed the pilot testing. It was the collaborative efforts of the following organizations that made the pilot testing a success: The Water Environment Research Foundation (WERF), The Milwaukee Metropolitan Sewerage District (MMSD), Veolia Water Milwaukee (VWM), Veolia Water Solutions & Technologies (VWS), University of Wisconsin-Milwaukee (UWM), and Corollo Engineers.

Daniel M. Austria Jr. is an application engineer for the ACTIFLO Systems division of Kruger / A Veolia Water Solutions & Technologies Company. His experience has focused on process design, engineering, and operation of physical/chemical separation technologies. Prior experience includes working in the environmental department of a pulp/paper manufacturer for two years, and also participating in water and wastewater treatment system design and operation for 12 years. He has a bachelor of Science In Chemical Engineering from The University of Dayton, OH.

Why Team's InsertValve™ is *the* industry standard



The patented InsertValve is a full functioning, resilient wedge gate valve with a rated working pressure of 250 psig. This proven valve provides tapping, line stopping, valve insertion and a capital improvement connection...all in a single system.

The InsertValve is available for immediate line cut-in by our trained and certified technicians or for third-party installation. Either way, you get superior results.

+1-800-662-8326 | www.teamindustrialservices.com

- Leak Repairs
- Field Heat Treating
- Field Machining
- **Valve Insertion**
- Hot Taps / Line Stops
- Technical Bolting
- Valve Repair
- NDE/NDT Inspection
- Emissions Control
- Pipe Repair Services

MADE IN USA

Scan to view animation

TEAM® Industrial Services

Pump Replacement By The Numbers

Making the case for pump upgrades through cost-benefit analysis.

by Steve London

Andy Myracle knows how to make a strong case for facility upgrades to his senior management.

As plant maintenance superintendent for Jackson Energy Authority, Myracle had watched aging — and high-maintenance — pumps in one of the utility's lift stations demand ever increasing man-hours for outages even after stepped up proactive maintenance inspections. The electric meter at the duplex station also implied recurring drag on the impellers and clogging resulting in high power consumption. These combined factors steadily sapped more and more of his budget, and the frequency of failures raised the risk of sanitary sewer overflows (SSOs).

Given these recurring problems at the facility, Myracle felt replacing the pumps was the logical solution and began compiling the incremental costs in electricity, man-hours, and truck use to make a documented case for replacing the pumps at the 321-gpm facility. This type of evaluation can help support future capital upgrade proposals for other projects to senior management.

"My reasoning was to show on paper our rising operating and maintenance costs that management could easily relate to in justifying the replacement cost for new pumps," Myracle said. "This particular station offered a good opportunity to show the before and after results of an upgrade. The electrically metered station also allowed a test of a new type of submersible pump whose energy efficiency and clog resistant impeller could also reduce our risk of SSOs."

The before-and-after results strongly reinforced Myracle's credibility when proposing the recent capital improvements and future projects.

The Jackson Energy Authority sewer plant recently underwent an upgrade that replaced the original counter-current aeration system with a fine bubble diffuser system.

A Utility Authority With Multiple Services

Jackson Energy Authority evolved from its 19th century origins into the present status as an autonomous public utility created by action of the state legislature in 2001. The utility supplies electric, gas, propane, water, wastewater, and broadband services to about 40,000 residences, businesses, and industry in Jackson, TN, and parts of Madison County. It remains one of the few utilities in the nation with this broad diversity of operations.

The sanitary sewer system consists of approximately 33,200 connections, 2.8 million feet of collection lines ranging from 2-inch force mains up to 54-inch gravity lines, 120 lift stations, and two wastewater treatment plants. The treatment plants consist of a 6 mgd (million gallons per day) SBR facility and a 25-year-old, 17.4 mgd extended aeration plant.

The Authority's larger plant recently underwent a $2.6 million upgrade that included an improved process in the plant's two aeration basins. The project replaced the original counter-current aeration system in the two, nearly 9-mg basins with a Sanitaire fine bubble diffuser system. Also replaced were 10 centrifugal blowers previously serving the two aeration basins. This involved the installation of six, 4500-cfm Neuros high-efficiency turbo blowers. Instead of the mechanical counter-current aeration, each of the basins, which have individual denitrification cells, now are aerated by 9,000 Sanitaire membrane discs serving the eight zones in each tank.

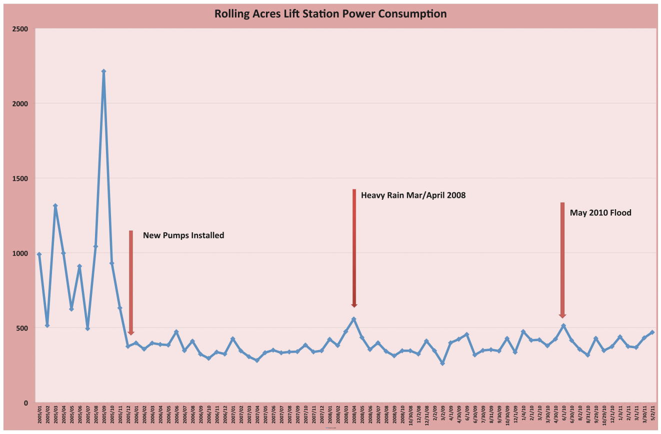
By eliminating the moving parts of the older mechanical aerators, Myracle expects an end to the excessively high maintenance imposed by the aging apparatus that had struggled and sometimes failed to deliver the plant's original design capacity.

Bringing Man-Hour Expense Under Control

Similar high maintenance has plagued the Rolling Acres Lift Station equipped with two, 7.5-hp/3-phase pumps. The facility serves a mature residential area whose wastewater flows to the 6-mgd SBR wastewater treatment plant.

"The Rolling Acres station presented ongoing problems for us due to age and clogging typically associated with older

pumps," Myracle said. "We were spending 16 hours a month having two field technicians routinely clean and inspect the station because of its condition. But the bigger costs occurred when the pumps quickly collected rags and other solids that required us to dispatch a crew and truck to pull and re-clean the pump impellers an average of twice more a week with additional incidents beyond that after hours that presented overtime charges. Keeping the station running had become an expensive proposition."



This graph further underscores the drop in energy consumption after replacing pumps with N-type units.

Myracle began keeping close track of those costs. The annual man-hour costs at the Rolling Acres Lift Station eventually reached $6,720. Power costs, due to the pump inefficiencies, climbed to more than $937. After adding in the vehicle expense — $960 — the total annual outlay involving the costs associated with the former pumps reached more than $8,617, he reported. From the principal line-item costs to keep the lift station running, it was clearly evident the units deserved replacement.

Myracle felt the Rolling Acres station was an ideal candidate to install Xylem's Flygt brand N-Pump at the recommendation of Gulf States Engineering Co., Inc. The new-generation pumps have earned a reputation for reliability and energy efficiency attributed to several hydraulic engineering features that prevent clogging and energy-robbing drag resistance imposed when waste materials accumulate on impellers.

The pump's semi-open, screw-shaped impeller facilitates the passage of fibrous material associated with solids and the 'disposable' cleaning and personal hygiene wipes being flushed into residential collection lines. Unlike traditional

grinder pumps that are less effective in dealing with hard or stringy foreign materials, the N-pump maintains continuous flow by the leading edge of the rotating impeller passing across a stationary relief groove at the suction port of the pump. The dynamic action cleans and passes any rags, stringy materials, and many solids without compromising hydraulic efficiency. The elimination of drag imposed by such buildups inherently reduces the N-pump energy requirement. The savings for Jackson Energy should potentially accrue into tens of thousands of dollars over the expected service life of the replacement pumps.

"The electrical cost reductions were immediate," Myracle noted. "Our monthly cost dropped from $78 per month to $39.95, and we've experienced a virtual elimination of high-level alarms that required emergency dispatches and extra man-hour expense or the need to defer work elsewhere on the system. Management could clearly see the savings in actual electric utility costs."

"Our total annual reduction in operating costs following the upgrade ran $5,737.92," he said. "At that rate, the total costs to replace the two pumps could be recovered in just 1.19 years!"

With the new Flygt pumps in place, the Rolling Acres Lift Station now requires only a routine inspection once a month by one field technician. The station is monitored 24/7 on the utility's SCADA at a central dispatch center whose record of significantly reduced alarms further supports the promised reliability of the new pumps.

He went on to note that Jackson Energy recently annexed a large area in the northeast part of the county that will receive a broader scope of improved services. The annexation and merger of sewer services will require removal of some stations in favor of building a consolidated 600-gpm station. The new Ashport Road Lift Station is engineered beyond the initial rating for expansion up to 1000 gpm. Based on Myracle's firsthand experience at the Rolling Acres Lift Station, the N-pumps became the preferred specification for the new station serving the annexed service area.

"Rolling Acres proved on a small scale the benefits of the N-type impeller," he said. "When planning the new station we could clearly see on paper that cost comparisons on a larger scale also favored Flygt N-Pumps." ■

Steve London is president of Steven London Associates. London has an extensive background as a writer and editor. For the past 17 years the company has been involved in the development of application stories that highlight various solutions for water management professionals. London can be contacted at slondon@comcast.net.

Just Add SCADA

Internet-hosted SCADA systems are a modern answer to modern municipal water and wastewater concerns.

by Thelma Akwei and Ben Manlongat

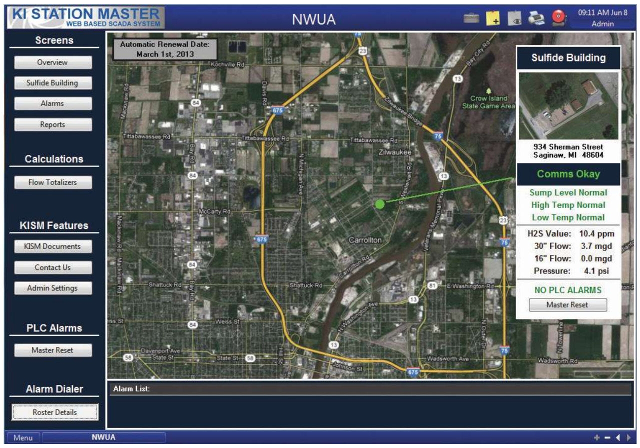
Water and wastewater utilities are under increasing pressure to prevent service disruption, control costs, and provide management and regulators with detailed process information. This requires a modern supervisory control and data acquisition (SCADA) system, including remote monitoring and control hardware such as programmable logic controllers (PLCs) and remote terminal units (RTUs), a communication network (usually radio-based), and a human machine interface (HMI) software application running on one or more networked computers. Many utilities simply cannot afford either the upfront cost of this infrastructure or the long-term maintenance it requires. This article describes how a hosted Internet solution can help such utilities quickly achieve advanced SCADA systems that would have been impossible considering the costs of traditional SCADA architecture.

A detailed pump station screen: monitors well levels, pumps, alarms, station power, panel temperature, and communication links; controls pumps, pump setpoints, and well alarm setpoints.

Hosted SCADA Solutions — A New Approach

In an Internet-hosted SCADA solution, equipment information from each remote site is transmitted via cellular modems to a central third-party SCADA software application. For a monthly fee, authorized utility personnel can monitor and control their equipment, change system set points, view active and historical alarms, and create custom reports. Secure Internet clients provide customer access from any computer with an Internet connection. This allows utilities to adopt a complete SCADA system including mission-critical components like trending, alarm dialer, remote access, and system redundancy that they could otherwise not afford using traditional server architecture. A working system can be up and running in a matter of days or weeks, not months or years.

Hosted solutions eliminate the upfront hardware costs and software licensing fees required to install a traditional SCADA system. In addition, there is no need to maintain licensing support contracts, server computers, or an IT department.



A custom overview screen for monitoring remote buildings. Displays status of communication links, alarms, and equipment.

In 2010, systems integrator Kennedy Industries, Inc., developed its own cloud-based SCADA system, KI Station Master (KISM), to meet the needs of the Michigan Department of Transportation (MDOT). MDOT was considering a SCADA system to monitor and control pump controllers at 160 stations across the state of Michigan. Due to the large number of sites that MDOT wanted to monitor, Kennedy Industries proposed KISM as an efficient way to meet MDOT's needs. After a careful review, MDOT approved the proposal not only because of the features of KISM, but also because the hosted application is installed at a server farm in Michigan.

A SCADA Software Central

Hosted solutions require a SCADA software application to provide a central repository for process information collected from each client utility. The application makes this information available to the appropriate utility via online graphic displays, reports, and trend viewers. It is important to research and examine various aspects of a system (thin client, thick client, cloud, or local installation) before choosing a SCADA platform for the hosted solution. Kennedy selected VTScada software from Trihedral because of its built-in communication drivers for more than 100 different devices, making it easy to connect to any type of equipment. It also provides the capability to perform hosting by grouping all customer areas into a single realm, ensuring that different utilities are not able to see each other's private information.

Installation And Customization

The hosting process requires a PLC at each site to collect data that can be sent to the hosted SCADA application by the cellular modems. If a customer already has these devices in place, they are simply reused in the new system. If not, the utility is provided with a PLC that can communicate with its existing equipment.

If the customer has a piece of equipment that cannot communicate with DNP3, Modbus, or any other communication protocol that the SCADA software recognizes, the engineer can tie in a PLC, which has a built-in DNP3 communication driver and directly wire in the equipment information into inputs and/or outputs of this new PLC. The PLC can then transmit equipment information to the hosted SCADA system through any cellular-based network. In addition to standard pre-built template pages, Kennedy also provides engineering time to create a selection of customized graphic screens unique to each of their customers.

Since each customer remote site is configured as an area within the Internet hosted SCADA system, all that customers require to view the realm of their areas is a Windows computer with Internet connection running Internet Explorer. Customers can also access the system from their smart phones or tablets.

A Secure Cloud

Kennedy runs their hosted application at a local server farm, which guarantees 24/7 power and Internet connection. For security, the integrator uses its own SSL certificate, which encrypts username and password information in addition to the VTScada advanced security features. As a further safeguard, Kennedy is working on an approach where the hosted solution is configured as the main system but another VTScada application is installed at the customer site as an automatic backup.

Room to Grow

Beginning with a hosted solution makes it easier to switch to a traditional SCADA application in the future as their resources grow. Since KISM is built on Trihedral's fully featured SCADA software, customers can choose to end their service contract with Kennedy and roll out to a full installation at their site if their needs change.

Just as in the backup scenario mentioned above, Kennedy can move the customer's application to an on-site SCADA server. Reasons to change could include greater ability to customize the application in house.

Hosted solutions allow utilities to quickly implement world-class SCADA systems while eliminating the need for extensive infrastructure and IT staff. Customers have peace of mind knowing that their system is always available and supported by a team of dedicated experts. ■

Thelma Akwei joined Trihedral in 2009 as a marketing coordinator. Outside of Trihedral, Thelma is involved in various volunteer organizations for community development and is currently the public relations and communications officer for the African Diaspora Association of the Maritimes (ADAM) in Halifax, Nova Scotia, Canada. Thelma holds a Bachelor of Commerce degree in marketing and psychology from Saint Mary's University in Halifax.

Ben Manlongat was hired as a controls engineer with Kennedy Industries based in New Hudson, MI. He currently manages the Controls Group for SCADA, PLC, and controls integration projects. In 2010, he led the design, programming, and implementation of Kennedy's new product offering, the KISM Internet Hosted SCADA Solution. Ben holds a Bachelor of Science Degree in electrical engineering from Kettering University, Flint, MI.

New Insights Into Waste Lagoon Water Mixing

An age-old treatment technique gets a technology update.

by Jim Dartez

Man-made lagoons have been used worldwide for the treatment of domestic and industrial wastewater, it seems, forever. All waste lagoons were first designed and thoughtfully planned considering their locations, soil makeup, and waste reduction processes prior to being implemented. The biological process of organic waste reduction is always a consideration of waste lagoon designs. There are three biological concepts considered for waste lagoons –

- Anaerobic lagoons, usually 10 feet deep at a minimum, have no dissolved oxygen in the lagoon water. Acid and methane bacteria work together to convert complex organics eventually to gases. There is very little, if any, mixing in these lagoons, and they are often used as an initial digestion process with aerobic lagoons downstream.
- Facultative lagoons are more shallow and were conceived to allow for anaerobic digestion in the bottom sediments and to allow for aerobic bacteria to consume the liquid and gaseous intermediate organic products in the water column. Surface water movement supplies the only water movement, and daytime algae are the oxygen source for the aerobic bacteria.
- Aerated lagoons are deeper, often up to 20 feet in depth, but mechanical and diffused air systems continuously provide dissolved oxygen to aerobic bacteria in the sediments and water column. The aerators are also the source of mixing in the lagoon.

Sludge in waste lagoons shortens the life of the lagoon and causes odors, extremely high algal blooms, and ... eventually resulting in the degradation of effluent water quality.

Sludge Buildup In Lagoons

This discussion will concentrate on facultative and aerobic waste lagoons. Once these types of lagoons reach 5 to 20 years of age, depending on their surface area, owners begin to recognize problems, especially with odors and effluent water quality. In facultative lagoons, operators will begin to notice that sludge is building up around the edges of the lagoon, especially near the influent, and often the effluent. Algae blooms become prevalent with noxious filamentous and blue-green clusters in the summer. Even in mechanically aerated lagoons, sludge buildups will appear. In all cases, odors become apparent, at times, and effluent water quality is negatively affected.

Because we can't actually see inside these lagoons, what we don't realize is that sludge is not only piling up around the influents, effluents, and sides of the lagoons, but long "ripple" type mounds of sludge are building up all over these aged lagoons. The sludge mounds also occur in mechanically aerated lagoons but for a different reason than the rippled, non-aerated lagoons. The cause of these mounds of sludge is poor mixing. In the case of the facultative lagoons, there is never enough flow generated from surface wind action to cause the sludge to level off on the bottom. In fact, the ripples are an expansion of the types of ripples one sees in the surf zone near the shore on a beach. But the mounds of sludge in a lagoon are much larger in size, and made up of very fine silt.

Aerators As Mixers

In the case of aerated lagoons, depending upon the type of aeration, the sludge mounds form around vortex and vertical splash aerators, in front of aspirating and paddlewheel aerators, and along the sides of the hoses in diffused air aeration systems. While all of these aerators provide dissolved oxygen to the water, their water-mixing capabilities are stunted or defeated by the mounds of sludge their high horsepower invokes on the fine silt that lies underwater. There is no question that some of the high horsepower aerator designs move water, thereby somewhat mixing the water; but, when water flow is deflected by mounds of sludge on the bottom, or the bottom itself, the forward momentum of the water flow has a tendency to deflect backwards, thus stunting forward flow and reducing efficient mixing. For diffused air hose and uplift or vertical splash aerators, they merely lift water, thereby dropping the solids particles directly beside the rising bubbles, and these particles become the basis for sludge

mounds between the hoses or below the vertical lift aerator. In these cases, water mixing is minimal at best.

These mounds, or rows, of sludge in waste lagoons shorten the life of the lagoon and provide major problems for the owner. The first problems that appear are odors, extremely high algal blooms, and the inability of the water in the lagoon to hold dissolved oxygen through the night. Eventually, the degradation of effluent water quality results in problems with lagoon owners' state and local environmental quality authorities.

When a sludge mound is analyzed, it is common for the mound to include from 30% to 60% undigested organic solids. These are solids that could not be digested by the natural bacteria in the lagoons, primarily, because of the excess of noxic gases from biological waste trapped in the sludge mounds. Visual proof of the existence of this trapped gas is the large methane bubbles that break the surface of a waste lagoon throughout the year.

Solar Powered Mixing

A recent technology introduced to the lagoon industry to aid water mixing is the solar-powered surface skimmer. While these products have the advantage of not requiring electricity, their effectiveness as true lagoon mixers is limited. In fact, they do cause a small amount of surface mixing, but the mixing influence is not much greater than a constant fair wind over the surface of the lagoon. There is never enough movement to affect the sludge mounds that have naturally built up on the lagoon bottom; so, eventually, the effluent water quality of lagoons using this technology will exhibit the same negative results as if they were never used. This minimal mixing influence does help in keeping algae mixed — to a point — as long as there are large numbers of the mixers in a relatively small area. But initial cost and maintenance upkeep have often been recognized as a poor cost-to-advantage ratio.

The Water-Moving Aerator

Just over three years ago, a new technology was introduced to the waste lagoon industry for the rehabilitation of old waste lagoons, some of which cannot meet effluent permit requirements due to the amount of sludge in the lagoon. This patented technology is unique because it recognizes that sludge mounds exist and understands how they negatively affect water quality.

The Model WQA Water Moving Aerator performs two key requirements necessary for the complete success of any waste lagoon:

- The continuous pressure of moving water that slowly falls to the lagoon bottom to quietly move sludge for full biological digestion of organic wastes, and
- Adding dissolved oxygen required to keep the lagoon's natural biology capable of digesting the organic sludge.

This unique aerator design uses only two horsepower of energy to move from two to five acres of water continuously — not on the surface — but on the bottom, where the weight of the water is used to shear the mounds of sludge and break them up. Within several days, the sludge becomes a low level, fluid mass. This movement allows for natural bacteria in the lagoon sediments to digest the organic sludge. The slow but continuous movement of the sludge also frees trapped ammonia and nitrogen gases to oxidize in the water column. Also, due to the downward movement of the water within the water column, a slight vacuum pulls algae

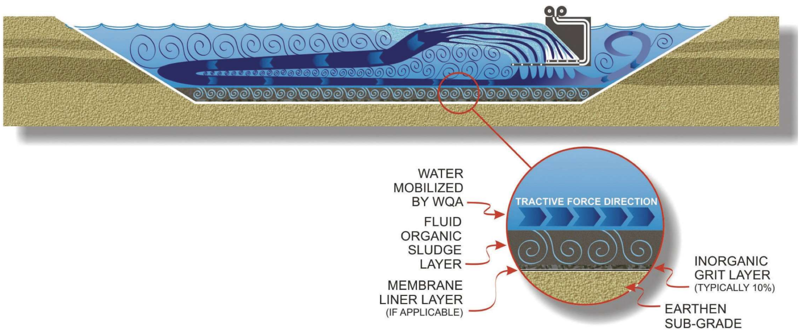


Figure 1: The water-moving aerator by Reliant Water Technologies moves more than 9 million gallons of water per day. The weight of the water makes the sludge a constantly moving fluid mass along the lagoon bottom, releasing gases and allowing natural bacteria to break down organic solids. Another blower provides DO through fine bubble diffusers that are placed forward and below the water moving diffusers.

cells down below the photozone, reducing or eliminating summer blooms (see Figure 1, right).

Another two horsepower blower feeds air to eight fine-bubble diffusers located below and forward of the coarse bubble water moving diffuser bars. Because the fine bubbles are too small to rise through the coarse bubbles and turbulence on the surface, they are carried horizontally forward for 25 to 35 feet, diffusing dissolved oxygen into the water. Due to the water column becoming free of polluting ammonia, nitrogen, and hydrogen sulfide gases, the water can hold more oxygen, thus improving water quality overall.

Successful installations of water-moving aerators have shown the following results:

— *Midwestern 28-acre segmented municipal lagoon system*

- **Problem:** Could not meet effluent permit requirements.
- **Resolution:** Four WQA units reduced effluent ammonia, BOD, and TSS to the point that the lagoons were in compliance within eight months.

—*Southeastern 2-acre chicken-rendering lagoon*

- **Problem:** Extremely high ammonia and an inability to hold DO with 4-20HP aerators.
- **Resolution:** Turned 2 large aerators off, and a WQA unit cut ammonia in half and brought DO to over 3 PPM.

—*Northeastern 3-acre racetrack infield lagoon*

- **Problem:** Extremely high fecal coliform and E. coli counts leaving the lagoon during the racing season
- **Resolution:** One WQA unit reduced both fecal coliform and E. coli counts over 99% during the racing season.

— *Eastern 1/4-acre hog waste lagoon*

- **Problem:** Wanted to use lagoon water for pen wash-down, but sludge was breaking the surface of the lagoon — and ammonia, nitrogen, phosphates, and BOD were extremely high
- **Resolution:** In 60 days, one WQA aerator leveled the sludge in the lagoon to 3 feet under the surface, while at the same time reducing all the residual components in surface water from 50% to 70%.

Conclusion

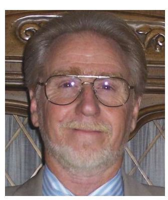
Wastewater lagoons, both municipal and industrial, have been proven to be an effective waste treatment technology for many years, if the land is available. But, because of their low level of technology, they have a tendency to be neglected and burdened with minimal attention. After a number of years, if effective attention is not provided to the lagoon, problems become apparent and effluent quality falls out of compliance or becomes an ongoing problem.

One of the major problems facing lagoon owners, has been the inability to effectively mix the lagoon in such a way as to allow for the sludge to become evenly distributed around the lagoon. This lack of total mixing causes the sludge to form into mounds that hold undigested organic solids. The mounds also hold large amounts of waste gases that have a tendency to degrade the lagoon's water quality, and feed intense algae blooms that only add to the problems.

Standard aeration technologies have not focused on mixing, so they do little, if anything, to address the sludge buildup problem. But a new patented design of a low-powered air-lift-based aerator has proven to use the weight of slow-moving water to break up sludge mounds located on the lagoon bottom. Eventually, tons of slowmoving water turns the sludge in the lagoon into a fluid bottom layer readily accessible to natural bacteria. While the bacteria digests the organic solids in the sludge, the waste gases are oxidized in the water column. This unique aerator, which uses a total of only 4 HP of energy, also adds oxygen to the water at a rate of over 1.5 lbs of DO per HP/hr.

At a time when the economies of small communities and rural industries do not allow for lagoon upgrades and overhauls, this new low-powered, low-priced water-moving aeration technology is:

- Providing lagoon owners a low cost way to get back into compliance
- Rehabilitating old lagoons that have been considered out of date
- Providing lagoon owners with another, lower-priced answer to lagoon overhauls other than vacuuming or dredging. ■



Jim Dartez is the president and CEO of Reliant Water Technologies. The company is located in New Orleans, LA, and can be reached at (504) 400-1239 or jdartez@reliantwater.us.com.

Corrosion In Wastewater Systems: More Than One Bug

Already susceptible to old age, wastewater infrastructure systems are also threatened by corrosive bacteria — but they needn't be.

by Heather Ramsey, John Davis, and Gary Hall

The role of various bacteria in the destruction of concrete in wastewater systems has been recognized since 1945. Parker[1] described the role of an acid- producing bacterium that he called *Thiobacillus concretivorous*, which he had isolated from corroded concrete from a Melbourne, Australia, sewage system. *Th. concretivorous* was described as a sulfate-reducing bacterium (SRB) which converts hydrogen sulfide (H_2S) and uses thionates, polythionates, and elemental sulfur as sources of energy, and in the process secretes sulfuric acid as a metabolic byproduct. This class of bacteria is collectively referred to as SRBs. The acids they secrete are often referred to as biogenic, as they were produced by a biological process. *Th. concretivorous* was later reclassified as *Th. Thiooxidans*. In 2000, *Bergey's Manual of Systematic Bacteriology*[2] reclassified this species as *Acidithiobacillus Thiooxidans*. Several other microbes that are thought to be involved in the microbiologically-influenced corrosion (MIC) processes were reclassified at the same time. Severe corrosion of concrete in sewage systems has been reported in Australia, Iraq, Israel, Ireland, the United States, the UK, Lebanon, Germany, and Mexico, among others. In many instances, the corrosion rate has been catastrophic, often resulting in total collapse of a concrete appurtenance, pipeline, or other structure. Concrete corrosion rates as great as 10 inches (25.4 cm) in less than four years have been described. With declining federal budgets and tightening local funding, municipalities and sewage authorities are faced with the necessity of protecting their expensive, difficult-to-replace infrastructure.

In order to determine the most effective means of protecting these critical assets, it is beneficial to understand the corrosion process, a process called Microbiologically Influenced Corrosion. Recent studies have found that the processes involved in MIC in wastewater collection and treatment systems are more complex and the organisms involved more diverse than originally thought. Further, it has been determined that the microbial species involved require the establishment of synergistic/mutualistic communities, in addition to certain non-biological chemical reactions, in order for the process to proceed. Studies have also confirmed that in addition to bacteria certain fungi are also implicated in the processes.


The crown section of this 14-foot tunnel displays severe degradation.

MIC Processes

Ubiquitous in the wastewater system are microbes, consisting of bacteria and fungi, molds, and yeasts. Some of these bacteria produce acidic metabolic byproducts secreted as waste products onto the surfaces upon which these microbes form their communities. The fungi digest their food externally and secrete enzymes in order to do so. These enzymes are amino acids and can cause corrosion on susceptible substrates. Additionally, fungi, molds, and yeasts secrete short chain fatty acids (SCFA). It is now recognized that the establishment of these synergistic communities is critical to the overall corrosion process. Most articles published on the subject of MIC in wastewater collection and treatment systems have focused upon the role of certain bacteria, notably the *Acidithiobacillus thiooxidans*. These bacteria cannot cause the observed corrosion without contributions from other species and some inorganic chemistry.

Decaying solid waste in sewage gives off H_2S gas, which is poorly soluble in water. Sulfate-reducing anaerobic bacteria, such as *Desulfovibrio,* convert sulfates in the solid waste into sulfides, including hydrogen sulfide. The H_2S escapes easily from the sewage with turbulence caused by flow through the sewer system. Points of increased turbulence increase the amount of H_2S evolved. The H_2S then dissolves in a thin layer of water that condenses on the crown of the structure. This condensate layer will have a high pH due to the pH of the virgin concrete on which it is condensed, which is 12 to 13. Tests have shown that distilled water will obtain a pH of 12.5

within four days of exposure to the concrete. At high pH levels, H_2S forms HS^- or S^{2-} ions. These serve to allow more H_2S to enter the condensed water layer. As the pH of the concrete decreases, the H_2S concentration increases. In the presence of oxygen, the H_2S reacts to form elemental sulfur and partially oxidized sulfur species. (See equation below.) CO_2, which is also ubiquitous in the sewage system, also dissolves in the water vapor condensate that accumulates above the sewage to form carbonic acid (H_2CO_3). These acids combine to reduce the pH of virgin concrete to ~8 to 9. It is felt by most cement technologists that the primary acidification reaction is due more to the carbonate formation.

$$2H_2S + O_2 \rightarrow 2S^0 + 2H_2O$$

Oxidation of H_2S to S by autotrophic bacteria

At this pH level, certain fungi and bacteria can begin to proliferate. Fungi grow best where there is an abundant supply of decaying, preformed organic matter and plenty of moisture, although they are desiccant resistant and will grow at humidity levels as low as 65%. Most fungi are saprobic, meaning they obtain their nutrients from dead organic matter. They are described as being chemoheterotrophic, or more specifically, chemo organotrophic, i.e. they obtain their energy from oxidation of organic matter. Fungi secrete specific enzymes onto their nutrient source. Enzymes are designed to facilitate one very specific chemical reaction. The enzymes break down the nutrients into smaller molecules and the fungi absorbs the digested meal. Most fungi grow at a pH of 5 to 6. Most fungi species grow best at a temperature of 25°C (77°F), except pathogens, which grow best at body temperature, 37°C (98.6°F). Various fungi also secrete several short chain fatty acids (SCFA), such as acetic, citric, formic, butyric, glutaric, propionic, oxalic, and lactic acids. These organic acids will attack alkaline substrates such as concrete as well as susceptible metallic components. It appears that the enzymes, even though acidic, do not participate much in the corrosion process, as they are very specific reaction facilitators.

Deteriorated concrete is shown in a wet-well.

Assessing the overall corrosion process of concrete in a wastewater environment must take into account the presence of these fungi and their acidic secretions. As noted earlier, the reaction of water, hydrogen sulfide, and carbonic acid will reduce the pH of virgin concrete. Raw, i.e. untreated, sewage has a near neutral pH of 6 to 8.5, which is considerably more acidic than the concrete. Exposure to raw sewage will further serve to decrease the pH through direct neutralization of the free lime in concrete and through demineralization of alkaline chemical species within the concrete by the sewage. Fungi will grow in a pH range of ~4.5 to 8.3. As the pH drops below 8.3, fungi of many genera and species begin to grow. See Table 1 below for a partial listing of fungi found in sewage. As these organisms proliferate, the SCFAs and enzymes secreted will attack concrete (and susceptible metallic alloys) further decreasing the surface pH.

Table 1. Partial listing of fungi associated with municipal sewage.

Alternaria	Epidermophyton	Prototheca
Aspergillus	Fusarium	Pyrenochaeta
Aureobasidium	Geotrichum	Rhiocladiella
Absidia	Gliocladium	Rhizopus
Botrytus	Gliomastix	Rhodotorula
Candida	Monialiales	Sepedonium
Cephalosporium	Mucor	Septoria
Chaetomium	Paecilomyces	Torulopsis
Cladosporium	Penicillium	Trichoderma
Coniothyrium	Phialophora	Tricophyton
Cryptococcus	Phycomyces	Tricosporon
Epicoccum	Phoma	Verticillium

As the substrate pH decreases, conditions become more favorable for acidophilic and acid-secreting bacteria. The formation of the biofilm begins with the initial approach and attachment of the bacteria in a random pattern. The second phase is consolidation and is indicated by the appearance of microbial communities. The final stage is maturation, which is characterized by cells embedded in a matrix of expolymers where the distribution of the microorganisms is well-established and biodiversity increases significantly over earlier stages. The expolymers, comprised primarily of polysaccharides, serve to anchor the biofilm and to stratify the biofilm community. These stratified communities serve to control component concentration (O_2, P, S, etc.,), density, absorption, diffusion, and the biomass activity.

It is at this point, where acidophilic and acid-secreting bacteria, such as *Acidithiobacillus thiooxidans*, begin to dominate. Sulfur-oxidizing bacteria, such as *Desulfovibrio*, oxidize elemental sulfur and sulfides to a sulfate. (See equations below.) Sulfate-reducing bacteria (SRB), such as *Acidithiobacillus thiooxidans*, then convert sulfates to sulfuric acid (H_2SO_4). It is common in microbial communities to find such mutualism, where the changes produced in the local environment by one microbe's metabolism serve to facilitate the growth of another species, which returns the favor. Mutualism has been observed in microbial communities comprising more than 100 species.

Other bacteria will oxidize elemental sulfur to a sulfate, which then reduces to form sulfuric acid:

$$2S^0 + 3\ O_2 + 2H_2) \rightarrow 2(S_2)^{-2} + 4H^+$$

Elemental sulfur oxidized to sulfate by SRB

Sulfide-oxidizing bacteria (SOB) will convert hydrogen sulfide (H_2S) to a sulfate:

$$H_2S + 2O_2 \rightarrow (SO_4)^{-2} + 2H$$

With the following intermediate chemical species:

$$SH^- \rightarrow S^0 \rightarrow (S_2O_3)^{-2} \rightarrow (S_4O_6)^{-2} \rightarrow (SO_4)^{-2}$$

Researchers have found that the corrosion of both alloys and concrete in biological systems is many times greater than in the acids themselves. This is not a surprising, considering the complex chemistry occurring within these microbial communities. Thus, it is not sufficient to test a proposed material used in sewer construction in sulfuric acid, for instance, when the exposure is biogenic sulfuric acid secreted within a microbial community of complex chemistry. Such an exposure would include oxidizing, reducing, and redox conditions as well as organic and inorganic chemistry. This fact points to the futility of laboratory simulations designed to duplicate the corrosive potential found in domestic sewer systems. If one were to try to culture in a laboratory all the microorganisms found within a sewer, one would quickly discover that only a fraction of the microbes can be successively cultured. Regrettably, the environment found within a sewer cannot be, at least presently, duplicated in a lab experiment, and the only meaningful exposure tests are those carried out within an active sewage collection or treatment system.

Consider The Concrete

An additional consideration for prolonging the life of a sewer system is the type of cement used to make the infrastructure. For many years, municipalities and their design-engineering firms specified the use of ASTM Type V portland cement for their pipelines and manholes. This was done based upon the belief that Type V would resist sulfuric acid better than Type I. Type V is a so-called “sulfate resistant” cement. It is more resistant to alkaline sulfate salts, such as sodium sulfate, magnesium sulfate, calcium sulfate, or potassium sulfate. These are the types of salts often found in groundwater and can cause degradation of Types I and III portland cement. It must be noted that these are alkaline salts. While Type V portland is more resistant to these alkaline salts, it is actually less resistant to sulfuric acid and other acid species, such as the SCFA previously described, than either Type I or Type III.

Some researchers have carried out laboratory simulations showing that some cements are more resistant to the biogenic sulfuric acid than other types. For example, calcium aluminate cements have fared well in these tests, as well as in actual installations. Some manufacturers have done studies that purport to prove that a calcium aluminate cement (CAC) binder blended with a fused calcium aluminate aggregate gives superior resis-


MADE IN USA
I always specify EBAA IRON products because I can always count on their pipe joint restraints and flexible expansion joints to be 100% made in the USA! Also, EBAA's unique traceability program provides an unequaled level of quality and accountability for the applications of these critically engineered devices!
MEGALUG®
Series 2000
MECHANICAL JOINT RESTRAINT FOR PVC PIPE
THE EBAA IRON GUARANTEE:
• Engineering Support
• Traceability Assurance
• MegaBond® Coating
• Environmental Safety
• Hand Assembled Quality
• American Foundry
Don't be fooled by copy-cat manufacturers who claim their joint restraints are made in the USA when only the gland component is, but the critical restraint design mechanism is not. EBAA completely manufactures and assembles 100% of their products and components in their own American foundry with only 100% USA made products.
1.800.433.1716
www.ebaa.com
BUILT STRONGER. LASTS LONGER.
EBAA IRON
EBAA IRON SALES, INC.

tance to biogenic sulfuric acid as compared to portland concretes and to calcium aluminate cement bonded siliceous aggregates. Field exposures do not reflect the laboratory results. In the field, there is no difference in the performance of CAC with calcium aluminate aggregate and silica aggregate. The same laboratory tests were reported to prove that biofilms were more difficult to establish on CAC concretes. Again, results from the field do not bear this claim out. Biofilms in a wastewater system are prevalent throughout, regardless of the base concrete.

Conclusion

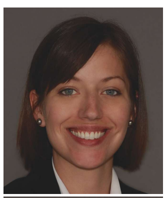
The corrosion mechanisms at play within an active sewer system are complex and involve many different microorganisms including bacteria, molds, yeasts, and fungi. Other microorganisms such as rotifers and worms may also play a role, especially within the sewage sludge. Fungi, molds, and yeasts do not secrete mineral acids such as sulfuric acid. They do, however, secrete amino acids and SCFAs. These are also active in the corrosion processes occurring within the mutualistic microbial communities common to sewage systems. It has been found that some types of protective coatings can be attacked by fungi, whereas they resist sulfuric acid. The composition of the microbial population will vary somewhat from sewage system to sewage system, but the primary corrodents will remain fairly constant. The role of fungi and bacteria must be considered when evaluating microbiologically influenced corrosion within a sewer system.

Based upon the likelihood of concrete corroding in a wastewater collection and treatment system, it becomes imperative to apply appropriate corrosion control methodologies such as protective linings in order to extend the service life of concrete in MIC environments. ■

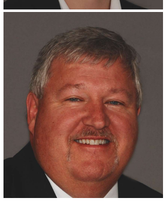
References:

1. Parker CD. The isolation of a species of bacterium associated with the corrosion of concrete exposed to atmospheres containing hydrogen sulfide. Australian Journal Exp Biol Med Sci 1945; 23:81-90.

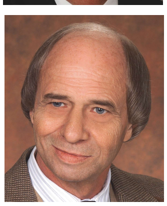
2. Bergey's Manual of Systematic Bacteriology. Second Edition. Volume Two Part A, Appendix 1, p. 188 and pgs.60-61, Springer, NY 2001



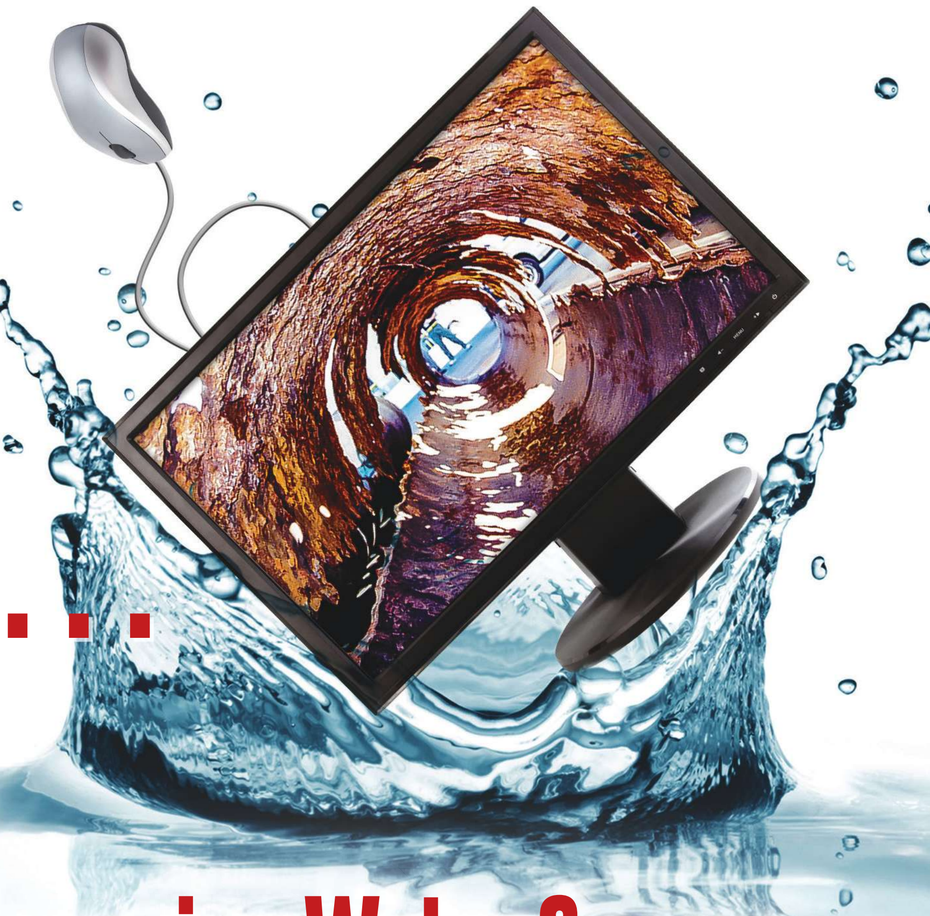
Heather M. Ramsey has been a chemist for Sauereisen, Inc., since 2006, and is involved in the research and development of both inorganic and organic corrosion-resistant materials as well as technical cements. A graduate of the University of Pittsburgh, she is a member of SSPC, ASTM, Pittsburgh Society for Coatings Technology (PSCT), and the American Chemical Society (ACS). Ramsey has co-authored several published papers and has presented at trade-shows such as SSPC.



John E. Davis is a marketing specialist with Sauereisen, Inc., a manufacturer of corrosion-resistant materials distributed globally for several industries. He joined the company in September 2000 in a production capacity before assuming responsibilities in marketing and inside sales. His current roles at Sauereisen combine advertising, marketing, sales, and trade show logistics. Davis frequently contributes to professional journals on the topics of specialty materials and the rehabilitation of wastewater infrastructure. Davis graduated with a bachelor's degree in business management and minor in marketing from Penn State University with honors.



Gary R. Hall is the manager of Organic Technology for Sauereisen, Inc., a leading manufacturer of organic coatings and linings as well as ceramic adhesives and refractories. Hall has been employed at Sauereisen for more than 40 years. A graduate of the University of Pittsburgh, he started in the laboratory, became chief chemist and then transferred to sales. He returned to Research and Development in 1997; he now has Research and Development responsibility for all organic products manufactured by Sauereisen, accounting for 70% of the company's total sales. Hall is a member of the American Institute of Chemical Engineers, National Association of Corrosion Engineers, and various ASTM committees. He also has additional responsibilities at Sauereisen for Environmental, Health, and Safety management.



The Perfect Lab Partner For Compliance

For water testing facilities dealing with testing, reporting, and regulatory compliance issues, a laboratory information management system (LIMS) becomes a critical tool.

by Jeanne Mensingh and Colin Thurston

In July 2011, the NELAC (National Environmental Accreditation Conference) standards were revised as the new The NELAC Institute (TNI) Standard 2009, based on ISO 17025 guidance. Implementation of this updated TNI standard by the respective accrediting bodies will become a reality in the next year, though many have already implemented the new standard. For water system operators and testing labs, not only does this require adherence with ISO 17025 standards, it also requires analysis of at least five new contaminants and lower limits for existing contaminants as designated by the EPA in their annual review.

The resulting increase in sample management and data analysis workload necessitates an investment in automated workflow. Laboratory information management systems (LIMS) are critical tools in enabling water operators and testing labs to meet the ongoing requirements of TNI standards, helping them prepare for state, regulatory, or NELAC audits with all defensible data properly documented and prepared. By automating operations and integrating instruments, labs can build in regulatory compliance, increase capacity and sample throughput, and also reduce time spent on manual activities such as recording data in paper notebooks or using spreadsheets to create reports.

"To ensure compliance and to make the audit process more efficient, water testing labs should have in place automated laboratory information management systems that will generate, store, and report on valid and traceable data."

Jeanne Mensingh, NELAC auditor and president, Labtopia Solutions

LIMS Facilitate Regulatory Compliance, Improve Lab Efficiencies

LIMS have been available for more than 25 years, helping laboratories manage their samples and laboratory processes. Many water laboratories currently use LIMS for some activities, but on the whole, much of the sample and related data management is still done through manual collection and reporting processes, using either paper lab notebooks or spreadsheets. While these types of manual processes may be comfortable, they also introduce a certain level of risk — manual processes are error prone, the data is not searchable or collaborative in any way, and they are more time consuming, taking lab managers and systems operators away from more value-added work.

Moving to a LIMS can be a daunting prospect for a water testing lab, but one which is becoming essential. By implementing a LIMS preconfigured to meet the needs of water system operators and testers, many of the challenges are significantly reduced. With a LIMS designed to address the specific workflow and regulatory requirements of water testing labs, lab managers are enabled to make quick decisions and rapidly share information with management, in addition to being able to respond to ongoing regulatory and business demands.

With recently developed LIMS, water testing labs are able to establish protocols and documentation methods that meet NELAC compliance requirements and ISO 17025 guidelines. With specific functionality built into the LIMS to improve workflow and lab efficiency, reports can easily be automated to ensure full traceability, and the integrity of the lab's data is assured. State regulatory agencies and the EPA require reporting of lab results in a standardized and structured format. A LIMS can easily store the sample data and collate it in the format appropriate for each regulatory recipient.

A LIMS designed specifically for water system operators allows labs to be much more efficient by taking data directly from the instruments and comparing it with the regulatory limits for various contaminants. Once the data is in the LIMS, a predefined set of templates for reporting can be used, allowing the lab to automate data output and enabling lab operators to spend significantly more of their time testing and processing samples. For commercial laboratory organizations, packaging and reporting results, and the associated quality control data for their clients, is often the deliverable product, so automating the creation and delivery of this package can also trigger the invoice process.

A LIMS designed for water and environmental labs

can also enhance the lab's capability for any audit situation that requires evidence of controlled sample management, proper labeling and identification, records of all proficiency training for operators, instrument calibration schedules, and full audit traceability of all records. For NELAC audits, which typically occur every two years, a LIMS simplifies the audit process, since it enables the lab to mine all sample-related data to provide an end-to-end review of all related information. TNI provisions that the audit will involve both a technical and quality system review, as well as the potential to review data over a five-year period — something which can be both challenging and very time consuming in a paper-based environment.

A LIMS Application – Nova Biologicals

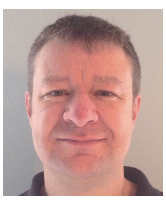
Nova Biologicals, a NELAC-accredited lab in Texas and one of the nation's largest providers of water testing for drinking and wastewater, has implemented a Water and Environmental LIMS solution from Thermo Fisher Scientific to work closely with municipalities, utilities, and federal and state authorities to meet the requirements of the federal Safe Drinking Water Act. The standards for environmental testing in laboratories have become more rigorous over the last few years as new requirements have been introduced via NELAP (National Environmental Laboratory Accreditation Program) and the EPA. Meeting these stringent requirements for water and environmental samples has introduced labor-intensive procedures to ensure compliance, such as sample tracking, chain of custody, record keeping, demonstration of capability, document control, reagent and standards traceability, proof of training, and reporting.

Prior to implementing the LIMS solution, Nova Biologicals managed its work using paper-based processes and an outdated LIMS that could not sustain Nova's growing business. A new system was required that would be user friendly, easily maintained, configurable to Nova's needs, web-based, capable of complex reporting requirements, and in compliance with all regulatory requirements (GLP, GMP, NELAC, HIPAA, etc.).

The implementation of the LIMS solution enabled Nova Biologicals to centralize all data in a single database, track status and workflow throughout the lab, automate processes to eliminate error-prone redundant data entry tasks, manage documents such as SOPs and training records for audit purposes and traceability, and enable efficient data migration to and from customers.

With the LIMS solution in place, Nova has been able to improve knowledge continuity as well as customer service and responsiveness. In addition, Nova is better prepared for regulatory compliance and any NELAC or other audit process, staff time is focused on value-added activities, and the use of paper-based systems has been significantly reduced, allowing the company to eliminate manual error-prone processes and improve data quality. ■

Jeanne Mensingh is president and founder of Labtopia Solutions, which provides tailored quality system advisory services to help business meet regulatory requirements and enhance performance. Labtopia Solutions is part of Labtopia, Inc. (formerly EM2 Management Solutions), a quality assurance/quality control solutions company based in Houston, TX.



Colin Thurston is product strategist for process industries in the Informatics business at Thermo Fisher Scientific. He is based in the United Kingdom. For more information about Nova Biologicals, a full case study may be found at www.thermoscientific.com/waterresources.

Water Online's Vendors To Watch

Tear out this page and bring it to WEFTEC 2012 to find Water Online's Vendors To Watch.

Turn the page for additional must see vendors!

At Xylem, we solve challenges at every stage of the water cycle. We help customers move, treat, analyze, and return water to the environment. With our market-leading brands and applications expertise, we produce highly efficient and reliable products that solve your wastewater challenges, address your emergency response needs, and meet your maintenance and rehabilitation requirements. Doing business in more than 150 countries, Xylem and its brands play an important role in improving quality of life, helping communities to grow, farms to prosper, and industries to thrive.

xylem Let's Solve Water

www.xyleminc.com **Booth #6239**

Water analysis has to be right. You deserve complete solutions you can be fully confident in. Hach is your resource for expert answers, outstanding support, and reliable, easy-to-use products. To learn more about Hach or our products, please visit Hach.com or call (800) 227-4224.

HACH® Be Right™

www.hach.com **Booth #5739**

The Myron L Company manufactures water quality instrumentation that can help you conserve chemicals, water, and energy; control product quality; and manage wastes. Our handheld meters and in-line monitor/controllers measure, monitor, and control critical process parameters and quality indicators: Conductivity; Resistivity; Total Dissolved Solids; pH; ORP; Free Chlorine; and Temperature. Instrumentation features in-cell alkalinity, hardness, and LSI conductometric titrations with LSI calculator for hypothetical water balance calculations. Bluetooth® wireless data transfer available on some models.

MYRON L COMPANY
Water Quality Instrumentation
Accuracy • Reliability • Simplicity
. . . Since 1957

www.myronl.com **Booth #2445**

Schneider Electric, Telemetry & Remote SCADA Solutions provides a scalable and flexible solution for water and wastewater applications. Our solution addresses the challenges of remote assets in geographically dispersed locations and facilitates the increasing demands for regulatory compliance and end-to-end security. Benefits include data confidentiality and integrity, remote diagnostic and configuration capabilities, SMS and email alarm notification, peer-to-peer communication, legacy equipment connectivity, and energy use minimisation. (888) 267-2232 or (613) 591-1943

Schneider Electric
Telemetry & Remote SCADA Solutions

www.controlmicrosystems.com **Booth #6012**

In wastewater applications, it's common to use uninterruptible power supplies (UPS) on computers, programmable logic controllers (PLCs), and radios to keep the SCADA system up during a power loss. But what about the process equipment? Schneider Electric UPS range from single phase UPS for SCADA backup applications to three phase UPS rated at several thousand kilowatts for process equipment backup. Plus, a three phase UPS can keep the critical systems operating during routine electrical maintenance.

Schneider Electric

www.schneider-electric-water.com **Booth #6012**

At Severn Trent Services, we understand water. That's why our products and services help protect and preserve the world's most precious resource. From filtration solutions to disinfection equipment, our experts are poised to provide innovative solutions to meet your specific need. Visit our website to learn more about ClorTec® on-site sodium hypochlorite generation systems, Capital Controls® gas feed disinfection, TETRA® potable, tertiary and biological filters, and MicroDynamics® microwave UV systems.

SEVERN TRENT SERVICES

www.severntrentservices.com **Booth #3437**

Thermo Scientific Water and Environmental LIMS solution will support the way you manage compliance in the laboratory. With its extensive built-in features for customer and sample management, the LIMS will generate, store, and report on valid and traceable data to support your quality and laboratory processes. Take advantage of the pre-configured solution that helps the laboratory improve efficiency, maintains records and traceability, and meets your compliance requirements for ISO 17025 and NELAC.

Thermo SCIENTIFIC

www.thermoscientific.com/waterresources **Booth #1804**

Water Online's Vendors To Watch

Tear out this page and bring it to WEFTEC 2012 to find Water Online's Vendors To Watch.

AQUA-AEROBIC SYSTEMS, INC.

OPTIMIZE PLANT PERFORMANCE WITH INTELLIPRO®

PROCESS CONTROL THAT SAVES TIME AND ENERGY

The proactive IntelliPro® process monitoring and control system is a PC based program that interfaces with any biological treatment system's PLC, providing operators with a powerful process optimization tool. This system efficiently manages plant performance by automatically responding and adjusting to changes as they occur – saving time and reducing O&M and energy costs.

- Real time control of treatment parameters including: NH3, NO(x), TSS, TP, DO and ORP
- Process trending of measured and calculated parameters
- BioAlert™ notification system provides corrective action for process challenges as they occur
- Designed to meet strict effluent objectives
- Supported by the industry leader in biological treatment

The IntelliPro® BNR System
Winner of the 2011 WEF Innovative Technology Award

www.aqua-aerobic.com | 1-815-654-2501

NEW PLANTS | EXISTING PLANTS | PLANT UPGRADES