MAY 2022

Water Innovations

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By Kevin Westerling
Chief Editor, editor@wateronline.com

Calling On Utilities To Combat *Legionella*

The risk level linked to delivered drinking water from municipal utilities is very small, even if some high-profile examples of failure (see Flint, MI) have degraded public confidence to a degree. Our treatment professionals usually hit their targets, so the onus then shifts to the research and guidance that determines the safe level of various constituents through U.S. EPA protocols. But there is one contaminant that rulemaking hasn't quite caught up to and which is downright deadly — *Legionella pneumophila*.

Named for the infamous American Legion conference in Philadelphia which brought national attention to the issue when 182 attendees got sick and 29 died of what came to be known as Legionnaires' disease, it typically infects the victim through vaporized water that is breathed in. The harmful bacteria, *Legionella*, is often present on premise — be it a hotel such as the Bellevue-Stratford in Philadelphia in 1976, or a hospital, apartment building, or any other facility — and forms as a result of certain water conditions and when storage tanks, pipes, or HVAC systems aren't properly maintained. This may lead one to believe that property/facility managers are the sole point of responsibility for reducing or eliminating Legionnaires' disease, but drinking water utilities have a role to play in the mitigation as well, as Dr. Mark LeChevallier of Dr. Water Consulting, LLC, explained to me in a recent interview.

Dr. LeChevallier spent 32 years at American Water, has been honored with numerous awards from the American Water Works Association (among others), authored more than 300 research papers, serves on the Water Science & Technology Board of the National Academies of Sciences, and is a member of the EPA's Science Advisory Board and a fellow of the American Academy of Microbiology. His most recent recognition is in the form of funding for a new Water Research Foundation (WRF) project that seeks to create guidelines for drinking water utilities to monitor for and respond to *Legionella* in their systems, giving our water stewards a set of tools to help mitigate this waterborne disease.

"There's been shockingly few studies of *Legionella* in the portion of public water that utilities control," LeChevallier noted, adding that there are many that have focused on buildings and hospitals, and particularly their cooling systems. Granted, these are trouble spots where *Legionella* often proliferates, due to stagnant water, temperature conditions, cleaning regimens, and other factors, but there is merit in knowing that water is arriving to these sites adequately managed for the harmful bacteria. Something needs to be done, as LeChevallier cites a tenfold increase in *Legionella* outbreaks since 2000.

While *Legionella* has been nominally part of the Surface Water Treatment Rule (SWTR) since 1989, there is no numeric minimum requirement of chlorine residual for preventing the bacteria from proliferating in distribution systems. Currently, as long as utilities filter and disinfect at the plant and maintain any amount of chlorine residual in 95% of the measurements, the issue is considered controlled, per 1989 guidance.

The WRF project led by Dr. LeChevallier will take steps toward strengthening the guidance for *Legionella* as part of the current Six-Year Review for the next update to the SWTR. The goal is to enroll 50 utilities to monitor for *Legionella pneumophila* throughout their systems and look at the relationship between system characteristics (e.g., treatment, disinfectant, residual levels) and determine best practices that they can report to the EPA for future rulemaking.

"The biggest problem is that there's been no good guidance from the EPA or CDC on how to monitor for *Legionella*," he said. "We want to ensure that utilities are doing everything they can to make certain that the water delivered to buildings is as high quality as possible. For operators and engineers, once you are aware of an issue and what you could possibly do [via regulatory guidance], you do it and it solves the problem."

"Every operator wants to go to bed at night knowing that they're doing their best job and providing safe water to their customers."

To help Dr. LeChevallier and his colleagues toward this mission, contact him to enroll in the project: e-mail lechevallier1@comcast.net, call (856)-287-2538, or visit drwaterconsulting.com for more information. ■

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TAKING THE "FOREVER" OUT OF PFAS: The Future Of PFAS Remediation

As PFAS treatment technologies continue to emerge, CDM Smith reviews some considerations for the existing options — and introduces a new one.

By Tamzen Macbeth and Charles Schaefer

Per- and polyfluoroalkyl substances (PFAS) are some of the most difficult chemicals to break down, or destroy, due to the strength of the carbon-fluorine bond, the strongest bond in chemistry. Most PFAS destructive technologies require extreme temperature or pressure, caustic conditions, or harsh chemical additives and consume tremendous amounts of energy.

Currently, no destructive technology has been demonstrated at full scale for large volumes of contaminated water. In addition, drinking water providers have relied on conventional technologies using sorption, ion exchange, or sequestration to separate and concentrate PFAS into other media or waste streams. However, this poses the risk of re-releasing these "forever" chemicals back into the environment. As such, destruction is a critical step in solving the global PFAS crisis.

Today, destruction technologies such as electrochemical oxidation (ECO), plasma, and supercritical water oxidation have demonstrated abilities to break down PFAS. To integrate these promising technologies for future water treatment, treatment trains that first separate and concentrate PFAS to reduce the volume are necessary to make these (and other) destructive treatments viable.

Separate And Concentrate

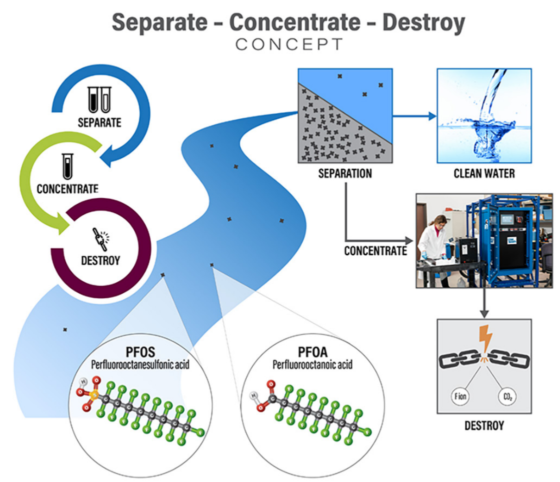
To address urgent needs to remove PFAS from drinking water supplies, we have developed methods to evaluate, design, and implement at full scale reliable technologies such as granular activated carbon (GAC), ion exchange (IX), and reverse osmosis (RO) for PFAS treatment. However, these technologies still generate PFAS-laden waste streams with volumes that are often impractical to treat with destructive technologies. Our researchers have been rigorously testing new ways to separate and concentrate PFAS that can be used along with or in place of these conventional treatments.

One particularly promising technology relies on using air bubbles to "strip" PFAS out of water and into foams, which are condensed to highly concentrated PFAS solutions. This technology has achieved concentration factors of 90,000 times at full scale and ongoing optimizations are working to achieve concentration factors of one million times. In other words, one million gallons of PFAS could be treated generating approximately one to 10 gallons of PFAS concentrate for destructive treatment. Together with EPOC Enviro, CDM Smith has been rigorously testing surface-active foam fractionation (SAFF®) in our treatment train concept. We recently completed the first U.S. pilot application, successfully treating 265,000 gallons of PFAS-contaminated groundwater and generating three gallons of PFAS concentrate. The concentrate has been sent to our laboratory in Denver, where it is being treated with our pilot destructive ECO system.

Destroy

Numerous PFAS destruction technologies are under development (see https://pfas-1.itrcweb.org/12-treatment-technologies/). Promising destruction technologies that have progressed from bench- to pilot-scale include ECO, plasma, UV-reductive, hydrothermal, and supercritical water oxidation. These technologies have successfully treated an array of water samples highly concentrated with PFAS and are considered ideal for destructive treatment, including one or more of the following:

- Aqueous film-forming foam (AFFF) concentrates
- Groundwater within PFAS source areas
- Remediation waste streams (such as wastewater generated from regeneration of GAC or regenerable IX resin; foam-fractionation, soil-washing, rejected-RO concentrates; chemical- or electro-coagulation)
- Landfill or biosolid leachate



Electrochemical Oxidation (ECO)

Our researchers have proven ECO to reduce high-concentration PFAS effectively, typically achieving reductions of 90% to 99.999% in laboratory and pilot studies.

ECO uses an electrochemical cell to generate an electric current between a reactive anode and cathode (the electrodes). The process degrades PFAS through two mechanisms:

- Anodic oxidation (direct electrolysis) – PFAS adsorb onto an anode surface and are destroyed directly at the electrode by a direct electron transfer reaction.
- Indirect oxidation – Strong oxidizing and nonselective radicals (such as hydroxyl, oxygen, sulfate, and carbonate) are generated in situ that react with, and break down, PFAS in the bulk liquid reactions.

Choosing A Destruction Approach

Because of the high demand for destructive PFAS technologies, they are often promoted hastily without demonstrating complete destruction (e.g., defluorination) and without confidence the technology can meet stringent effluent discharge requirements. The feasibility of these technologies must be carefully considered for each new application. To effectively develop a treatment train approach, technology compatibility, engineering constraints, and O&M requirements must be considered.

Currently, technology evaluation for a particular site/application must include bench- and pilot-scale tests to demonstrate technology and incorporate economic feasibility in the selection process. A thoughtful approach will ensure the system can meet required treatment volumes, rates, and discharge criteria.

The development and commercialization of PFAS destruction technologies is in its infancy. Technology benefits and limitations should be discussed with technology providers, including:

- Energy demand and efficiency to achieve desired treatment goals at the scale required for the system.
- Health and safety concerns.
- O&M requirements and longevity of the system.
- Scale of available systems and feasibility of operating large-scale systems, if required.
- Potential for incomplete PFAS destruction resulting in accumulation of fluorinated intermediates that are generated but not measurable.
- Feasibility of achieving stringent (i.e., very low) treatment requirements. Often a treatment train approach may be needed before effluent discharge.
- Effectiveness in destroying all PFAS chemicals, including short-chain PFAS (which are generally harder to treat) and precursors as sources of perfluoroalkyl acids (PFAAs).
- Generation of non-PFAS toxic byproducts, such as perchlorate or hydrofluoric acid. For instance, perchlorate is known to be formed during electrochemical oxidation treatment due to the aggressive oxidation of chloride in the feedwater. Although perchlorate can be addressed easily, treatment systems must account for, and treat, perchlorate in the process.

CDM Smith has been investigating PFAS destruction for nearly a decade. Our approach to assessing PFAS destructive technologies at a site includes treatability testing at the bench-, pilot-, and full-scale levels, using three lines of evidence to confirm complete PFAS destruction. ■

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Tamzen Macbeth, PhD, PE, BCEE, is an internationally recognized remediation expert who develops innovative, cost-effective technologies for contaminated soil, sediment, and groundwater. Tamzen has helped advance countless technologies within her field, publishing more than 100 technical papers, training manuals, and guidance documents on remediation topics.

Charles Schaefer Jr., PhD, is an environmental scientist and the director of CDM Smith's Bellevue, Washington, Research and Testing Laboratory. Charles has received multiple awards for his research into PFAS, most recently earning a top prize from the American Society of Civil Engineers (ASCE) for investigating AFFF with the U.S. Department of Defense.

How IoT Could Open The Floodgates To INNOVATIVE Water Management Projects

As the water industry continues to adopt more high-tech and data-centric solutions, it is important to consider the communications infrastructure that supports such investments.

By Phil Beecher

The use of Internet of Things (IoT) technology in the water sector is no longer in its infancy. A new Wi-SUN study[1] of UK and U.S. information technology (IT) decision-makers reveals that half of all companies with smart utility strategies have now delivered projects, up from 38% five years ago. But there's still a long way to go as the industry gradually matures.

U.S. providers have a huge opportunity coming their way after Congress last year passed a landmark $1 trillion infrastructure spending bill. And IoT technology should sit front and center in their proposed projects. But success will depend a great deal on the quality of the underlying communications infrastructure on which such initiatives are built.

Why We Need Tech Innovation

These are challenging times to be a water operator in the U.S. According to the latest stats released in March, over three-fifths of the contiguous United States is now classified as suffering some form of drought. In just a month, the portion of the country in drought increased by an area larger than the state of California. In this context, it's never been more important to find and fix leaks and encourage more responsible and efficient use of water by customers. Technology can help with both. In fact, we found that advanced meter infrastructure (AMI) is now the third most likely use case for IoT deployments, cited by 80% of respondents. That's up from 67% back in 2017.

Water companies aren't only looking to technology innovation to help conserve water use. Driving operational and cost efficiencies remains important, and increasing competitive advantage has become even more so over recent years. Some 92% of organizations, including utilities firms, now agree that they must invest in IoT over the next 12 months in order to stay competitive.

Yet there remain roadblocks. According to our research, only half (47%) of organizations polled in 2022 say they've fully implemented their IoT strategy, down from the 55% who said the same five years ago. It could be that projects and plans are becoming more ambitious, which is to be welcomed. But security, complexity, and the need to see proven ROI remain persistent technical challenges.

How The Right IoT Can Help

The benefits of IoT in the water industry are well recognized by now. With judicious use of edge computing sensors and other devices placed at strategic points of the network, operators can monitor flow and pressure to pinpoint with great accuracy and speed where leaks occur. Temperature readings can even be taken of the soil surrounding pipes, to detect when water is escaping.

Research tells us that a staggering 17% of water is lost from the average U.S. urban water utility before it even reaches end users.[2] Such technology rollouts could substantially lower this figure, not only helping to conserve valuable water resources but also saving companies the costs associated with excessive leaks. They also save on costs and disruption linked to traditional methods of leak detection, such as the drilling of "dry holes" down to pipes, which can impact local traffic flows.

Similarly, intelligent IoT devices could help to monitor water purity levels to ensure compliance with sanitation standards and the management of graywater. The latter can help providers meet environmental mandates to optimize water use and support the requirements of agricultural customers for irrigation water.

Finally, there are customer smart metering systems, which utilize IoT technology to deliver more transparency and control to the end user. Both commercial users and consumers can leverage this enhanced visibility and control to limit their water usage and reduce wastage. For the provider, it's not only about delivering an improved end user experience but also reducing costs otherwise spent on meter readings and other callouts.

Why Open Standards Matter

Yet not all IoT systems are created equal. The communications backbone that such devices connect to is critical. Using 5G communications won't work in these scenarios: It isn't cost-effective or energy-efficient enough for the kind of devices used around the water network. Instead, field area networks (FANs) based on wireless mesh topologies offer the most reliable, cost-effective, and secure option.

They're specifically designed for very large-scale outdoor networks and built on open standards, meaning a range of IoT devices such as advanced metering and pressure sensors could be plugged in without any concerns about interoperability. Open standards also mean more choice of device manufacturers, driving cost efficiencies and reducing the risk of vendor lock-in. And they open the door to cross-industry collaboration. Wi-SUN FANs can be incorporated into citywide smart streetlighting, for example, to create a canopy network off which water providers could hang leaf nodes for their edge devices. That means commercial opportunities with energy companies and local municipalities, which could reduce upfront CAPEX.

Because devices must be certified to rigorous standards, there's added reliability, robustness, and security. The latter is particularly important for water providers in light of ongoing cyber threats[3] to the water industry. IEEE-certified encryption and device certification ensures devices and networks can't be spoofed and data cannot be intercepted, reducing the risk of sabotage, ransom-based attacks, or data theft. According to our research, security and safety remains the most common technical challenge among IoT project managers.

There's a wealth of choice, innovation, and opportunity for U.S. water providers that know where to look. To optimize projects from the get-go, it pays to start from the ground up with secure, open, and standards-based networks. ■

References:

1. https://wi-sun.org/iot-maturity-model/
2. https://cwee.ucdavis.edu/research/economic-leak-loss-model/
3. https://www.cisa.gov/uscert/ncas/alerts/aa21-287a

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CYBERSECURITY: A Marathon, Not A Sprint

To become more resilient against increasing cyber threats, water and wastewater utilities should employ a multibarrier approach.

By Kenneth Crowther

Digital technologies are fundamental to solving major water and resource challenges. However, as more water operators and users adopt these increasingly connected and integrated solutions, there is also a growing need to strengthen cybersecurity protections and build resilience to cyberattacks across their networks.

In recognition of the increasing threat to water systems, and following a number of high-profile cyberattacks, the U.S. Congress and the Biden-Harris Administration have rolled out initiatives to strengthen cybersecurity in the water sector.

For example, having already established industrial control system (ICS) initiatives for the electric and natural gas pipeline subsectors, the administration has expanded its efforts to the water sector with the creation of the Water and Wastewater Sector Action Plan. The plan, which is currently in development, is a collaborative effort between the federal government and the critical infrastructure community to facilitate the deployment of technologies and systems that provide cyber-related threat visibility, indicators, detections, and warnings. Developed in partnership with the U.S. EPA, the Cybersecurity and Infrastructure Security Agency (CISA), and the Water Sector Coordinating Council (WSCC), the plan outlines actions to confront cyber threats and address cybersecurity gaps within the water utility industry. The 100-day sprint to establish the plan includes the creation of a task force of water utility leaders. The EPA and CISA will work with water utilities and invite them to participate in a pilot program for ICS monitoring and information sharing. The initiative will also engage with the task force and use these learnings to inform future regulations and proposed statutes.

In further efforts to prevent disruption due to cyberattacks, the Cyber Incident Reporting for Critical Infrastructure Act of 2022 contained in the Strengthening American Cybersecurity Act will require critical infrastructure companies to report any substantial cybersecurity incidents or ransom payments to the federal government within 72 and 24 hours, respectively. Before these reporting requirements come into effect, CISA has up to 24 months to establish clear guidelines and rules — e.g., for defining what "critical infrastructure" entities must comply with and what constitutes a "covered cyber incident" — providing sufficient clarity to ensure that the act successfully disadvantages attackers by improving reporting and analysis, offering better protections to critical infrastructure and the citizens that they serve.

Shared Responsibility

These initiatives represent a positive step toward building resilience across the sector. However, as cyber threats become more sophisticated, the risk to infrastructure networks, including water systems, increases. We need a more holistic, integrated approach to protecting our water systems, with a sense of shared responsibility across the supply chain.

Traditional cybersecurity models whereby the owner or operator has sole responsibility for evaluating and protecting their own control equipment are not adequate without sufficient cybersecurity professionals who can understand and respond to threats. There are over 153,000 public drinking water systems and 16,000 publicly owned wastewater treatment systems in the U.S., according to CISA.[1] The majority of these are owned/run by small municipal operators who, more often than not, don't have the capacity to screen all technologies or hire cybersecurity expertise in the way that an electric or oil and gas utility might. While the plan intends to develop protocols for sharing information with operators of all sizes, operators are still faced with the challenge of deploying unfamiliar technologies and systems.

Shifting this amount of responsibility and investment onto water utilities could significantly harm the viability of the water sector and exacerbate issues associated with water rates and aging infrastructure in the U.S.

Water utilities are lean, and the security and resilience model must recognize their resources and, in some cases, limitations. We need to look beyond the operators to the entire sector if we really want to secure the water sector in a cost-efficient way.

A Multibarrier Approach

An alternative to the historical cybersecurity model is a "multibarrier approach" with collaborative outcomes, community partnerships, shared responsibilities, and communication channels all clearly defined from the outset. This model enables a broader distribution of responsibility, removing some of the burden from utilities.

This multibarrier approach is not a new concept to the water sector — it is frequently used by water treatment systems to improve water safety and reduce health risks associated with contaminated drinking water. This layered depth of defense is also highlighted in a recommended set of safeguards as aligned with ISA/IEC 62443,[2] which is an industry standard for securing ICS assets. These standards form the backbone of Xylem's recommended cybersecurity approach:

- *Secure Products* – Enhance protections for user identities by leveraging strong authentication and authorization along critical paths to ICS assets such as remote access channels.
- *Secure Deployment* – Execute a multibarrier approach to keep assets resilient to attack.
- *Continuous Health and Monitoring* – Employ a security-relevant monitoring approach that includes active threat detection and response based on traceable events.
- *Incident Response Services* – Establish capabilities that preempt operational risks, including backup and recovery, cybersecurity incident planning, training, and awareness for critical staff. Leverage relevant expertise as offered by industry associations, partners, and retained service providers.

As active participants in digital transformation, we are all responsible for managing risk. Within these guidelines, responsibility is spread across the product makers, integrators, and utilities, with the burden of continuous monitoring and incident response falling on utilities.

Once connected, digital systems provide opportunities to shift some of those responsibilities to integrators and product makers that are providing services, thus reducing the cybersecurity headcount requirements on water utilities. Integrators and product makers can understand and apply cloud software, CloudSCADA, and conditional monitoring, enabling enhanced visibility and rapid detection and incident response — thus expanding security and resilience. This model will enable the vendor to protect thousands of utilities with greater effectiveness due to centralization of expertise and greater ability to distribute costs of security across products in a way that does not yet exist in the water sector.

Xylem is a member of the ISA Global Cybersecurity Alliance, where we are working across multiple product-making vendors of controllers to establish standards for cybersecurity of connected digital technology that leverages what has been learned during the creation of the IEC 62443 standards, and what we are learning now from the effectiveness of cloud-connected systems, to ensure that we can create connected digital technology for the water sector.

We believe this shared responsibility, multibarrier approach to cybersecurity will empower the water sector to combat cybersecurity threats in a way that is consistent with the sector's values and unique challenges.

Prioritizing Cybersecurity Across The Water Cycle

As we continue to adapt our ways of working to maximize the digital opportunity, we must put cybersecurity at the center of the conversation and we must all do our part to help mitigate cybersecurity threats. This means collectively including cybersecurity in all critical phases of water, from product development and supply chain management through to sustainability efforts, so that assets stay current with regard to security best practices and standards. This also means keeping an open mind for new cybersecurity models built on shared responsibilities that specifically address the unique challenges the water sector faces. This approach will require innovation and evaluation to accomplish successful collaborative cybersecurity outcomes.

Xylem is partnering with customers around the world to help them build resilient networks. We embed cybersecurity in every new connected digital product and have a suite of cybersecurity assessment services available that can enable water utilities to understand their cybersecurity capabilities. ■

References:

1. https://www.cisa.gov/water-and-wastewater-systems-sector
2. https://www.isa.org/intech-home/2018/september-october/departments/new-standard-specifies-security-capabilities-for-c

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4 Keys To Adopting INDUSTRY 4.0 At Your Water Processing Facility

As the water industry continues to walk the road of digital transformation, here's a step-by-step guide to help utilities keep pace.

By Bryan Christiansen

Using modern technology to automate processes and equipment in facilities has proven to be beneficial. Successfully integrating digital technology reduces operational costs and streamlines workflows. It also enhances the quality of water treatment and distribution processes.

There is increased pressure on water facilities to serve a growing population. Most of them use aged equipment and distribution networks. That, along with climatic changes, complicates operations in the water sector. Water processing facilities are embracing Industry 4.0 to address these challenges.

Industry 4.0 combines different, interoperable technologies. The digital solutions work in unison to improve the productivity of water facilities. Popular Industry 4.0 technologies for water processing facilities include:

- The Industrial Internet of Things (IIoT)
- Cloud computing
- Blockchain
- Big Data analytics
- Artificial intelligence (AI) and machine learning (ML)

Industry 4.0 revolves around data. Companies utilize data for process improvement, asset management, and performance optimization. Some of the benefits of Industry 4.0 in water facilities include:

- Increasing the efficiency of available water treatment and distribution resource
- Combating water scarcity[1]
- Using innovative upgrades to old water processing and distribution systems
- Predicting floods and droughts and their impacts on water reserves
- Doing real-time analysis of water quality
- Centralizing the management of the workforce and dispersed water equipment
- Reducing operational costs and increasing revenue by using smart meters, leak detectors,[2] and SCADA systems to eliminate nonrevenue water

The adoption of Industry 4.0 in different sectors is expected to grow further[3] as digital technologies mature. The water industry is keen on leveraging digitization to adapt to global water challenges. Industry 4.0 ushers in innovative water management solutions. How can water facilities successfully implement Industry 4.0 in their operations?

1. Identify opportunities for automation with a quick return on investment.

There are endless opportunities for automating water facilities. Some technologies require a short time to implement, while others take time to mature and yield visible results. The variation in implementation timelines depends on the sophistication of technology, cost of acquisition, and availability of expertise. Water facilities that successfully undergo a digital transformation during the early stages of implementation have an easy time upscaling and introducing newer technologies for water management.

Once the company decides to adopt Industry 4.0, the management needs to conduct a facilitywide audit of equipment, processes, and personnel. They must identify the prevalent challenges and suggest relevant technologies to resolve them. The facility then initiates a pilot program and begins automating a small section of processes or equipment.

The company uses the pilot digitization program to collect data on the relevance of various solutions. They evaluate the early success of the pilot program and identify possible bottlenecks or challenges that can derail future implementation. The water facility leverages the lessons from the pilot program to draft policies for full-scale implementation of Industry 4.0 and measures for prioritizing subsequent automation of processes or equipment.

2. Develop a long-term implementation strategy.

Industry 4.0 is a combination of diverse digital technologies with varying levels of success in the water industry. Water processing facilities may shun new technologies out of fear of failure. The most common cause of failure is a lack of a long-term implementation strategy. The challenges of the water sector, like digital technology, are dynamic and change by the day.

Companies aiming to adopt Industry 4.0 must establish a robust implementation strategy and increase the probability of success. An implementation strategy defines:

- The cost of acquiring and maintaining digitization tools and technologies
- Short-, medium-, and long-term digital transformation goals
- Implementation timelines
- Scale and quality of implementation
- Innovative measures for addressing arising challenges during the implementation phase
- Guidelines for prioritizing technology and processes for automation[4]
- Indicators for measuring the success of adopted digital solutions

Water facilities require access to relevant data when developing an Industry 4.0 adoption strategy. They can utilize data from their operations or evaluate how companies from other industries managed their digital transformation. The implementation strategy should estimate the success rates and possible failures likely to accompany digital technologies. The facility must be ready to embrace the different outcomes of digitalization.

3. Train your employees.

Employees are a critical ingredient when implementing technological solutions in the water sector. They understand the shortcomings of different water industry operations. Water processing facility employees provide feedback to improve workflows, streamline equipment maintenance, and eliminate waste. When a company resolves to adopt Industry 4.0, it must engage the employees and provide requisite training to enable them to exploit advanced digital tools or solutions.

Training sessions are instrumental in driving a culture shift among employees. It is common for experienced workers to shun digital technology over fears of job losses or salary reduction. A well-structured training session is a powerful utility to convince employees of the benefits of new technology. Gaining buy-in from all levels of the organization improves the adoption and implementation of Industry 4.0 solutions.

Water facilities use training sessions to showcase the technical capabilities of different solutions. Field and office workers demonstrate their comprehension of the digital tools and provide feedback for improving them. Such inclusiveness boosts employee morale and enhances the integration of solutions to routine activities. The early success of digital solutions manifests as better productivity and visibility of operations.

4. Continuously explore opportunities for improvement.

Adoption of Industry 4.0 follows a continuous learning path. Apart from streamlining routine operations, the facility should focus on achieving excellence in water management. Industry 4.0 technologies collect vast amounts of data critical for decision-making and operational improvement. The availability of accurate computerized maintenance management software (CMMS)[5] data improves predictive maintenance of assets, real-time monitoring of water processing systems, and better communication with customers.

Water facilities can enhance the success of Industry 4.0 by systematically updating digital tools and exploring opportunities for integrating advanced solutions like blockchain for water management. Evaluating the performance of each technological solution enables the company to identify its efficiency. That way, the facility can scale up the implementation of high-value digital solutions. Continuous improvement involves periodically training employees to upskill them and acquaint them with changes in digital technology.

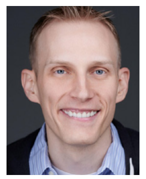
Summing Up

Industry 4.0 is the next big thing in the water sector. The potential of the different technologies will change the fortunes of the companies in the water sector, enabling them to compete favorably against other industries. Companies can enhance the success rates of new technology through a culture shift, strategic implementation, training, and continuous, data-driven improvement. ■

References:

1. https://www.unwater.org/water-facts/scarcity/
2. https://www.wateronline.com/doc/how-acoustic-leak-sensing-devices-and-data-analytics-can-save-billions-of-gallons-of-water-0001
3. https://www.marketsandmarkets.com/Market-Reports/industry-4-market-102536746.html
4. https://limblecmms.com/blog/industrial-maintenance-automation/
5. https://limblecmms.com/cmms/

About The Author



Bryan Christiansen is the founder and CEO of Limble CMMS. Limble is a modern, easy-to-use, mobile CMMS software that takes the stress and chaos out of maintenance by helping managers organize, automate, and streamline their maintenance operations.

HOW PREVALENT AND DANGEROUS IS PESTICIDE CONTAMINATION?

Add pesticides to the list of contaminants that are prevalent in U.S. drinking water and can cause severe health impacts, including cancer and Parkinson's disease.

By Miguel Leyva

Unfortunately, there is a myriad of toxic agents that can lead to drinking water contamination, from heavy metals such as lead and arsenic to chemicals such as per- and polyfluoroalkyl substances (PFAS), which have recently garnered much attention. However, pesticides are contaminants that few people imagine lurking in their drinking water. The term "pesticides" encompasses all substances whose purpose is to control pests, and they can be herbicides, insecticides, rodenticides, fungicides, and many others. Pesticides have a crucial role in food production as they protect yields and increase the number of times a crop can be grown on the same land.

Over 1 billion pounds of pesticides are used across the United States every year. America ranks second after China[1] when it comes to countries that employ the largest amounts of pesticides. Pesticides are currently used on 900,000 farms and in 70 million households in the U.S.[2] While 75% of pesticides are involved in agriculture, 85% of American households have at least one pesticide in storage, and 63% of families have one to five pesticides at home. Pesticide use in the country has grown because not only must the ever-increasing population be supplied with food, but crops and food need to be grown for export, too.

While pesticides are very effective in keeping weeds, insects, and rodents at bay, they are extremely harmful to our health. Exposure to pesticides, whether direct or indirect, can lead to numerous terrible, debilitating conditions and diseases over the years.

Indirect pesticide exposure occurs by drinking or cooking with contaminated water. For instance, glyphosate, a dangerous and highly toxic herbicide popular in the U.S., is very soluble in water, at 1.01 grams per 100 milliliters. Therefore, boiling alone cannot remove glyphosate from drinking water. Pesticides that are applied to farmlands, lawns, and gardens can easily make their way into groundwater, as well as surface water systems that feed drinking water supplies. Pesticides lurk in up to 41% of supply wells[3] that provide households with drinking water.

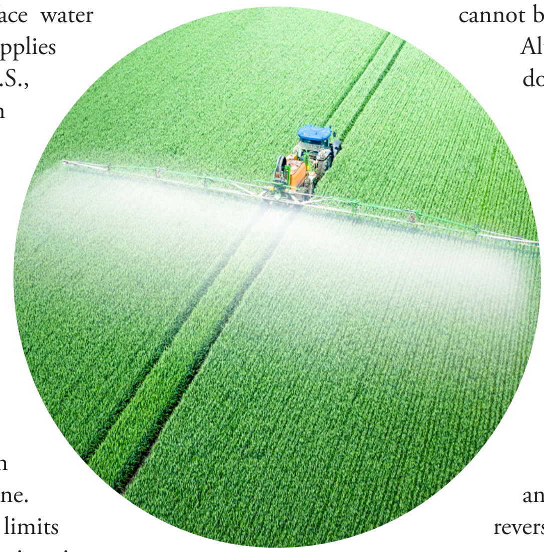
How Do Pesticides End Up In Drinking Water?

Before reaching municipal water systems, pesticides first contaminate groundwater, as the soil they permeate facilitates this process. Pesticide contamination of groundwater is a very serious subject, since groundwater is used for drinking water by roughly 50% of America's population.[4] This is a great concern for people who live in the agricultural areas where pesticides are most often used. In fact, a whopping 95% of this demographic relies exclusively on groundwater for drinking water.[5]

Pesticides enter the hydrologic system from point and nonpoint sources like most water contaminants. The former are specific release points, such as pesticide manufacturing plants, whereas the latter are diffuse and widely dispersed. Nonpoint sources are the dominant ones for pesticides found in streams and groundwater. These include runoff to streams from agricultural and urban land, deposition of pesticides from the atmosphere, and seepage to groundwater in areas where pesticides are used.

There are plenty of factors affecting groundwater contamination with pesticides, such as the pesticide itself. This refers to the active ingredients, the additives mixed with the active ingredients, and how long it takes for the pesticide to break down. Other factors include the pesticide's mobility in soil, whether the pesticide is soluble in water, microbial activity, soil temperature, and irrigation management. Irrigation heightens the chance that the pesticide will migrate to groundwater and surface water. Irrigating at a speed exceeding the soil's infiltration rate will result in runoff that carries the pesticide with it.

Consequently, because pesticides can easily make their way into groundwater, which is the primary source of drinking water for many people, surface water systems that feed drinking water supplies most likely contain pesticides. In the U.S., approximately 15% of the population (about 43 million people)[6] relies on water from their private wells, but these are not regulated under the Safe Drinking Water Act (SDWA).



What Are The Health Consequences?

The health effects of pesticide exposure depend on what substance an individual has been ingesting. Two of the most common pesticides in drinking water are atrazine and simazine. Both are regulated and have maximum limits — 3 ppb for atrazine and 2 ppb for simazine. Nonetheless, there are a lot of other pesticides present in drinking water that are not regulated. This is a serious cause for concern. There are thousands of chemicals being washed into U.S. waterways. This includes many pesticides, out of which only 100 are monitored and regulated by the U.S. EPA.[7]

Usually, it takes several years of mild to severe exposure to pesticides for an individual to manifest disease. The level of contamination that poses a risk to human health ultimately depends on the toxicity of the pesticides, the amount present in the water, and the extent of exposure that occurs daily when using contaminated drinking water.

Among the unhealthy conditions and diseases, contamination with pesticides causes neurotoxicity, cancer, and Parkinson's disease. The pesticide notorious for causing the latter disease is paraquat, one of the most prevalent in the United States. Farmers in America use over 8 million pounds of paraquat annually on crops such as peanuts, wheat, citrus, soy, corn, almonds, garlic, pears, grapes, and strawberries. Paraquat is soluble in water and is most likely to contaminate drinking water when used together with atrazine or simazine. Still, it can end up in drinking water by itself as well.

Paraquat exposure causes Parkinson's disease[8] by damaging the brain region that releases dopamine, medically known as *substantia nigra*. Dopamine is one of the neurotransmitters in our bodies responsible for sending messages to the area of the brain that controls movement and coordination, among others. In people with Parkinson's disease, movement and coordination are severely affected, these symptoms being hallmarks of the disorder. Sadly, Parkinson's disease is irreversible, has no cure, and the symptoms typically worsen over the years.

How Can This Issue Be Minimized?

The EPA has drinking water regulations for about 100 contaminants, including pesticides, and the SDWA includes a process that the EPA must follow to identify and regulate new contaminants. Concerning pesticides and other drinking water contaminants, the EPA's responsibility is to set legal limits for these as the contaminants' occurrences in drinking water cannot be avoided entirely.

Although the EPA monitors and regulates dozens of drinking water contaminants, many pesticides are not regulated. While municipal water systems treat drinking water with chlorine to kill bacteria and viruses, this substance removes only 60% of the pesticides present in the water.

Combining oxidation by chlorine with a coagulation-flocculation-decantation process is more effective in getting rid of pesticides from drinking water. Individuals can make the water in their household safer to drink and cook with by using charcoal filters and reverse osmosis (RO) treatments. Water filters are a good option to remove pesticides, at least partially. They are easy to use and relatively inexpensive. RO treatment that entails activated carbon filters supposedly removes between 97% and 99% of all pesticides, insecticides, and herbicides from drinking water. ■

References:

1. https://www.worldometers.info/food-agriculture/pesticides-by-country/
2. https://people.forestry.oregonstate.edu/steve-strauss/sites/people.forestry.oregonstate.edu.steve-strauss/files/PestUse1996.pdf
3. https://beyondpesticides.org/dailynewsblog/2021/01/millions-of-people-drinking-groundwater-with-pesticides-or-pesticide-degradates/
4. https://www.usgs.gov/news/featured-story/quality-nations-groundwater-progress-national-survey
5. https://www.usgs.gov/special-topics/water-science-school/science/pesticides-groundwater
6. https://www.usgs.gov/mission-areas/water-resources/science/domestic-private-supply-wells
7. https://www.washingtonpost.com/national/health-science/in-us-drinking-water-many-chemicals-are-regulated--but-many-arent/2016/06/09/e48683bc-21b9-11e6-aa84-42391ba52c91_story.html
8. https://www.atraxialaw.com/news/does-paraquat-exposure-cause-parkinsons-disease/

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As the case manager at Atraxia Law, Miguel Leyva specializes in gathering and organizing the information about paraquat exposure and Parkinson's disease he receives from people whose health was affected by pesticides. He also supports agricultural workers and their families in defending their injury claims filed with paraquat manufacturers.

LEAN TECHNIQUES CAN HELP IMPROVE WATER AND WASTEWATER OPERATIONS

All the rage in the private sector, "lean" principles – smoothing out processes to remove non-value-add parts – can also bring greater efficiency to utility operations.

By Emily Newton

Lean techniques, inspired by lean manufacturing, can help improve inefficiencies, reduce waste, and speed up output if the core principles are met. When they first entered the scene in the 1980s, they were very much tailored for the manufacturing industry alone. The concept has evolved over time, and many businesses now use it across a vast array of industries.

An area where it can really make a difference — yet is rarely implemented — is in utilities. Water and wastewater facilities can implement lean techniques to improve operations. Moreover, the paradigm is an excellent way to reduce operating costs, considering that water maintenance and management operations can be extremely expensive.

Breaking Down Lean

As presented by the Lean Enterprise Institute (LEI), a renowned purveyor of the concept, five key principles[1] make up the entire strategy. Those are value, value stream, flow, pull, and perfection, and they often progress in that order.

1. Define Value: Value is best described as what the customer is willing to pay for, and how you achieve that synchronization. Use qualitative and quantitative measures to discover and understand that value.
2. Map the Value Stream: Mapping out the value stream includes identifying every factor that adds value. Anything that does not is considered waste. The idea is to identify nonessential waste, which can be avoided or reduced, and necessary waste, which is a natural byproduct of the value stream.
3. Create Flow: You must create a reliable, mitigated flow, which becomes the general operation. Continue to focus on value-adding activities most of all, adapting your operation to prioritize a smooth process.
4. Manage Pull: Managing or establishing pull involves limiting inventory, resources, and other items that often contribute to greater waste, like work-in-process (WIP) items. The pull system is specifically designed to empower just-in-time delivery and applications.
5. Perfect the Process: The entire team must work together to eliminate waste and strive for complete perfection through consistent improvements.

You'll need to develop a data collection and audit process[2] to better understand these key principles and how they're applied within your operation.

Of course, another pertinent question arises while reading these key factors. *How does this apply to water and wastewater facilities?*

Implementing Lean Techniques In Water And Wastewater

The overarching goal for any utilities provider or plant is to create as much value as possible while expending fewer resources. You're trying to achieve maximum output with zero waste.

Work your way through your current operations, studying your business purpose, active processes, people, and performance. The key principles of lean can be implemented at each of these stages to improve the entire organization.

What is the purpose of the business? The company may be focused on revenue by providing a service or product, but what about the core values, mission, and vision? What else is the organization trying to achieve?

That purpose can be applied throughout the lean implementation to achieve more specific goals. Are you trying to make active processes simpler while using fewer resources? Would you like to see better output?

Taking that a step further, what existing conditions or applications affect the operation? For example, industrial water treatment is incredibly vital to manufacturing processes[3] and any organization that utilizes a clean water supply. Could scale or corrosion buildup be interfering with your purpose and performance? What new policies can you enable to mitigate that problem? How can you do it without expending an inordinate number of resources and creating a host of new responsibilities and roles?

Concentrate on the people your operation serves, along with team members who create that value. Start collecting feedback that can be used to further improve activities. What inefficiencies have they identified? How can you remove those modifiers from the equation?

Finally, study and work to improve performance. Don't just measure things in terms of output, but also consider your active goals, like waste levels, resource usage, and people's demands. The focus during this phase would be community involvement[4] and how the surrounding landscape can be improved to help the operation while reducing waste.

Don't just measure things in terms of output, but also consider your active goals, like waste levels, resource usage, and people's demands.

Parsing Lean Techniques To Improve Operations In Water And Wastewater

Anything that does not bring value to the operation or the people you serve should be immediately removed from the general process. That is the inherent goal of lean manufacturing. You can then focus on improving existing applications to further boost output, efficiency, and consumption.

In wastewater, this would entail taking a closer look at the entire business, from how and where water is collected to how it's processed and beyond. What can be changed to improve that output and make the work far less costly and time-consuming?

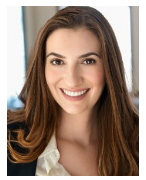
The mean time to make repairs and confront failures plays a huge role in output and performance as well. When something goes wrong, what is the process for identifying and remedying the situation? That could be hundreds, if not thousands, of dollars of resources going to waste from spilled water during a pipe or system leak. The longer and more convoluted your maintenance process is, the more that goes to waste. That also applies to how your team administers support.

Getting a lean system in place means perfecting those smaller tasks to reduce completion time, improve success, and further bolster budgets. It's not just about vague implementations across the board. It's about really digging in to understand the entire operation and what can be done better and leaner. ■

References:

1. https://www.lean.org/lexicon-terms/lean-thinking-and-practice/
2. http://www.jett.dormaj.com/docs/Volume8/Issue 4/Using Lean Principles in Water Maintenance Operations with Application to Water Treatment Plant.pdf
3. https://www.chardonlabs.com/industries/manufacturing/
4. https://revolutionized.com/sustainable-groundwater-management-guide/

About The Author



Emily Newton is an industrial journalist. She regularly covers stories for the utilities and energy sectors. Emily is also editor-in-chief of Revolutionized (revolutionized.com).