

wave

Insights from Veolia Water Technologies



BIOSTYR® IMPROVES HEALTH OF LONG ISLAND SOUND

The Power of Reclaimed Water

CRAFTING H₂O – THE SCIENCE AND ART OF BEER MAKING

New Horizons for Sludge

EFFECTIVE SLUDGE MANAGEMENT AT REMOTE MINING SITE

Increase the value of water



WATER TECHNOLOGIES

Through its innovative solutions, Veolia Water Technologies enables industry, local authorities and citizens to optimize their use of resources for more efficient, environmentally-friendly and socially responsible outcomes.

We understand the value of water resources, and we preserve them by supplying high quality water, treating and reusing wastewater, producing and/or recovering energy, extracting raw materials and capitalizing on valuable byproducts.

www.veoliawatertech.com

Resourcing the world



wave

Insights from Veolia Water Technologies



Cost-effective water solutions

Veolia Water Technologies specializes in water treatment solutions and provides the complete range of services required to design, build, maintain and upgrade water and wastewater treatment facilities for industrial clients and public authorities. We help cities and industries to manage, optimize and recycle water.

Our portfolio of technologies features everything from state-of-the-art water and wastewater treatment technologies to evaporation and crystallization, energy-producing sludge treatment, desalination plants, and mobile water services. These innovative technologies maximize energy production and product recovery, allowing our clients to extract raw materials and capitalize on valuable byproducts. What is discarded by some becomes a resource for others.

We develop access to these resources through standardized technologies, state-of-the-art customized solutions and water reuse techniques. By optimizing both treatment processes and technologies, we help our clients reduce their water footprint while generating considerable savings in energy and chemical consumption.

Veolia is furthermore the only company in the world that can combine all that expertise, process knowledge and our existing digital solutions into one comprehensive digital service package, Aquavista™, which supports and enhances the operation of industrial as well as municipal installations.

This magazine highlights a number of articles about our technologies and solutions including some of our references in North America, and I hope you will find it an interesting read.

A handwritten signature in blue ink, appearing to read 'Klaus Andersen'. The signature is fluid and cursive, with a prominent initial 'K'.

*Klaus Andersen
CEO, Veolia Water Technologies Americas*



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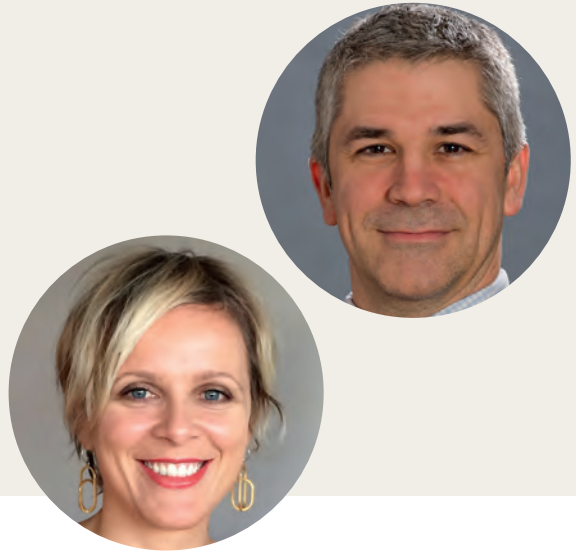
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SMART WATER

Interview with Jean-François Nogrette, CEO & Aude Giard, Chief Digital Officer Veolia Water Technologies



What are the main challenges facing the water world?

Jean-François Nogrette: We often talk about the issue of access to water. This is of course a very important topic that needs to be addressed, along with access to sanitation and the importance of water reuse. But there is another topic that we don't address as much, and that I feel is very important, and that is the issue of trust.

In many parts of the world, we are sharing, exchanging and reusing water in various ways, through many different partners at a much faster pace than ever before. These exchanges must be based on trust, and trust can only be established through information.

Information about water quality, of course, quality of the water coming in, quality and composition of the water going out, but also information about chemical consumption, about the amount of sludge generated, of biogas produced and energy used. Information about hydraulics, about the network, even about the weather.

This information must be accurate and reliable; it must be available in real time, over a long period of time.

How can we get accurate and reliable information?

JFN: This information can be obtained by establishing the digital plant.

For me, the digital plant is a lever to boost operational performance and it is also a way to solidify a long-term pact with the client. This pact of trust is based on real-time data paired with water treatment expertise and a worldwide benchmark.

The world is changing fast. Technologies need to respond to an increasingly complex environment and help us address the challenges of water scarcity and water reuse. And as I mentioned before, they need to somehow secure the trust of the client and of the end-user.

Water is either an ingredient of our customer's value creation or a cost of compliance but either way, it needs to flow as per expectations. Implementing a digital plant can help clients focus on their own business

value and on the performance of their daily operations.

These digital tools need to be flexible, they need to be available 24/7, and most importantly, they need to be available on a highly secured Cloud platform. This is how we can provide information to our clients and establish a long-term relationship based on trust.

Could you give us an example of the benefits of a digital plant?

Aude Giard: Yes of course, we have several projects. One example is our customer BlueKolding who optimized its energy consumption thanks to our digital offer AQUAVISTA™.

BlueKolding is an environment, energy, and climate company which covers the entire municipality of Kolding in Denmark. They are inspired by the concept of blue economy and are constantly working to find new ways of exploiting the resources in wastewater and improving processes to clean it.

Veolia has been working with BlueKolding for several years. In

2017, they decided to adopt our digital service offering, AQUAVISTA™. Doing so gave them access to a sort of digital autopilot at the service of energy optimization, while maintaining robust and sustainable water treatment.

They had the flexibility to choose which features of AQUAVISTA™ they wanted to activate on the processes in their plant. They have access to real-time cloud-based information that optimizes energy use and energy production through biogas. It also optimizes sludge production and recirculation, and chemical usage.

To what extent does AQUAVISTA™ help municipalities and industrial companies better operate their plants?

AG: AQUAVISTA™ is a complete suite of digital services using internet-of-things, advanced analytics and our water treatment expertise. We developed AQUAVISTA™ on several of our existing technologies, on solutions provided to our customers during these past few decades, based on our design & build experience. We are really lucky to be able to take advantage of the many decades of experience gathered by Veolia Water

Technologies. Innovation is in our DNA and we count on this new offer to improve the operations of our clients' plants.

But AQUAVISTA™ is not just one offer, it presents four different modules which can be adapted to the different needs.

One of these modules, called AQUAVISTA™ Portal, is a customer portal which provides real-time remote monitoring of equipment and alert management.

The AQUAVISTA™ Plant, our most complete offer, is a stack of remote-control algorithms that embed 25 years of process knowledge from our engineers in Denmark. This product provides real-time remote controls on drinking water and wastewater treatment plants (municipal and industrial).

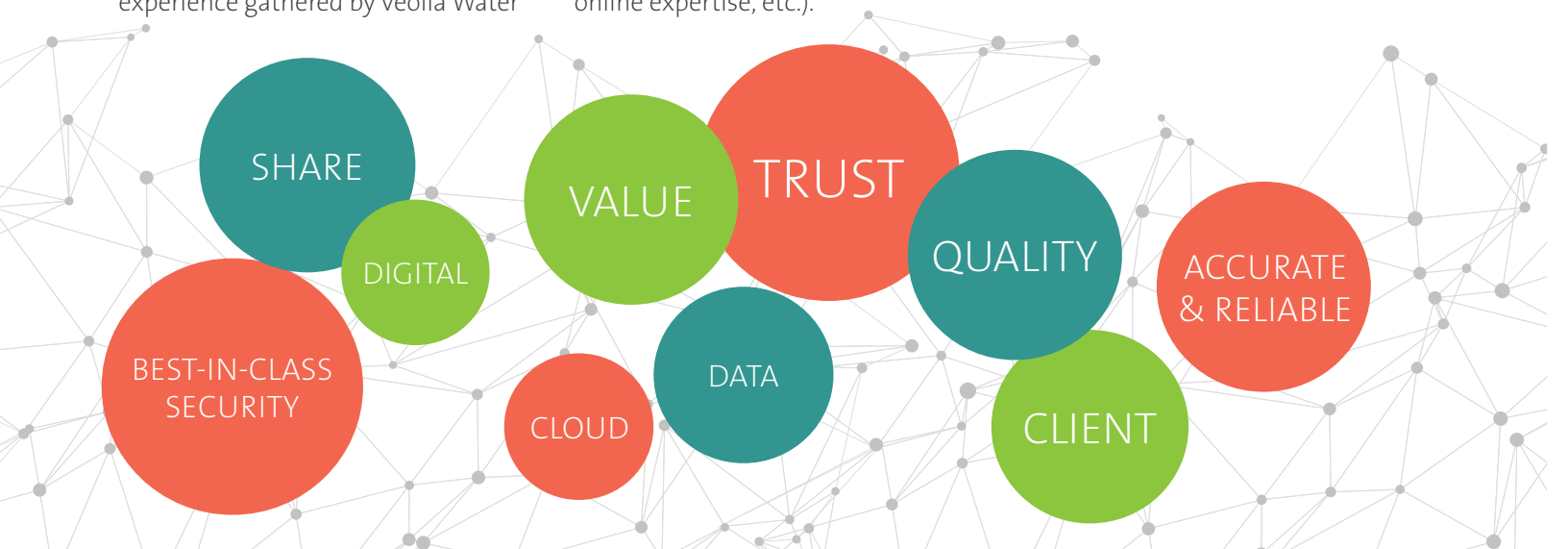
We have some other modules in the pipeline, for example, a module called "Assist" which aims to provide our customers with remote expertise by giving access to the network of Veolia Water Technologies process and commissioning engineers (water quality reports, compliance reports, online expertise, etc.).

And we have an "Insight" module, based on more advanced analytics, looking at long-term data, liaising operational information and financial information to deliver business decision KPIs and enable operators and managers to simulate the impact of an operational decision.

As a digital services solution, AQUAVISTA™ is value driven. Our ambition is to deliver high-value services to our customers and address their key business stakes and industrial challenges :

- increase their operational efficiency and plant uptime;
- improve their water quality, anytime and anywhere;
- ensure the effluent complies with regulation and results in a smaller environmental footprint;
- work on the complex energy exchanges between the plant parameters: biogas management optimization, SMARTGrid and energy balance, water network optimization, etc.

Connecting our customers to AQUAVISTA™ will make them better operators of our technologies and will boost their own value creation. ●



AQUAVISTA™

The water digital service



AQUAVISTA™ Portal

KEY FEATURES

Single point of reference for all information relating to your water treatment system:

- real-time remote monitoring of equipment data,
- dynamic alarm management and information for operators,
- key information about service contracts and reports,
- archive of all service and sales orders,
- access to equipment data: user guides, performance documents, calibration certificates, documentation for a specific site, O&M manuals and training videos/materials for operation of selected technologies,
- notification of events for equipment.

ADDED VALUE

- Improves preventive maintenance through dynamic alarm management,
- access data from multiple sites via a single point of entry,
- private and secure,
- 24/7 managed service,
- ATAWAD: Any Time, AnyWhere, Any Device,
- improves convenience and simplifies operations.



AQUAVISTA™ Insight

KEY FEATURES

Through remote access to an information dashboard, benchmarks and suggestions for process optimization, AQUAVISTA™ provides:

- key operational information overview,
- analysis of technology units' performance,
- global benchmarks (comparison, scenario and optimization).

This data-driven optimization of equipment performance could ultimately result in a full auto-pilot solution.

ADDED VALUE

A dashboard for managers, operators and engineers, built in conjunction with the existing AQUAVISTA™ Portal and leading to:

- global benchmarking,
- continuous optimization review,
- monitoring of key performance indicators.



AQUAVISTA™ Assist

KEY FEATURES

Support operators' treatment processes through access in real time to knowledge, digital training and a network of process engineers for:

- › advice in a timely manner, enabled by data as well as a consistent platform,
- › a better understanding of the specific end users' operations,
- › an improved risk mitigation to meet your challenges (compliance, plant shutdown, etc.).

ADDED VALUE

- › Community management where operators can communicate and share knowledge with other operators and Veolia process engineers.
- › Operators can request support from Veolia Water Technologies (site visit, online assistance for maintenance service, troubleshooting, emergency support).



AQUAVISTA™ Plant

AQUAVISTA™ Plant is a holistic solution:

- › a suite of intelligent software solutions,
- › a state-of-the-art plant overview,
- › an online control & forecasting tool.

AQUAVISTA™ Plant is implemented across several countries with hundreds of plants already connected.

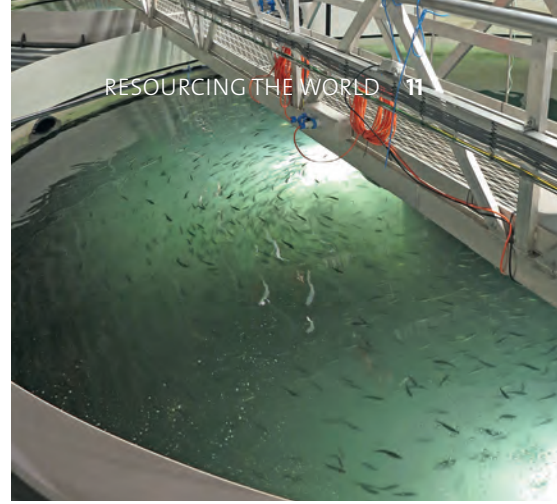
It is suitable for small and large municipal and industrial plants.



AQUAVISTA™

DIGITAL SERVICES





The importance of intake water

Ensuring success at large-scale recirculating aquaculture facilities

Inland fish farms utilizing recirculating aquaculture systems (RAS) will be key players to help meet the global demand of fish production. The number of inland RAS systems is expected to skyrocket in the near future. According to independent research and advisory firm Lux Research, by the year 2030 more than 40% of the world's global aquaculture production volume will be grown in advanced RAS systems.

There are numerous factors for fish farmers to consider as they develop RAS projects and evaluate potential site locations. An experienced workforce, geographic proximity to key markets, climate, environmental regulations, and of course, available water sources and the ability to discharge water are a few of these considerations. Therefore, it is important to undertake an in-depth analysis of the physical, chemical, and biological characteristics of a potential site's water source.

The importance of intake water quality

Water quality is the most critical element of a RAS system. It helps ensure satisfactory fish health and can even affect the quality of the harvested product. The newest generation of large-scale RAS systems are engineered to be very efficient in recycling and maintaining water quality within the system. Though these systems are considered to be closed-loop and can recirculate more than 99.5% of the water, they still require a large amount of high-quality intake water to continually replenish the system.

"It is vital to thoroughly evaluate all water sources

in the early stages when developing a new aquaculture project," says Frédéric Gaumet, Ph.D., Business Development Manager of Aquaculture for Veolia subsidiary Krüger Kaldnes in Norway. "Performing this analysis at the start of the project can help avoid expensive equipment retrofits to properly treat incoming water."

Understanding your water source

Though aquaculture has a very low water footprint when compared to other agribusinesses, it still depends heavily on a reliable source of water. Managing water resources efficiently can contribute to the overall success of a facility's operation. Because of this, water should be a leading factor during the site selection process. Not only is the available volume of water important, but the physical, chemical, and biological characteristics are equally significant. Also critical is biosecurity. Regardless of the water source, there should always be upfront water treatment to ensure the water is disinfected to maintain the biosecurity at the facility. Depending on the water source, additional treatment may be needed to ensure a successful RAS operation.

Most likely, water sources at a potential site will be one of these sources: groundwater, surface, seawater, or municipal water. Each water source has its own particular treatment challenges for RAS systems. For instance, surface and seawater may have contaminants and other biohazards that can create biosecurity concerns. It is possible to

use sea or surface water as a supply source, but in all cases, the costs to treat this water should be closely evaluated.

If the site location is in a developed area, facilities will likely be able to connect to a municipal water source. Although these sources are relatively consistent in terms of quality and quantity, making them very reliable, they still present treatment challenges. At the minimum, municipal water will need to be treated to remove residual chlorine and potentially trihalomethanes. The largest downside of municipal water as a source for aquaculture is the cost. This water is usually expensive and can negatively affect the economics of the project.

Groundwater is usually the preferred source of water for inland aquaculture. Firms do have to ensure that the groundwater source can support the volume of water an aquaculture operation consumes year-round. The water supply should also be able to accommodate future production expansions and tertiary water needs, such as fish processing and hatchery and fingerling/fry additions. According to Gaumet, *“Capacity and flexibility are very important. In most cases, a farm uses much more water than calculated only for the RAS.”*

What are some of the key elements to identify related to intake water? Although water characteristics greatly vary depending on fish species and type of system, modern RAS's are able to maintain a very specific aquatic environment. These systems are able to monitor and adjust temperature, pH, dissolved gases, suspended solids, and ammonia. When it comes to intake water, some key constituents can negatively impact the RAS's performance and jeopardize fish health.



Important water characteristics to evaluate when analyzing available water sources

Total Dissolved Solids (TDS)

Total dissolved solids (TDS) are inorganic salts within the water supply. These include calcium, magnesium, potassium, sodium, bicarbonates, chlorides, and sulfates. Though many freshwater fish can withstand relatively high levels of TDS (>400 mg/l), aquaculture facilities may face challenges discharging this water to the municipality or the environment. The sites most affected by this issue are those in inland regions that would prefer to discharge to surface waters. Many states have water quality standards that restrict the discharge of TDS to freshwater rivers and streams. Groundwater sources can have higher levels of TDS, depending on the depth of groundwater and the local geology. The cost to treat or responsibly dispose of higher TDS wastewater can significantly add to the CAPEX and OPEX of the farm.

Hardness (calcium and magnesium levels)

Depending on the geographic location, both groundwater and municipal water are susceptible to having high hardness levels. In most cases, hardness is not harmful to fish health; however, calcium carbonate can precipitate and create deposits within the various RAS equipment. Over time, these deposits can build up on equipment and prevent the RAS from maintaining a suitable water quality to sustain fish health and maximize production. One area most susceptible to hard water is the RAS's biofiltration system. For RAS that use a fixed film bioreactor, scaling can significantly restrict flow and prevent proper biological treatment. If a moving bed biofilm reactor (MBBR) is utilized, deposit build-up on the



carriers can weigh down the media and reduce circulation inside the reactor. In all cases, this can result in poor performance of the biological process and result in an increase in ammonia levels, causing unsafe conditions for the fish. Another area susceptible to scaling is the degasser. Depending on the design of the system, scaling of the equipment can increase and result in harmful levels of dissolved gases within the RAS.

In most cases, intake water concentrations for hardness (CaCO_3) should be under 200 mg/L. If not, it should be treated prior to entering the RAS. One common method to treat hardness is to utilize a high-rate softener that can efficiently remove scale-forming constituents within the intake water before it enters the RAS. This treatment will significantly reduce the possibility of scaling throughout the system.

Sulfate levels

The water's sulfate (SO_4) level is another parameter to analyze in preparation for a RAS project. Sulfate commonly occurs in water sources and usually poses no immediate concern for fish health. However, if intake water is high in sulfates and there is an accumulation of biodegradable

material from spent food or fish waste, it can promote the growth of hydrogen sulfide-producing bacteria. Fish are very sensitive to hydrogen sulfide (H_2S), and the RAS design should anticipate the potential for this condition to occur. If there are elevated sulfate levels in the incoming water, it is important to ensure that the RAS is designed to minimize hydraulic dead-spots and other areas where solids can accumulate.

Organic contaminants

Another characteristic that is sometimes overlooked in a water supply is organic contaminants. Agricultural runoff of pesticides and herbicides from nearby farms can infiltrate the groundwater. This is a greater concern if the water tables are shallow. Since the application of these on crops is seasonal, it will be important to monitor the water throughout the year to identify whether this condition exists. If so, the water needs to be treated prior to entering the RAS to avoid fish harm or accumulation of these organics in the muscle tissue of the fish that can result in poor taste and possible odors. Organic contaminants can typically be removed with the help of an activated carbon filtration system.

Ensuring success with intake water

Building a strong partnership with an experienced RAS technology provider that has an in-depth understanding and expertise in water chemistry and treatment will help to ensure the success of an aquaculture facility. Through careful analysis of the water and pairing the technological mix to ensure the RAS performance, companies can prevent significant oversights that result in unexpected operational and capital costs.

The stakes are high as inland aquaculture transforms itself to be a staple agribusiness. Bioplans and business plans need to be accurate and executable for emerging companies to succeed. Water is a foundational element within these plans. Understanding how water affects a RAS's operation and the fish living inside of it can provide a competitive advantage for future aquaculture companies. ●



New horizons for sludge

Increasing production worldwide, higher cost for disposal, tighter restriction... sludge management solutions are in high demand. New technologies are rapidly multiplying, fueled as well by sludge's potential as a source of energy and potential for phosphorus recycling.

Several drivers are contributing to the need for sludge solutions. A global population of 7.5 billion people, growing at a rate of 200,000 per day, is increasing production of sludge – and all other wastes – all around the world. Sludge problems are exacerbated by the increasing number of megacities, with their populations greater than 10 million.

In Europe, environmental restrictions and shrinking available space are making it more difficult to continue traditional approaches of disposal. For example, Germany is taking steps to prohibit agricultural application of sludge and to require phosphorus recovery. Wastewater treatment plants in urbanized areas also face limits on truck traffic and all factors are contributing to rising disposal costs that can range from €20 to €150/ton.

In North America, attitudes are changing. Sludge is converted to biofertilizer that can be reused, including as a dry pelletized product applied in agriculture and landscaping.

Recovering nutrients such as phosphorus from treated sludge, called biosolids, is being driven by economics and regulatory pressures. Increasingly

important is the recovery of water, which makes up to 99% of untreated sludge, especially in drought-stricken western regions.

Attractive values

Appreciation of sludge's energy producing qualities as a means to fulfilling renewable energy goals is rising. The European Union, for example, has set an objective of increasing to 20% the portion of energy generated from renewable sources by 2020 and to 27% by 2030. In the U.S., utility companies unable to build solar and wind farms fast enough to meet new renewable energy mandates are purchasing energy from sources powered by biosolids.

Proven technologies such as anaerobic digestion, thermal hydrolysis, co-digestion or thermal drying are enabling sludge to be converted into a valuable energy source, with uses varying according to country energy prices. In Germany, for example, sludge producing wastewater treatment plants often consume the energy they produce. In France, plants such as the one being built in Cagnes, are able to export the green energy produced back to the grid while in the UK, sludge is collected from multiple sites and processed in big digesters, with the energy sold on the market.

Sludge is also increasingly being viewed and treated as a source of valuable by-products and agriculturally beneficial ingredients, such as phosphorus extracted from struvite. France-based Veolia Water Technologies has long regarded sludge not as a costly waste but rather a resource

from which to extract value for the benefit of customers. The company is applying an array of technologies to produce energy and fertilizer products from sludge.

Heated response

Coupling thermal hydrolysis with anaerobic digestion minimizes sludge volumes while maximizing biogas and green energy production. Thermal hydrolysis uses heat to break down sludge prior to treatment by anaerobic digestion, considerably increasing the biogas yield and reducing the quantity of sludge for final disposal.

One leading thermal hydrolysis technology, BioThelys™, is being applied to increasingly large projects. In Bonneuil, France, energy efficiency is at the heart of a new wastewater treatment plant which will feature BioThelys™. Energy produced from wastewater will be used to heat the plant and surrounding buildings, while biogas produced from the sludge will be treated and injected into the grid. Dehydrated, digested sludge will be transformed into compost and spread in fields to facilitate agriculture.

In Denmark, the Billund BioRefinery, which features the Exelys® thermal hydrolysis process, treats wastewater and organic waste from households as well as from industrial sources to generate biogas for energy production, reducing the plant's power requirement and creating additional income through the sale of surplus energy, both heat and electricity, to the local grid. Both BioThelys™ and Exelys® technologies can be applied for thermal hydrolysis, depending on the client's need and existing conditions at the site.

Thermal dried pellets

Applying the Biocon™ thermal drying process allowed the municipality of Buffalo, Minnesota, to do much more than simply reduce the biosolids mass from its wastewater treatment plant by 95%;

it also resulted in 70-80% savings of the plant's thermal energy requirements, helping to reduce operating costs by 50% (compared to disposal of wet sludge). In addition to generating inexpensive renewable energy, the remaining biosolids are ready for land application. The Biocon™ dryer is available with the option to operate at low temperature (70 to 90 °C), enabling the client to use different energy sources.

Oxidation power

The Pyrofluid™ thermal treatment solution oxidizes organic matter contained within sewage sludge in a number of countries. At Marne-Aval in France, for example, steam from two Pyrofluid™ furnaces feed an electricity-generating turbine, contributing to meeting the plant's energy needs.

In Hong Kong, Veolia designed and operates the world's largest sludge incineration facilities. With state-of-the-art incineration and flue gas treatment technology, the facility generates 14 MW of electricity that is used to power the plant while up to 2 MW of surplus electricity are exported to the power grid.

Multiplying solutions

Another innovative solution is SOLIA™ Mix, a new generation of solar sludge drying. This process can achieve dry solids content up to 90%, reducing sludge volume and removal costs and opening multiple disposal routes, including agricultural reuse, composting, landfill, incineration and co-incineration. Among Veolia's references is Belchatow, Poland.

Veolia's sludge expertise doesn't stop with energy recovery solutions. The company is constantly looking for new ways to derive value and produce materials that are recyclable or reusable. Its Ecrusor™ depackaging solution turns food





and other waste high in caloric value into useful energy by depacking the waste from its packaging in order to extract the organic material. The process creates a homogenous mixture of liquid and solid organics that can then be conveyed to an anaerobic digester to produce biogas, which can then be converted into energy for use at the facility or for sale back to the grid.

As the multiple drivers combine to increase the demand for new sludge management solutions, Veolia is continuing to work on new technologies and upstream improvements. These include advanced instrumentation and control technologies to optimize the environmental and energy performance of facilities. Work is ongoing as well to improve existing approaches such as the

introduction of low-temperature dryers capable of being used with a heat pump.

Finally, Veolia's patented TurboMix™ mixing system provides improved phosphorus recovery capabilities through its compact, resource-efficient Struvia™ process. In the U.S., new regulations driven by eutrophication concerns and recognition of the potential value of the phosphorus is making recovery strategies increasingly popular. As a result, Veolia is working to increase the Struvia™ system's application range in other parts of wastewater treatment and industrial phosphorus recovery.

Clearly, the future of sludge has never burned so bright! ●

BIOSTYR®

improves health of the Long Island Sound

The New Rochelle Wastewater Treatment Plant, located in Westchester County, New York, discharges to the Long Island Sound. It serves a population base of 65,000 people and is permitted to treat average flows of up to 20.6 MGD. Operating with primary clarification and pure oxygen-based activated sludge treatment since a 1979 upgrade, the plant used to remove only BOD and TSS from the wastewater.

It has long been known that nitrogen discharges into the Long Island Sound are a key factor in its water quality. New SPDES limits issued in 2005 and a negotiated Order-of-Consent would require an upgrade to the New Rochelle WWTP to meet a total nitrogen (TN) discharge limit of 4.0 mg/l or less on average at design flow. In addition, tighter restrictions on CBOD and TSS would be included in the new permit.

Land availability in New York is scarce, so the solution needed to fit on the existing site. Dozens of technologies were evaluated by Savin Engineers, PC, including

pilot-scale testing, to determine the preferred solution. At the conclusion of the evaluation phase, a competitive life-cycle based procurement was bid and the Veolia BIOSTYR® Biologically Active Filter (BAF) technology was selected as the preferred alternative.

The solution

BIOSTYR® is a high-rate biological system that offers full treatment capabilities for BOD, TN and TSS removal in a single process, in 10% of the footprint of other technologies. The system utilizes multiple treatment cells operating in parallel to biologically treat and simultaneously filter the wastewater, producing an effluent free of contaminants and solids.

Biological growth occurs on a fixed bed of innovative BIOSTYRENE™ media, which is contained within each cell and not exposed to the atmosphere. Flow enters at the bottom of each cell and clean effluent collects at the top of each cell. This makes for a very clean installation that fits well into facilities with nearby communities such as urban, densely populated areas.

Process description

To meet the new SPDES permit requirements of this facility, Veolia

designed a BIOSTYR® system containing two distinct stages of operation. The first stage is fully aerobic and targets complete nitrification to convert incoming ammonia into nitrate. The second stage is anoxic in the lower portion of the BIOSTYRENE™ biological filter bed to target denitrification of the incoming nitrates.

The system was designed to meet future flow needs of up to 31 MGD average and 61.5 MGD peak with guaranteed effluent nitrogen performance. In addition to the BIOSTYR® system, Veolia provided an upgrade to the existing pure-oxygen activated sludge system to improve CBOD removal and produce a more stable influent to the BIOSTYR® process.

Results

The New Rochelle WWTP has been operational since late 2014 and has been a tremendous success, reducing the plant TN discharge from 2,000 lb/day in 2014 to 200 lb/day in 2015. Summer and winter performance tests were completed in 2015 to fully demonstrate the system's capabilities, and exceptional nitrogen removal has continued throughout 2016. Thus, the BIOSTYR® system is allowing Westchester County to improve the health of the Long Island Sound. ●





Mobile water treatment anytime, anywhere

Fast mobile water services

Veolia Water Technologies has strengthened its “Anytime, Anywhere” water treatment capabilities by adding 600 and 900 gallon per minute (GPM) Reverse Osmosis (RO) units to its extensive mobile water services fleet.

The new units join a fleet of portable trailers and containerized water and wastewater treatment solutions for temporary, emergency and long-term water treatment applications. By combining various equipment with Hydrex™ chemistries and field services, customers have the flexibility to choose a stand-alone mobile equipment rental or complete, integrated service. Current units in the U.S. fleet are reverse osmosis, Actiflo® Turbo clarification, filtration, softening and demineralization.

Potential applications served include physical and chemical separation for suspended solids, turbidity, hardness and metals removal; membrane separation and demineralization for TDS (total dissolved solids) reduction,

specialty ion exchange and heavy metals removal.

According to Michael Reyes, Veolia’s Mobile Water Services National Sales Manager, the breadth of water treatment capabilities provides solutions for a variety of customer water needs including:

- short and long-term use for planned maintenance and retrofits,
- rental options for peak or seasonal demand,
- permanent supplemental capacity without requiring design/build construction,
- emergency situations.

Reyes refers to a nuclear plant where a short-term, targeted solution was needed for a highly problematic local water supply that threatened to contaminate the seal water in the main reactor clear well.

“In this instance, we deployed our mobile Actiflo® Turbo clarifier system to treat 250 GPM of excess river water, followed by multi-media

filtration. This was an ideal solution because it allowed the client to rent the system on a short-term basis until the flood was contained,” he explained.

The new mobile Reverse Osmosis (RO) rentals can operate in either single or double pass orientation, with flows ranging from 100 GPM up to 600 GPM. The systems are fully automated and come complete with CIP (clean-in-place) capabilities, to meet water purity requirements with a minimal amount of manpower.

The 900 GPM High Recovery RO technology relies upon a patented design and operating function to provide higher recoveries and higher permeate flux rates than traditional RO technology. Through a closed circuit recycling of the RO feedwater, the membranes are less susceptible to fouling by water impurities and are able to capture up to 95% as permeate, reducing needed pretreatment capacities and saving valuable water. ●

The power of reclaimed water

Power generation need not be another source of strain on diminishing freshwater resources. Well-established water reclamation technologies are enabling producers to conserve resources—and money.

Meeting the needs of a planetary population expected to surpass eight billion people by 2025 is requiring more output from fewer resources. In the case of dwindling supplies of freshwater, the strain on the natural resource from economic and population growth, and climate change, can be exacerbated by other demands.

Power generation draws heavily on water resources: the energy sector is responsible for 10% of global water withdrawals, second only to agriculture, mainly for power plant operation as well as for production of fossil fuels and biofuels. As new power plants are built to accommodate the growing population's power needs, increasing amounts of water will be needed for power generation and cooling.

Interwoven resources

In addition to water's importance to power production, energy is also vital to providing freshwater needed to power systems that collect, transport, distribute, and treat it. Each resource is thus interdependent on—and vulnerable to—the other. In recognition of the vulnerability of water, the power industry is

increasingly looking to solutions that conserve water through reclamation, recycling, and reuse.

Multiple solutions

A relatively easy way for the industry to reduce water consumption is to use water more efficiently, such as by increasing the cycles in cooling towers. Another method is identifying non-freshwater sources for cooling, which accounts for most of the water usage in a power plant. This can involve recycling and reusing plant wastewater and/or using treated sewage or industrial wastewater from an external source. Power unit efficiency can also be improved to produce more megawatts per gallon of water used, which also adds to both sustainability and profitability.

One solution for power plants to reduce freshwater usage that is proving increasingly interesting is using reclaimed water or treated municipal wastewater. Use of sewage effluent for cooling began in the U.S. in the 1970s, and it is proven and safe. Today, more than 70 power sites in the U.S. are using treated, reclaimed water—and not just in arid regions.

Highly available, sewage is a virtually risk-free source. It has consistent quality and temperature compared to surface waters. Because secondary effluent is relatively consistent in quality, the treatment process, and the design and operation of the water treatment system, become easier. In addition, the cooling tower blowdown may be able to be returned to the municipality, eliminating one of the waste streams requiring treatment at the power plant.

Reclamation requirements

Several sets of regulatory requirements govern the use of reclaimed water for cooling. Federally, the Clean Water Act requires a permit, issued under the National Pollutant Discharge Elimination System (NPDES) program, authorizing any discharges of pollutants to surface waters. The U.S. Environmental Protection Agency (EPA) implements the NPDES program and has the power to authorize states to issue permits and administer the program.

NPDES permits contain discharge limits determined by the treatment

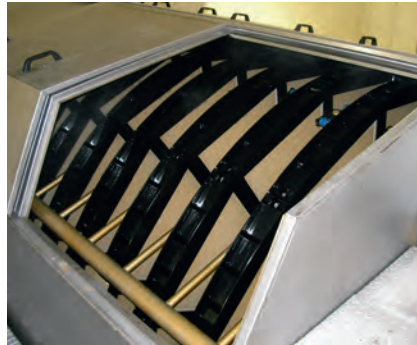
technology that the EPA believes is available and affordable, as well as by the states' water quality standards and available dilution in the receiving water bodies. State rules vary according to factors such as the likely degree of public exposure to reclaimed water. Where exposure is high, reclaimed water must be highly treated. States usually establish limits on fecal or total coliform bacteria and may require that wastewater be filtered before it can be reused as reclaimed water. Turbidity standards are also frequently established.

On the operational side, unique treatment issues posed by utilizing reclaimed water include the need to determine cleanliness levels that must be achieved to satisfy a plant's individual operational requirements. Reclaimed water's chemical elements can cause problems like mineral scaling, corrosion, stress cracking, and biofouling. These problems can increase in closed-cycle cooling systems when water evaporates and leaves behind higher concentrations of constituents.

To control the water quality, power plant operators have a number of options, including removal of some of the concentrated, recirculating water. Flow volumes and makeup can also be adjusted, and incoming reclaimed water can be treated prior to being added to the recirculating system.

What is the best option?

In determining whether use of



reclaimed water makes sense for a power plant, a series of questions need to be asked about the circumstances. Some questions to ask and items to consider include:

- **Does the plant need to meet a specific legal or regulatory performance requirement?** What is the level of water risk in the local area?
- **What are the costs?** The costs of technologies can vary widely. Investment in disc filtration, for example, even for a very large flow may be as low as \$500,000 to \$1 million. While ultrafiltration costs may be three to four times as expensive, other savings such as from running cleaner water through the system or lowering chemical costs may favorably impact life cycle costs. The costs of freshwater resources also are rising in some places and beginning to reflect the true costs of water.
- **What are the benefits?** These may include less immediately tangible, but still important, benefits to the power company's image with key stakeholders.
- **Are there publicly owned treatment works (POTWs) nearby to keep the costs of transporting**

wastewater sufficiently low?

A study by the University of Pittsburgh found that 97% of power plants proposed in the U.S. could meet their cooling needs by utilizing secondary treated wastewater from POTWs located within 25 miles.

- **What technical option is the best approach?** Alternatives could include clarifying systems, disc filters, biological processes, submerged microfiltration, or ultrafiltration membranes.
- **Are there special issues that need to be addressed?** For example, some POTWs have low ammonia levels, while others can be quite high. Chlorine treatment is one option, but breaking down the ammonia requires high levels of chlorine, creating new risks and adding costs. Biological systems may negate some of these concerns, although requirements to maintain a minimum flow circulation even during planned power outages can be a drawback.
- **Is the power company comfortable operating the water treatment system, especially if it's biological?** If not, alternative solutions may be possible, such as having the POTW host and operate it, or outsourcing the operation to the system supplier.

Based on the responses to these and other questions, the right combination of primary and secondary systems to provide the appropriate level of water purity at a reasonable cost can be determined with the help of an expert systems solution provider.

Award-winning treatment

A pretreatment strategy was the approach applied in the growing city of Mankato, Minnesota. The city installed a new water reclamation facility (WRF) to treat effluent from its wastewater treatment plant (WWTP), which would supply the cooling tower needs of an electrical generation plant. In addition to providing quality reuse water for the energy center, the WRF needed to meet new state phosphorus removal regulations.



The city turned to Veolia Water Technologies, a global expert in optimizing water use and wastewater treatment. Veolia provided a two-stage treatment process using a combination of its Actiflo® and Hydrotech™ Discfilter processes. The first-stage Actiflo® process is a compact, extremely high-rate clarification system that utilizes the combination of coagulation, flocculation, and sedimentation, using microsand as a seed for floc formation. The microsand provides surface area that enhances flocculation and acts as a ballast or weight. This first stage was designed to provide phosphorus

removal for all of the WWTP's current and future needs. The second stage provides additional filtration to meet the California Title 22 water reuse requirements, which focus on suspended solids and effluent turbidity reduction.

The system enabled the city to avoid supplying water from its local surface and groundwater supplies to the power facility in order to accommodate the plant's needs. Annual savings for the city from the process changes were estimated to be about 680 million gallons of water and \$1.5 million in potable water costs. In saving its natural water supply and monetary expenses, the city was able to turn waste into a resource.

The effluent water characteristics produced by the Mankato treatment facility are:

- Total phosphorus <0.4 milligrams/liter (mg/L)
- Total suspended solids <5 mg/L
- Turbidity <0.6 nephelometric turbidity unit
- Biochemical oxygen demand <2 mg/L

The water reuse project was the first of its kind in the state of Minnesota and one of the first in the nation. The Minnesota chapter of the American Public Works Association gave the Mankato facility its Project of the Year award following the treatment process upgrade, and it was also honored with a Minnesota Government Reaching Environmental Achievements Together (MnGREAT) award.

Replicated success

Veolia has also helped clients in custom-designing biological processes to resolve other specific treated effluent challenges, such as ammonia. In New Jersey, Veolia furnished West Deptford Energy with a BIOSTYR® biological aerated filter and Hydrotech™ Discfilter system, allowing effluent from a municipal wastewater plant to be reused in the operation of their new environmentally friendly energy station.

The use of recycled water has proven to be a win for the environment and for West Deptford Energy in saving significant chemical oxidant costs while making their power station a model of highly efficient and sustainable energy generation.

After the power plant was operating, West Deptford Energy decided to add ultrafiltration (UF) to further treat the effluent from the Discfilters. The UF treated water was a suitable source for their existing boiler feedwater system, which further reduced their reliance on city water and the cost associated with it.

As the strain on freshwater resources intensifies and energy demand grows, the power industry is increasingly turning to reclaimed water as a highly valuable resource. Reclaimed water offers a win-win solution that ensures the continued ability to respond to rising global demand by an inseparable pair. ●

A “fresh approach” to industrial water utilization

In today’s fast paced, competitive environment, industrial manufacturers need to react quickly and efficiently to changing marketplace conditions with an “out of the box” mentality. Those that don’t often find themselves falling behind their competitors in the rush for growth.

With limited resources, more and more manufacturers are realizing they cannot maintain the focus needed to operate their own production processes efficiently while also operating their utility and process water systems. Therefore, they are leaving the retrofit and/or operation of these systems to trusted suppliers who can provide the quality and quantity of water they require to meet their changing needs in a safe, cost-effective and compliant manner.

Recognizing that clients across all industry segments and geographies are having to react to increasing costs for influent water and wastewater discharge, Veolia Water Technologies has developed an integrated approach to water management using their comprehensive technology and service portfolio.

By developing an overall understanding of a client’s water

balance and its economics through their “ Best Practice Evaluation ”, Veolia develops innovative water **Conservation, Reclaim & Reuse programs** to drive efficiency, reliability and overall cost reduction in the water systems they manage. The objectives of these integrated programs are quite simple:

- To improve the utilization of water in a client’s operation,
- To minimize the amount of influent to and effluent from the facility, utilizing technology to reclaim and reuse water where possible,
- To effectively minimize water problems related to scale, corrosion and fouling which might hamper production efficiency or reliability,
- To minimize the client’s water footprint, reduce their environmental impact, and optimize their total costs of ownership related to the water they utilize.

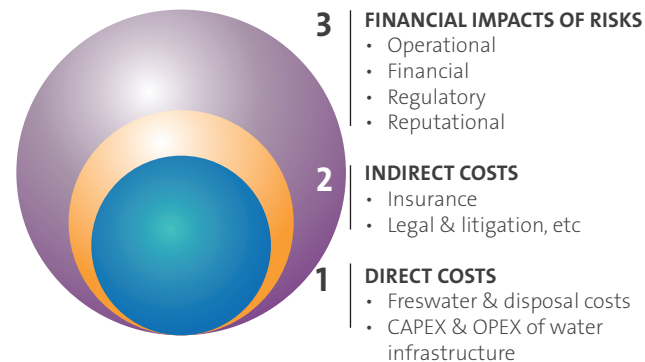
At the foundation of an integrated Veolia Conservation, Reclaim & Reuse program are over 350 water treatment equipment technologies, a complete line of Hydrex® water treatment chemicals, and a bevy of consultative and on-site operational

services. No matter what issues an individual plant may be facing, this comprehensive quiver of products and services allows Veolia to develop innovative and technically sound solutions for even the most demanding of industrial water applications.

Opportunities for manufacturers to improve and impact their water footprint can only be uncovered by first understanding the “True Costs of Water” and its utilization in their plant. This entails a detailed technical and economic audit of every water stream entering a plant, the water being used in a process, and the water being discharged back to the environment.

Once the water balance at a plant has been outlined and documented, Veolia then develops a specific, prioritized summary of potential opportunities by applying its

VEOLIA'S TRUE COST OF WATER MODEL





engineering resources to look at the water quantities and qualities as well as all treatment, production, environmental and manpower costs associated with it. This priority involves looking for improvements in the following areas:

- CONSERVATION – Where can water utilization or performance results be improved, with the assistance of improved chemical treatment, standardized equipment technology, or on-site services?
- REUSE – Where is water being either blended with other waste streams or discharged to wastewater treatment or to the municipal POTW where its quality can provide value back in the plant with little or no investment?
- RECLAIM – Where are there large volumes of water being used and discharged, where an investment in technology could improve the water's quality enough to be used in other applications and eliminate discharge?

Once the list of potential opportunities has been identified and discussed with the client, a full economic assessment is developed to include all factors that will influence the return on investment or payback each will provide the facility. The economic assessment will help to identify which projects stand out as the vital few that will have the largest impact.

Case Studies:

In one such example, a large Midwestern chemical manufacturer was dealing with changing river water quality to its plant, and could not develop a sustainable water plan to enable its 10-year growth plan.

Over an 18 month period, in 6 distinct project phases, Veolia utilized its Actiflo® mobile clarification technology, Filtraflo™ multimedia filtration technology, Sirion™ reverse osmosis technology, Hydrex® chemical treatment technology and Aquaservice™ on-site consultative engineering resources to help the client conserve, reclaim and reuse over 138M gal/yr, with an 11-month payback on its investment.

In another example, an automotive parts manufacturer was using reverse osmosis to pretreat water and heating it for use in cleaning its finished products. The water was then discharged and replaced with fresh city water.

Veolia retrofitted the process by simply installing a UFlex™ ultrafiltration unit on the discharge line from the process. By removing the high

molecular weight solids from the discharge stream, it was able to be reclaimed and reused as makeup to the cleaning process. By recovering the water, which had already been processed through a reverse osmosis unit, and the BTUs contained in it, the payback on the UFlex™ unit, the Aquaservice™ operational contract and the Hydrex® chemical treatment program was 73 days!

Water has become a very precious commodity. The quality and quantity of available fresh water can influence where a production plant is located, due to the importance water plays in manufacturing processes. The proper utilization of this water can also influence a plant's long-term reliability and efficiency. Only through a complete understanding of a plant's water balance can a manufacturer be aware of water conservation, reclaim and reuse opportunities that can influence its top and bottom lines. At Veolia, this is our responsibility to our clients, which we call integrated water management. Some might just call it "A Fresh Approach." ●

Effective sludge management

Pretium Resources Inc.'s Brucejack underground, high-grade gold mine, located in northwestern British Columbia, Canada, started commercial production in 2017. Pretium challenged Veolia Water Technologies Canada to provide a wastewater treatment plant to remove Total Suspended Solids (TSS) and some heavy metals from its new gold mine effluent, using as little land space as possible while producing a solid waste.

Environmental challenges

Veolia was approached by Pretium in 2014 to assist with the permit request of all government instances, to supply a temporary plant used for the exploration and construction phases and ultimately, a permanent wastewater treatment plant to be used once the mine is in operation.

The project brought its own set of challenges, mainly due to the location of the mine: with the mine situated near a glacier, the treated water criteria are very stringent. Furthermore, with no road or air access, the site is only accessible by using a Husky tracked vehicle to cross the glacier.

The available space at the site being very limited, Pretium was unable

to find space to build a pond for primary decantation, which meant that the TSS in the wastewater was correspondingly potentially very high. Space constraints also meant that the treatment chain needed to be as compact as possible.

Optimized technological solution

The permanent effluent treatment system, started-up in 2017, consists of several Veolia proprietary technologies which were selected for their robustness and compactness, starting with the Actiflo® high-rate ballasted clarification process for primary metals removal. The water is further polished by a highly-efficient Hydrotech™ Discfilter, which gives added assurance in meeting very stringent discharge criteria.

A centrifuge was installed to dewater the water treatment sludge. The inlet flow is between 3,200 and 6,000 m³/d.

Veolia operated the temporary plant for more than two years. As can be seen on the figure on page 27, TSS concentration at the treatment inlet (blue bullets) was much higher than

expected during design. As the construction activities increased, the TSS increased gradually to eventually exceed 10,000 mg/L. Even given this, the Actiflo® effluent quality (red bullets) was better than required with an average TSS at the Actiflo® outlet around 8 mg/L.

The Hydrotech™ Discfilter, acting as polishing after the Actiflo®, was able to decrease the TSS even further, with an average of less than 2 mg/L (green bullets). This mining application demonstrated that the Actiflo® can operate with much higher TSS than normally believed, and operated for more than two years with no degradation of performance with TSS at more than 10,000 mg/L.

New heights for sand ballasted decantation

One of the perceived weaknesses of sand-ballasted decantation is the relatively low solid content of the produced sludge. Pretium requested that Veolia produce a sludge that could be dry stacked with over 30% solids. Given the space constraints, the use of a conventional thickener was not possible. The sludge was first thickened by recycling part of

Example of Brucejack Influent and effluent water criteria (in mg/L)

PERFORMANCE CRITERIA	RAW WATER	EFFLUENT CRITERIA (Monthly average)
Total Suspended Solids	2 000	15
Total Aluminum	18.9	0.15
Total Arsenic	0.80	0.005
Total Cadmium	0.011	0.00015
Total Chromium	0.15	0.01
Total Copper	0.37	0.01
Total Iron	88.0	0.25
Total Silver	0.0094	0.00025

ent at Brucejack Gold Mine



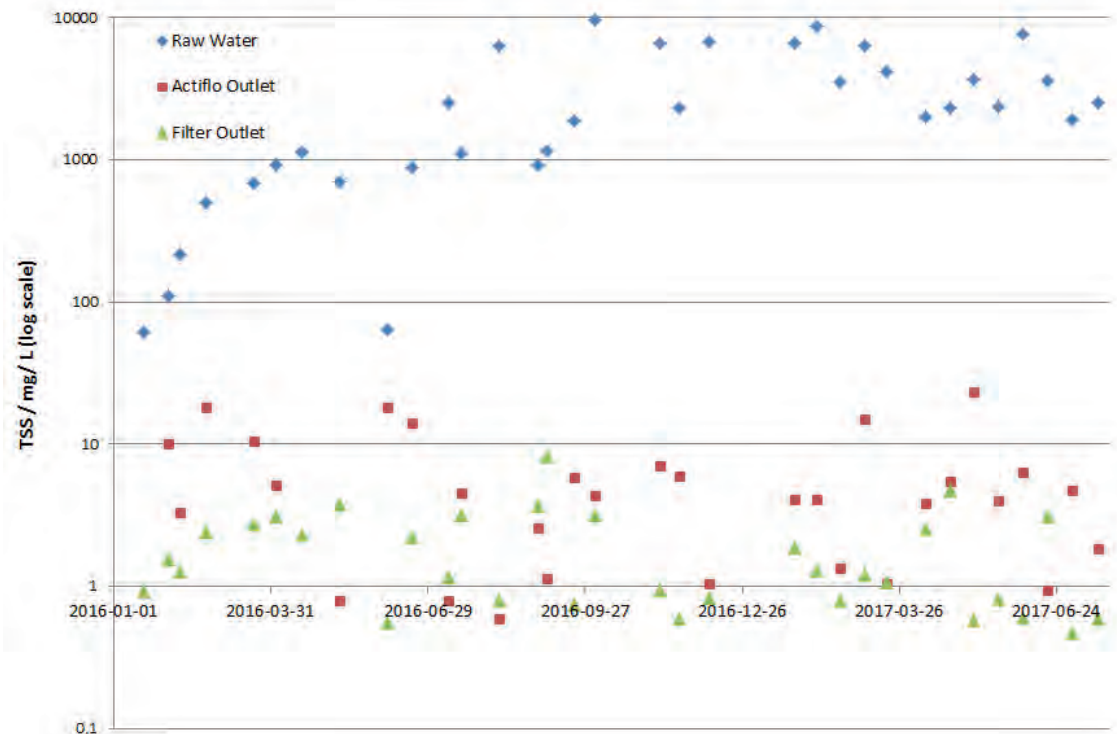
cake produced by the centrifuge was much better than required, while maintaining 24/7 operation and no significant downtime except for normal preventive maintenance.

Veolia was able to meet Pretium's expectation by building a compact and efficient plant. The two years of operation data collected on this project have proved the robustness of the equipment used. The treatment chain used on the project was able to handle more than 10,000 mg/L TSS and to deliver clarified water at less than 10 mg/L while producing sludge at well over 40% solids. ●

the slurry produced by the Actiflo® upstream of the process. To achieve the sludge requirements, Veolia provided an Andritz centrifuge

to dewater the sludge. With a judicious choice of polymers, the sludge solids content was increased from 1.9% to 47% on average.

Brucejack wastewater treatment plant's TSS removal results ▶



Crafting H₂O

The science and art of beer making



Cincinnati-based MadTree Brewing Company is serious about how they make their beer. Their scientific approach means that they also pay close attention to the water they use, a message they're more than happy to share.

The influence of geology on water chemistry and how it affects the flavor of beer has long been recognized. The hard water of Burton-upon-Trent in the UK, laden with calcium, magnesium and sulfates, is used to produce IPAs. Bicarbonate-rich water in Munich and Dublin combined with dark-roasted grains yields the dark German dunkel and Irish stouts, respectively. The mineral-free water of the Czech city of Pilsen gave rise to the Pilsners, surprisingly replicated in another source of soft water: Brooklyn.

Yes, although water comprises 95% of beer, little has been done through the years to try to control the quality of this primary ingredient. Now, advanced technologies are transforming the art of beer making into a science.

For the brewers at MadTree Brewing Company, there's no question of leaving it all up to nature. *"Many brewers take what's provided in terms of the local water source, but we recognize that the quality of the water has a major influence on a beer's profile,"* says MadTree Director of Brewing Operations, Matt Rowe. *"Having control over the incoming water is therefore critical to our ability to ensure the consistent quality and taste of our beers."*

Consistency and repeatability in the quality of their beer production is a mantra that underlies

MadTree's vision to be one of the region's most respected breweries. Launched in 2013 from its base in Cincinnati, Ohio, the company has grown rapidly from a 15-barrel brew house to the second largest beer producer in greater Cincinnati.

To keep pace with demand for its product, MadTree converted a former manufacturing plant into a new 50,000-square-foot brew house and taproom opened in February 2018, with capacity to eventually produce up to 200,000 barrels a year. Reflecting the company's focused approach to its craft, the new facility, dubbed "MadTree 2.0," includes an extensive lab with the latest tools to support quality control and ensure that every beer meets the brewer's precise expectations. Standardizing the quality of the incoming water was naturally a key priority for the expansion.

"We spent countless hours manipulating and charting each batch of beer brewed to achieve a desired result, then defined the specific steps to be repeated to consistently produce the desired recipe and process," says Matt Rowe. *"Controlling the incoming water for our brewing process is critical to ensuring we maintain consistent quality and taste."*



For this, MadTree turned to Veolia Water Technologies, a company with worldwide experience providing water quality and wastewater solutions to breweries, with more than 150 references in North America and Europe.

Veolia's solution includes 100-gallon-per-minute Sirion™ Mega Reverse Osmosis (RO) technology to remove up to 97% of dissolved inorganic and more than 99% of large dissolved organic material, colloids and particles. Prior to the RO, the incoming water is first dechlorinated with sodium bisulfate and softened with an anti-scalant. After passing through the RO, the water undergoes ultraviolet sterilization treatment to remove any residual bacteria before going into a 20,000-gallon permeate storage tank. The water is moving all the time, either being sent to the brewing process, as needed, or recirculated in the tank. Any excess output from the RO is used as water make-up for boilers, increasing the operation's water and energy efficiency.

The ultra-high purity water produced provides MadTree with the flexibility to create individual water profiles for each beer, using ion sources to add desired quantities of calcium, magnesium, sodium sulfates, chlorides and bicarbonate. "With our most recent IPA, Entropic Theory, for example, we went with a higher chloride ratio to accentuate sweetness and increased the magnesium levels to bring a rounder, fuller flavor," says Matt Rowe.

Of particular appeal to the MadTree team was the Veolia system's ability to generate data that can be recorded and tracked to provide historical trending for its systems across the board. With its focus on science and precision, MadTree is using the data to make better and more informed decisions on beer and water.

"MadTree is very scientific about the brewing process and wanted to understand everything



about every step of our processes," says Veolia's Strategic Marketing Director for Industrial Solutions in the U.S., Ted Lawson. "As such, they consider the RO to be an integral part of their business."

Future outlook

Consistent with its methodical approach to beer-making, MadTree is charting a logical, progressive path for regional expansion as its sales and reputation grow, says Matt Rowe. The company also is committed to helping to raise standards in the craft beer industry. One of a small but increasing number of "open source brewing" companies, MadTree readily shares information about its products and processes, posting its recipes online and engaging with home brewers interested in honing their craft.

By seeking to change the paradigm regarding the benefits of a consistent incoming water source, the brewer is helping to ensure that the consumer knows what they're going to get with each can of beer. Says Ted Lawson, *"We were a bit surprised at first with MadTree's willingness to share information with potential competitors, but it's truly part of their philosophy. They're ready to share the information because they don't want bad craft beer out there."*

Maybe it's something in the water.

Follow the electron

Veolia's capabilities for lithium, nickel and cobalt producers

Process Development Expertise

Veolia Water Technologies has a long history of supplying systems for purification, recovery, and drying of inorganic chemicals utilizing its HPD® Evaporation and Crystallization Technologies. State-of-the-art research and development capabilities allow investigation into the behavior of complex multi-component aqueous systems and subsequent optimization of the process design to most efficiently achieve the desired product quality and reduce performance risk.

Unlike typical for hire hydrometallurgical laboratories, Veolia also designs and supplies commercial equipment. Veolia understands how learnings at the lab or pilot scale translate to commercial performance and will take responsibility for the processes that are developed in our facility. We can typically scale up from the laboratory scale directly to offer commercial systems on a design build basis with complete process, mechanical, and schedule guarantees.

Precursor materials for lithium ion battery production must be provided at extremely high purity levels. Nickel and cobalt compounds are particularly sensitive to contamination during the crystallization process. Through our crystallization expertise supplemented with specific testing, Veolia is able to identify the appropriate crystallization processes required to achieve desired purity levels from unique sources with differing contaminant levels.

Lithium Processing Experience

Veolia has supplied several process systems to leading lithium suppliers worldwide as well as having performed analytical, bench and pilot scale testing.

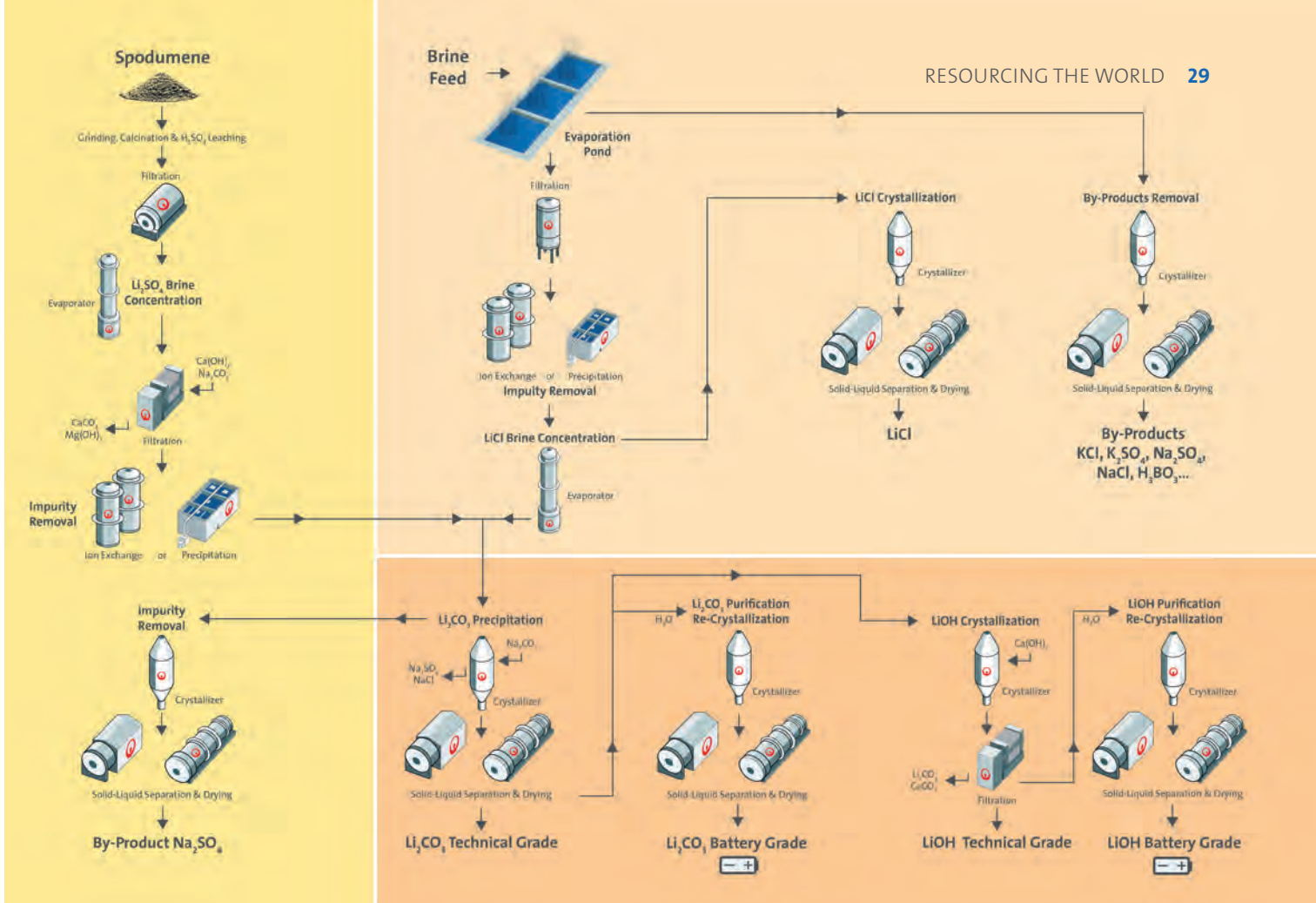
- Lithium brine concentration
- Lithium salts crystallization
- Lithium salts purification by re-crystallization
- By-product recovery from lithium processing
- Impurity removal (precipitation, ion exchange, etc.)
- Solid/liquid separation systems and solids handling

Lithium salts crystallization

- Lithium Chloride (LiCl)
- Lithium Carbonate (Li₂CO₃)
- Lithium Hydroxide anhydrous and monohydrate (LiOH)
- Lithium Sulfate anhydrous and monohydrate (Li₂SO₄)
- Lithium Bromide (LiBr)
- Lithium Phosphate (Li₃PO₄)

By-product recovery from lithium processing

- Potassium Chloride (KCl)
- Sodium Sulfate (Na₂SO₄)
- Sodium Chloride (NaCl)
- Potassium Sulfate (K₂SO₄)
- Boric Acid (H₃BO₃)



Research & Development

Veolia's 5,000 m² Research and Development Center is crucial for development of challenging process designs for HPD® Evaporation and Crystallization technologies.

The facility is home to a wide variety of tools used for investigation of new process designs, testing to support customer projects, and development of new technologies. It is the foundation for design evaluation, feasibility, and process validation as well as improvement and economizing overall system designs.

The analytical, bench-scale, and pilot-scale testing capabilities, with an extensive catalog of data, allows advancement of first-of-a-kind innovations.

This is especially important to design processes for achieving the purity requirements in evolving lithium, nickel and cobalt applications and purity requirements.

Rigorous testing provides the confidence that the commercial system will perform as designed. ●



Veolia Events

Educational seminars

Water is a precious resource and is becoming increasingly scarce. Veolia Water Technologies is committed to helping professionals best manage this resource by holding educational seminars.

These one-day events provide attendees the opportunity to connect with the world's most knowledgeable and innovative experts in water and wastewater treatment. Guests will gain practical insights about the latest trends, technologies, services, and information on how to most efficiently manage water at their own facility.

We look forward to meeting you at our next Veolia Educational Seminar.

Check our website to find out when and where the next Veolia event will be:
www.veoliawatertech.com



Actual Feedback from Past Attendees

"Good variety of topics"

"Presenters knew their stuff"

"Thank you for an informative and interactive day"

"Very informative!"



ACTIFLO®

A high rate clarification process with extremely small footprint

ACTIFLO® is a high rate clarifier exclusively developed and patented by Veolia Water Technologies. With more than 1,000 references all over the world, ACTIFLO® has been in use for municipal and industrial water and wastewater treatment for more than 25 years.

APPLICATIONS

- **Drinking and process water applications** for the production of consistently high treated water quality, with removal efficiencies up to > 99% for Turbidity, Iron, Color, Algae, Arsenic, etc.
- **Municipal and Industrial Wastewater applications,** consistently achieving high effluent quality with removal efficiencies of up to > 99% for Total Suspended Solids (TSS), Total Phosphorus, Heavy Metals, Total Coliforms, etc.

A COMPLETE RANGE OF CONFIGURATIONS

- **ACTIFLO® Duo** Operational flexibility with or without microsand depending on the flow rate.
- **ACTIFLO® Carb** With Powered Activated Carbon (PAC) addition in order to eliminate nonflocculable organic matter,

pesticides and emerging micropollutants.

- **ACTIFLO® Softening** With lime and/or soda addition for decarbonation and water softening.
- **ACTIFLO® HCS** For the reduction of the sludge volume and the associated water losses.
- **BioACTIFLO®** For the online stormwater treatment and the reduction of the soluble BOD.
- **ACTIFLO® Rad** For the removal of radioactive elements from contaminated water at nuclear sites.
- **ACTIFLO® Disc** Actiflo followed by Hydrotech discfilters for treated water polishing.
- **ACTIFLO® Pack** Standardized units for the treatment of any flow rate up to 2,500 m³/h (11,000 gpm).

BENEFITS

- High treatment efficiency:

Eliminates up to > 99% turbidity, suspended solids and associated pollutants

- Extremely small footprint: The process requires little space; it is especially suited for use in restricted areas and ideal for retrofitting existing basins while expanding treatment capacity
- Reduced civil costs: Thanks to its extremely small footprint, significant savings in civil costs are achieved
- Few minutes of hydraulic residence time: Rapid start-up and quick treatment optimization
- Unique process stability, also in the event of sudden flow and/or load variations
- Ideal for automatic and remote operation, including frequent shut-downs & re-starts
- User friendly process: Easy operation, requires minimum operator attention



ACTIFLO® Carb

Optimum treatment for natural organic matter and micropollutants

*Designed to treat and refine water, **ACTIFLO® Carb** combines the fast flocculation and sedimentation performance of Actiflo® with the adsorption capacity of Powdered Activated Carbon (PAC) to eliminate substances resistant to the clarification process.*

APPLICATIONS

- For municipalities and industries
- Drinking water: for the treatment of non-flocculable Natural Organic Matter (NOM), pesticides, emerging micropollutants, micro-algae, odors
- Process water: for refining and treating resistant NOM
- Sewage: to eliminate hard Chemical Oxygen Demand (COD) and other compounds resistant to chemical or biological treatment
- “Reuse”: for the advanced tertiary treatment and refinement of treated sewage

PERFORMANCES

- Advanced Powdered Activated Carbon treatment

- Maximum elimination of NOM and emerging micropollutants (removal of up to 95%)
- Polishing of the treated water
- High sedimentation speed: ≥ 30 m/h

BENEFITS

- Compatible with other clarification processes upstream: Actiflo®, Multiflo™, Spidflow®
- Using Hydrex Biosourced flocculants
- Small footprint
- Simple to commission: start-up in a few minutes
- Easy, low-cost upgrading of existing installations

REFERENCES

Nantes Métropole, France

- 160,000 m³/day



DSM Nutritional Products, Village-Neuf, France

- 2,400 m³/day

Fuyang, Zhejiang, China

- 250,000 m³/day



Harpeth Valley, Nashville, USA

- 90,000 m³/day



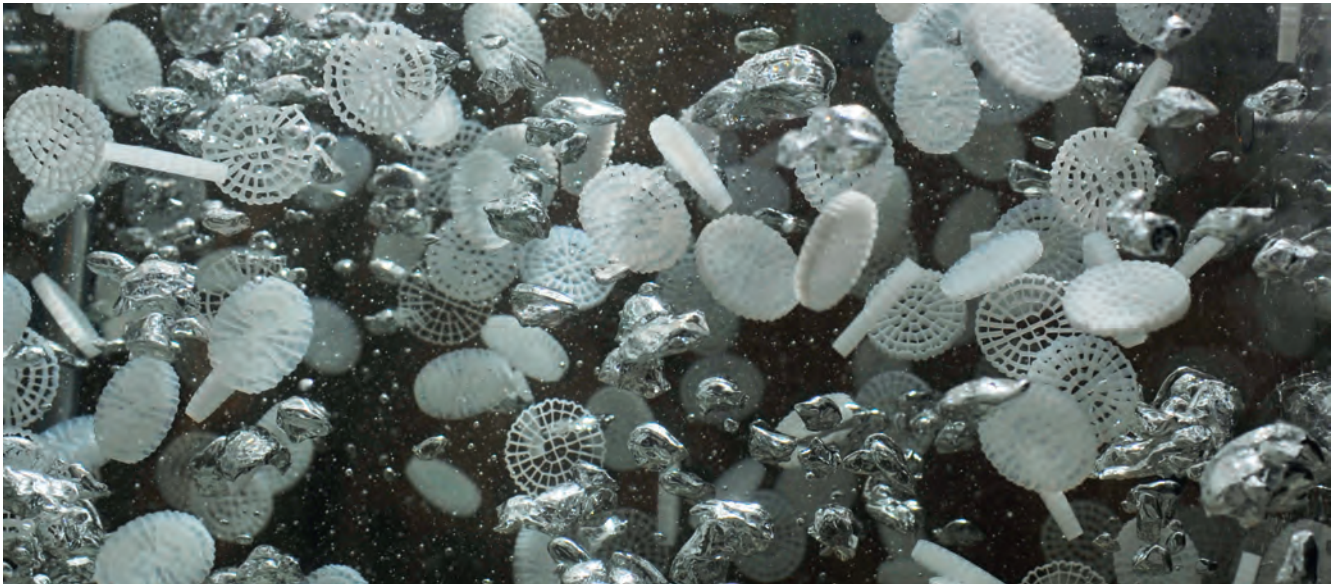
TW Moses, Indianapolis, USA

- 91,000 m³/day

Raffineria di Millazzo, Italy

- 7,200 m³/day





ANOXKALDNES™ MBBR

Leading edge biological treatment

APPLICATIONS

- For new plants, especially those requiring a small footprint and easy operation
- For BOD/COD and nitrogen removal
- As a high loading system in front of existing biological treatment - roughing reactor

PERFORMANCES

- Durable and stable process with high removal efficiency at higher loading rates
- A high level of flexibility allows for optimized solutions
- High tolerance to load variations & toxics
- Worldwide experience with > 800 reference plants

BENEFITS

- Increases the treatment capacity of existing installations
- Small footprint
- Fast start-up and recovery

**1,000+
references
worldwide**

REFERENCES



Hickory Run, PA

Veolia Water Technologies supplied raw water and demineralized water systems for Hickory Run Energy power station, which included Actiflo®, Hydrotech™ Discfilter and AnoxKaldnes™ MBBR technologies. The feed water is effluent from the local public owned treatment works and is used as plant cooling water and boiler feed water after demineralization, conserving 5,000 gpm of fresh water resources.

City of Palmer, AK

The City of Palmer chose Veolia's MBBR system to provide ammonia removal capabilities to ensure the cleanest effluent possible is discharged into the northernmost channel of the Matanuska River. The AnoxKaldnes™ MBBR has proven to be a high-performance process for cold weather applications.



HYDROTECH™ Primary

Smarter solution for carbon diversion

Hydrotech filters are a compact, cost-effective, and easy to operate alternative to conventional primary clarification. Advanced controls offer the flexibility to manage the BOD, COD, and TP loading to downstream biological treatment processes.

APPLICATIONS

- BioEnergy enhancements
- Carbon resource recovery
- Small footprint
- With chemical pretreatment

- Can be used for a variety of applications (primary, wet weather, CSO/SSO, etc.)

ADVANTAGES

- Compact (up to 90% less than conventional)
- Lower energy costs due to reduced load on secondary treatment
- Increased solids capture for energy recovery
- Flexibility to control organic load to biological treatment
- Easy to install, operate and maintain

REFERENCE

Stavange, Norway

- 64 MGD
- Followed by a Bio-P process based on an A/O configuration
- Reduced aeration volume and demand
- Increased energy recovery in digestion





BIOSTYR® Duo

The next-generation biological aerated filter

Biostyr® Duo, an evolution of Biostyr®, the benchmark technology in biofiltration, is designed to help the local authorities meet their new wastewater treatment challenges. It increases the removal efficiency (COD and BOD, nitrogenous (N-NH₄ and N-NO₃) and TSS) while reducing upstream chemicals consumption and the plant's footprint.

APPLICATIONS

- For municipalities
- An evolution of Biostyr®, the benchmark technology in biofiltration, to help the local authorities reduce pollution, environmental footprint and operation costs
- Ideal for plants where space is constrained
- Especially valuable for retrofitting projects

PERFORMANCES

- A combination of Biostyr® technology with the MBBR technology in a single reactor

- More load acceptable in COD & Nitrogen and TSS
- More flexibility on primary settler to minimize upstream chemicals consumption
- Increases the pollution removal efficiency

BENEFITS

- More treatment but with the same footprint
- Minimal change in headloss
- Greatly reduces the upstream chemicals consumption
- Very energy efficient
- Fully automated, simple to operate

REFERENCES

Cornwall, Ontario (Canada)



Saint-Thibault les vignes (France)



Aeris, Cagnes-sur-mer (France)

- Contract awarded in 2016 for 6 Biostyr Duo biofilters



BIOETHANE

Leading anaerobic technologies for industrial effluent treatment

Biobed® Advanced EGSB

- Pressurized & gastight concept
- Up to >95% COD removal, with loading rates up to 15-25 kg/m³/day
- A highly stable technology for a great variety of industries
- Large net energy production by biogas recovery
- Low sludge production and very low energy consumption

Biobed® DUO

- Pressurized & gastight concept
- Up to >95% COD removal, with loading rates up to 25-30 kg/m³/day
- Biobed® design for heavy duty influent with specific features:
 - > Biobed® Advanced three phase separation technology
 - > Controlled mixing by means of Biobed® Influent distribution System
 - > Patented In-Situ Cleaning of three phase sections
 - > Sludge Management Control for removal of heavy biomass

600+
Full scale
installations
worldwide

REFERENCES

Leading Beer Producer Pennsylvania (USA)



A leading brewery engaged Veolia to pretreat the wastewater prior to discharge to the municipal sewer system.

Technology: Biobed® is a compact anaerobic treatment process utilizing a granular sludge bed and dissolved air flotation.

Results: The brewer is saving on municipal surcharges from the wastewater treatment plant's ability to reduce BOD and TSS.



BIOTHELYS™

A batch thermal hydrolysis process to maximize energy cost savings

BioThelys™ uses low pressure and low temperature steam applied to dewatered biosolids resulting in greater biogas production and a significant decrease in sludge viscosity, increasing mesophilic digester capacity by more than 300%.

APPLICATIONS

- Combining BioThelys™ and Anaerobic Digestion results in:
- Increase the digestion capacity of an existing installation, maximizing existing infrastructure
- Reduce the amount of biosolids produced, offering disposal costs savings
- Meets Class A requirements, providing a marketable end product
- Reduce the digestion volume of a new installation by up to 50%, decreasing capital costs
- Increase biogas production, meeting sustainable initiatives

BENEFITS

- Custom designs
- Variable configurations
- Worldwide experience
- Understanding of full biosolids treatment plant





BIOCON™

Sludge drying, incineration & energy optimisation

The **BioCon™** dryer treats municipal dewatered sludge within a safe environment for the operator.

APPLICATIONS

Municipal dewatered sludge Low temperature treatment for low energy plants

PERFORMANCES

- Safe operation due to low drying temperature
- Delivers disinfected and granulated dried biosolids
- Low operation and maintenance costs
- Meets Class A requirement
- Energy recovery
- Low carbon footprint

BENEFITS

- Safe, simple & efficient operation
- Customised end product
- Self-cleaning nozzles
- No dust
- Air tight
- No odors

REFERENCES

Marquette-lez-Lille (France)

- 620,000 population equivalent
- 3.6 tons / hour



Rosny-sur-Seine (France)

- 142,000 population equivalent
- 1.7 tons / hour

Lagares Vigo (Spain)

- 800,000 population equivalent
- 3.8 tons / hour



Juneau, AK (USA)

- 200,000 population equivalent
- 3 tons / hour



Alderwood, WA (USA)

- 100,000 population equivalent
- 1.5 tons / hour

Pomorzany (Poland)

- 420,000 population equivalent
- 2 tons / hour

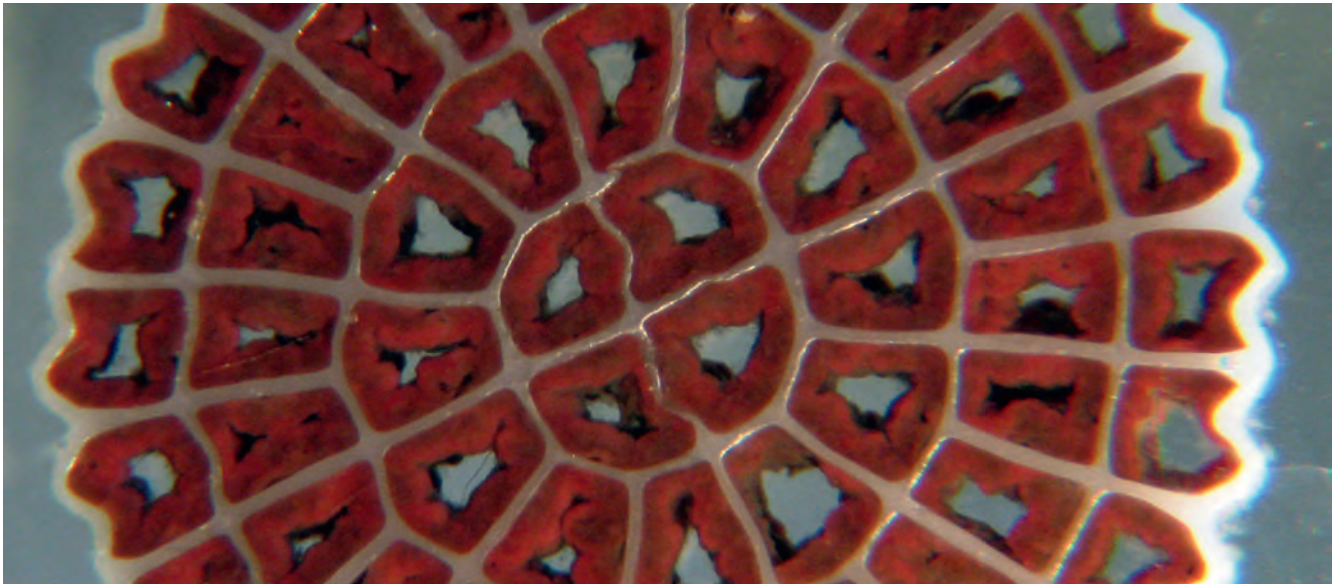


Bioco SDL:

Cagnes (France)

- 160,000 population equivalent
- 2.1 tons / hour





ANITA™ Mox

The cost-effective ammonia removal solution

With an ammonia removal efficiency of over 80% with no use of external carbon source and at a very low energy cost, **ANITA™ Mox** is well suited to efficiently reduce the operating cost and improve the environmental record of a wastewater treatment plant.

APPLICATIONS

- ANITA™ Mox is specially developed for the treatment of streams highly loaded in ammonia such as:
- Reject water following anaerobic digestion from municipal WWTP to reduce the nitrogen load on the main wastewater treatment line
- Industrial wastewaters, especially after anaerobic treatment and landfill leachates

BENEFITS

- No carbon source needed
- Compact process
- Almost 60% oxygen savings
- Reduced sludge production
- Robust process
- Stable process
- Lower CO₂ emissions

Next revolution in biological nutrient removal

Deammonification for mainstream treatment

Removes most of the incoming nitrogen load without requiring large amounts of organic matter to denitrify.

REFERENCES

Denver, CO, USA

- Operating since 2017
- Treating municipal digestate
- 3,000 kg N/day



South Durham, NC, USA

- Treating digestion returns by MBBR
- 330 kg N/day

Gothenburg (Gryaab), Sweden

- Operating since 2018
- Treating municipal digestate
- >1,000 kg N/day



Osberstown, Ireland

- Treating municipal THP digestate
- Start-up 2018
- 600 kg N/day



Five Fords (Wales), UK

- Treating municipal THP digestate
- Start-up 2018
- 775 kg N/day





STRUVIA™

Sustainable recycling of phosphorus from wastewater

Phosphorus is a key ingredient in the fertilizers used in agriculture and for animal feed. **STRUVIA™** allows for phosphorus to be recovered as struvite crystals from the effluents produced by industrial, agricultural and municipal activities. This opens the way to a local reuse of phosphorus, especially in agriculture.

APPLICATIONS

Recovery, valorisation and reuse of phosphorus contained in wastewater and in concentrated industrial water as struvite.

PERFORMANCES

- Reduction of internal phosphorus load
- Reduction of chemical sludge production
- Prevents operation downtime and maintenance cost caused by uncontrolled struvite precipitation
- Reduced needs for chemicals for P-precipitation

BENEFITS

- Low investment and operating costs
- Limited footprint and building height requirements
- Recycle struvite by incorporating it into a fertilizer
- The recovered phosphorus is made freely available for plants and crop
- Cadmium free and improvement of carbon footprint

REFERENCES

Brussels North (Belgium)

- Prototype reactor (0.2 to 0.5 m³/h)



Helsingør (Denmark)

- First industrial unit (4.8 tons of phosphorus extracted per year)





ECRUSOR™

Solution for depackaging and preparing biodegradable wastes for energy generation

***Ecrusor™** is a patented process to separate biodegradable wastes from commercial packaging. The single unit then grinds the organic material into a homogeneous slurry. Once processed by **Ecrusor™**, the highly organic, biodegradable material can be combined with indigenous and imported sludge and sent to the digester/biogas system.*

APPLICATIONS

- Liquids
 - > Sewage liquid with 1% to 30% dry matter content
 - > Packaged dairy waste
- Packed products
 - > Packaged dairy, meat and confectionery products
 - > Manufacturing residues
 - > Packed cakes and left-over uncooked dough
 - > Expired food products and packaged soft drinks

CHARACTERISTICS

- Compact and robust
- Fully-automated

ADVANTAGES

- Ecrusor™ removes plastic, metal and mixed material packaging simultaneously
- Very low operating energy while producing a slurry that generates electricity
- Over 10 years of full-scale operation at multiple installations
- Installed below grade, outdoors or within truck off-loading stations to receive material directly from vehicles
- Ecrusor™ is capable of processing up to 40 cubic meters of waste every hour

REFERENCES

Braunschweig (Germany)

- 275,000 PE
- 100% electricity autonomy

Gera (Germany)

- 200,000 PE
- 100% electricity autonomy

North Pest (Budapest, Hungary)

- 200,000 PE
- 100% electricity autonomy

Nagykörös Biogas Plant

- Industrial biomass to energy project, 3rd largest in Hungary
- 100% electricity autonomy

Prague (Czech Republic)

- 1,400,000 PE
- 75% electricity autonomy



EVALED®

Evaporation technologies for wastewater treatment

APPLICATIONS

- Effective solutions for the treatment of industrial wastewater, concentrating and removing salts, heavy metals and a variety of hazardous components.

PERFORMANCES

- ZLD
- Water reuse
- Valuable matter recovery
- Up to 95% distillate yield
- Sizes from 0.1 to 200 m³/day of distillate produced

BENEFITS

- Waste disposal costs reduction
- Low energy consumption
- Fully automatic, minimum labor
- Remotely controllable (Industry 4.0 compliant)
- Standard & Package design
- Small footprint, Plug & Play
- High quality of distillate

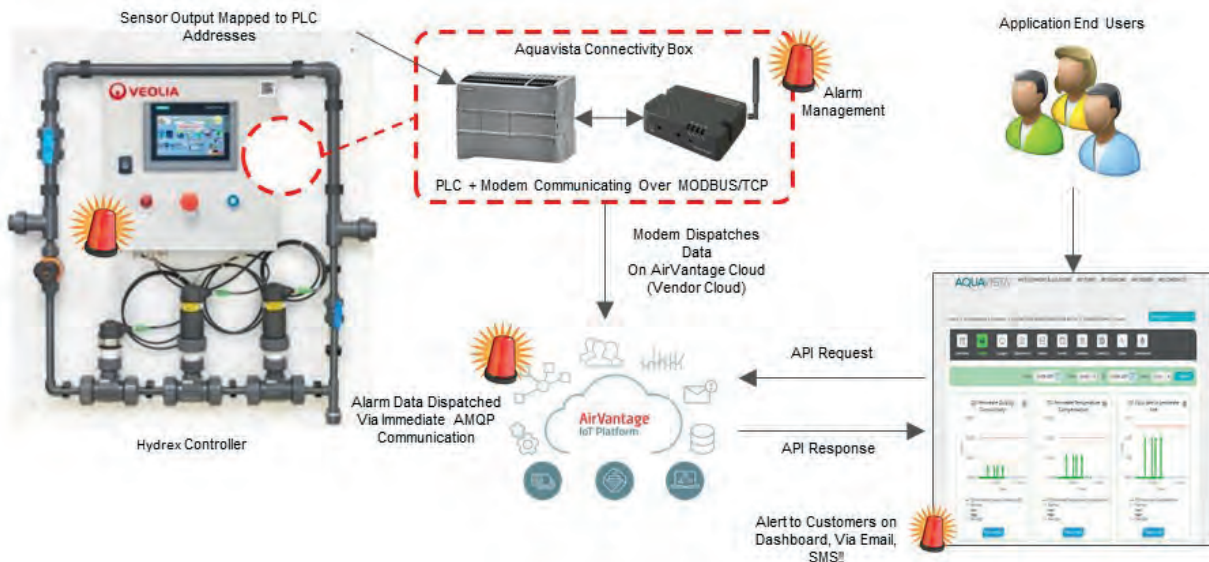
Evaled is now boosted by our digital services offer AQUAVISTA™

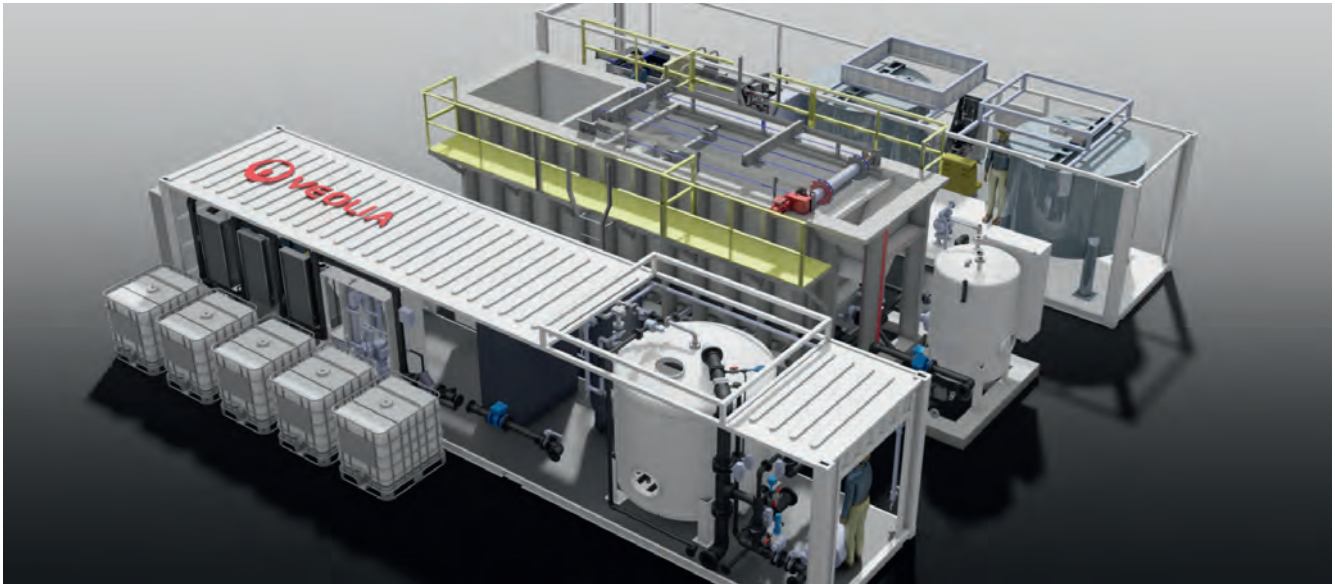


Did you know that HYDREX® covers all your water treatment chemical needs?

Veolia Water Technologies provides a **full range of water treatment additives but also associated services** (technical assistance and audit onsite + support of Hydrex experts' team) and **equipment** such as dosing systems and tanks. You can also take advantage of our **AQUAVISTA™ monitoring** / digital tools and on-line scanners to ensure better performance of the treatment. If you need water treatment chemical assistance, Hydrex® has the solution!

- Boiler Water Treatment Products ➤ HYDREX 1000 SERIES
- Cooling Water Treatment Products ➤ HYDREX 2000 SERIES
- Drinking Water Treatment Products ➤ HYDREX 3000 SERIES
- Membrane Treatment Products ➤ HYDREX 4000 SERIES
- Maintenance and Cleaning Products ➤ HYDREX 5000 SERIES
- Wastewater Treatment Products ➤ HYDREX 6000 SERIES
- Biocides Products ➤ HYDREX 7000 SERIES
- Industrial Application Products ➤ HYDREX 8000 SERIES
- Thermal Desalination, bulk chemicals & Others ➤ HYDREX 9000 SERIES





SHALEFLOW™

A transportable solution for produced water reuse

Veolia Water Technologies has developed **ShaleFlow™** - a cost-effective modular solution for reuse of flowback and produced water from hydraulic fracturing operations. This compact system utilizes proven technologies designed to enable reuse with the flexibility to be moved as the field is developed.

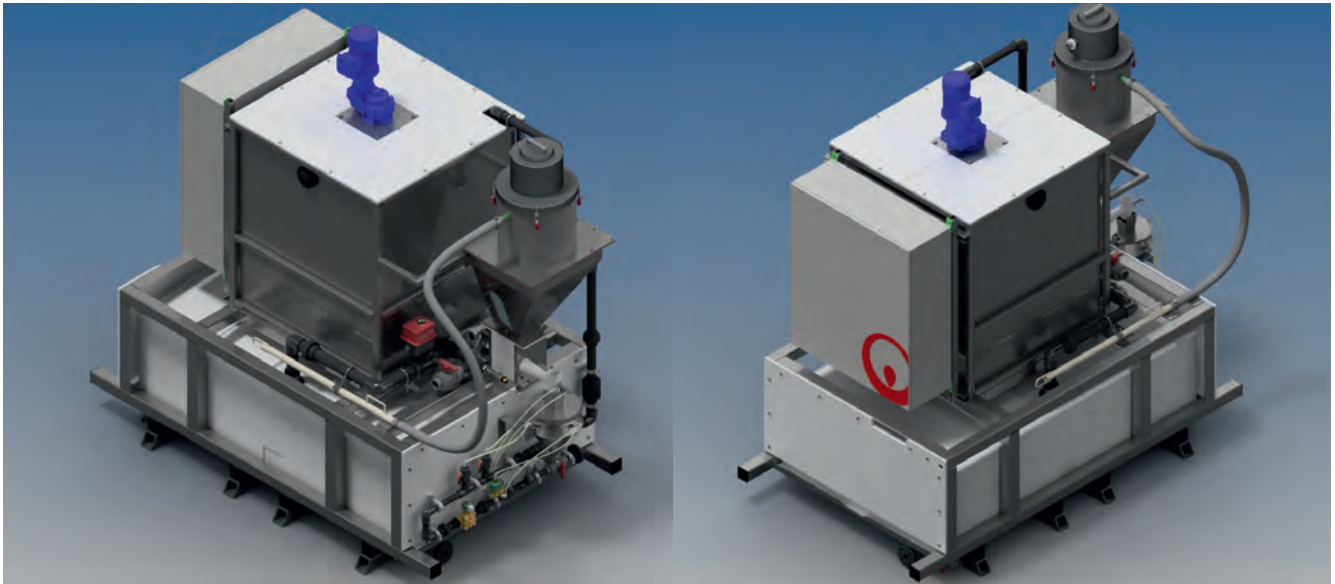
FEATURES

- Compact “Drop & Go” system in 3 modules
- >98% water recovery, zero liquid waste
- Non-hazardous sludge suitable for landfill disposal
- Designed to operate in high corrosive environment
- Accepts a wide range of influent water quality

BENEFITS

- Enables water reuse, reducing fresh water demand
- Reduces overall operating costs
- Minimizes deep well injection
- Flexible delivery options: DBO or DBOO
- Guaranteed performance when operated by Veolia
- Fully equipped to implement AQUAVISTA™ digital services for remote monitoring and data-driven optimization





HYDRAPOL™ Compact

Dry polymer make-up system

Veolia's HydraPol™ Compact dry polymer make-up and dosing systems are designed to prepare and activate any type of dry polymer.

APPLICATIONS

All processes requiring activated polymer in municipal and industrial water and wastewater applications, such as flocculation, decantation, sludge dewatering and sludge thickening.

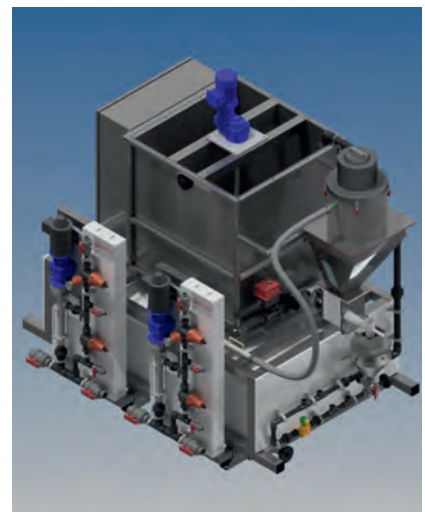
PERFORMANCES

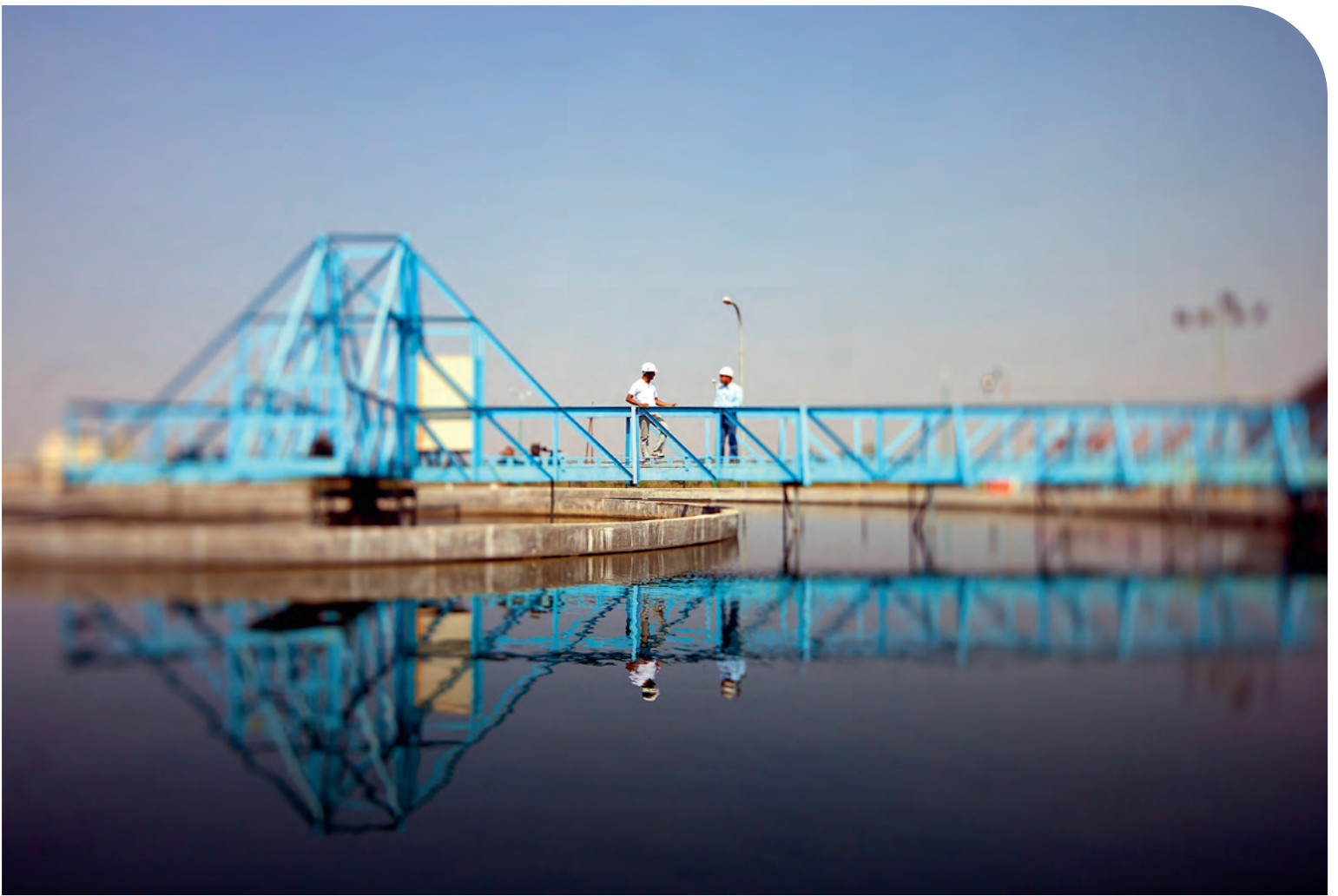
- Capacity: up to 18.6 lbs/hr (8.5 kg/hr)
- Concentrations: up to 1% (depending of polymer type)
- Manual or vacuum dry polymer handling
- Precise volumetric feeder equipped with automatic shut-off valve to prevent any contact between dry polymer and moisture

- Optimal activation of the dry polymer ensured by pre-wetting multiple shearing zones
- Stacked mixing and storage tanks, with gravity transfer
- Fully automated solution with PLC standard control panel

BENEFITS

- Compact integrated design for specific applications
- Standard pre-engineered models with defined packaged options
- Small footprint, all pre-wired and pre-piped
- Easy to install, operate and maintain
- Easy integration of dosing skids





WATER TECHNOLOGIES

Optimize your assets

Veolia technologies protect the environment through sustainable treatment solutions.

Veolia Water Technologies has the capability to transform your **wastewater into valuable resource**:

- > Maximize treatment capacity and water reuse
- > Achieve carbon and whole life cost reduction
- > Optimize energy recovery

www.veoliawatertech.com

Resourcing the world



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