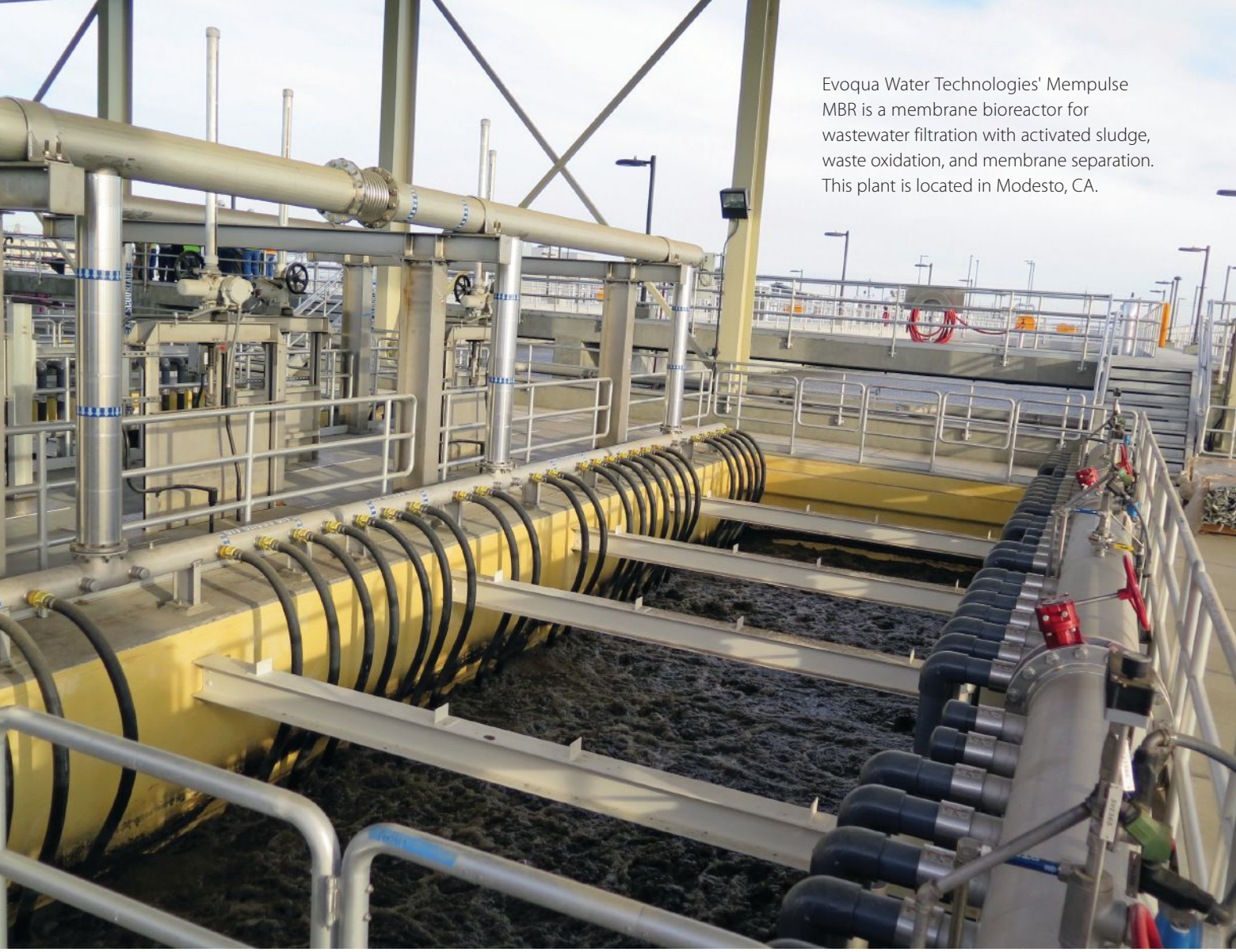


Evoqua Water Technologies' Mempulse MBR is a membrane bioreactor for wastewater filtration with activated sludge, waste oxidation, and membrane separation. This plant is located in Modesto, CA.

A Wave of Innovation

Cutting-edge technologies for wastewater treatment

By Lyn Corum

Wastewater treatment plants are impacted by the same infrastructure issues as highways, bridges, and municipal water systems. As population increases and permitting requirements are strengthened, there is little room to upgrade and expand. Costs are also prohibitive. New technologies like membrane bioreactors (MBR), however, can fit in the footprint of an existing plant, expand it, and respond to local, regional, and national permitting requirements at the same time.

Wastewater treatment plants are not all alike. They are designed to provide treatment for a particular region or location which has unique permitting requirements. These requirements drive technology, says Mike Snodgrass, membrane technology leader for Ovivo Water.

Snodgrass says the basic process of wastewater treatment is to grow microorganisms with oxygen, then separate out the unwanted bugs via gravity. "But it doesn't get you the quality of water you want," he says. Membrane bioreactors, his specialty, do the same thing without gravity, instead using a filter to capture the bugs and remove them. In an existing conventional wastewater plant, adding an MBR and quadrupling the process adds up to huge cost savings.

MBR is a recent technology development beginning in the early 2000s, says Snodgrass. An installation takes up two to four times less space and has a higher level of treatment producing higher-quality water. However, the cost will depend on the level of treatment, and a discharge permit will determine this. New requirements to treat wastewater to higher levels would require a conventional plant to increase the treatment

process, adding expense. An MBR would guarantee reaching the required discharge levels, Snodgrass explains.

EVOQUA INNOVATES

Evoqua Water Technologies is a new name but it has a long history, having evolved from the Link-Belt company beginning in 1874 to become Siemens Water Technologies. It was spun off from the parent company in 2014 and renamed.

Evoqua, headquartered in Pittsburg, PA, continues to supply OEM parts for all of the brands that were acquired through those years and today for virtually the whole wastewater technology chain.

The extensive list of technologies on Evoqua's website is impressive. This reflects the different needs at thousands of wastewater treatment plants across the country, which differ in the type of effluent, location, and the regulatory requirements of different treatment schemes.

Marc Roehl is the vice president and general manager of Evoqua's wastewater treatment business. He says the industry continues to look for technologies that use less energy. Aeration is the biggest energy user and Evoqua continues to look for technologies that use as little energy as possible across the wastewater process.

The membrane bioreactor provides filtration with activated sludge, waste oxidation, and membrane separation. Roehl says it has been around since the 1990s and continues to be developed. Evoqua developed its latest version, MemPulse MBR, which has few maintenance requirements, in the 2000s along with Xpress MBR.

MemPulse utilizes no moving parts during the membrane air-scour process. It features a modular design and can be used for parks and resorts, turnkey projects, and water reuse. The Xpress MBR is a small-flow bioreactor package plant that is pre-assembled in-house and then shipped to the client on a pad. It is an MBR that reduces energy and maintenance costs. It also saves space due to its compact design.

OTHER SECONDARY CLARIFIERS

The BioMag ballasted settling system is similar to that of the MBR and is applied to the secondary clarifier. It, along with CoMag, infuses magnetite as a weighting agent into biological floc (BioMag) or chemical floc (CoMag).

BioMag and MBR both have higher treatment capacity and relatively high performance in smaller spaces. The choice of footprint depends on effluent input. The two technologies are normally not installed together, says Roehl, but could be to compress plant footprint.

The advantage MBR offers is its barrier on effluent, allowing it to produce reuse-quality water in compliance with California's Title 22 requirements. BioMag technology would require a filter in the back of it to produce reuse water. The BioMag is generally less costly but not always, says Roehl, and it depends on the site requirements and application.

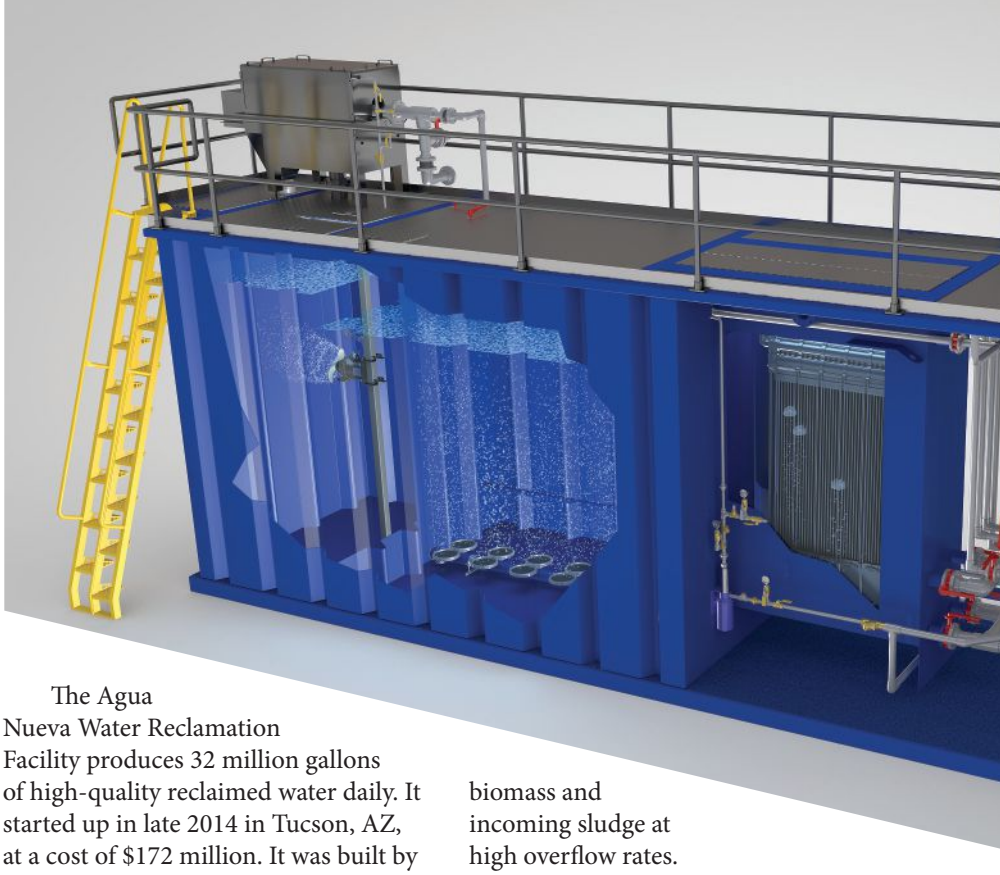
Roehl says the CoMag Particulate Removal System was developed about 10 years ago and with it, solids settle faster in primary treatment due to the magnetite. Its application

is ideal for industrial discharge or in dense populations and for tertiary treatment and stormwater management. It is NSF-approved for drinking water applications.

The Orbal system also uses an activated sludge process and provides enhanced biological nutrient removal with suspended growth. It operates as a simultaneous nitrification/denitrification process. Roehl says it has been around since the late 1960s and 1970s when the technology was developed. Evoqua has come out in the past two or three years with a new aerator device for it that has reduced capital costs by doubling oxygen transfer to reduce maintenance and construction. Roehl says Orbal is similar to the MBR but it is a conventional process and aerates with disc operators. Unlike MBR, it has no membranes. Its advantage is that it can run with low energy requirements. "It effectively delivers oxygen at low cost," he says. Applications include biological phosphorus removal and stormwater treatment, particularly in high storm areas.

DAF & CAPTIVATOR

Another technology Evoqua offers is the Dissolved Air Flotation (DAF) clarifiers, which treat both screened raw sewage and waste-activated solids before entering a bioreactor. Roehl says it is a fairly old technology going back 40 years and has seen improvements in the last five to 10 years.



EVOQUA

The Agua Nueva Water Reclamation Facility produces 32 million gallons of high-quality reclaimed water daily. It started up in late 2014 in Tucson, AZ, at a cost of $172 million. It was built by the Pima County Regional Wastewater Reclamation Department in response to requirements by Arizona regulators to reduce the nitrogen in its wastewater by January 2015 as part of its Regional Optimization Master Plan.

It installed the DAF system partnered with Evoqua's Captivator, which some consider the first large-scale primary clarifier in the world, using DAF for primary treatment. It was designed, built, and is operated by CH2M HILL. The DAF applied to the liquid stream removes and thickens the majority of biomass and incoming sludge at high overflow rates.

According to the case study available on the Evoqua website, the DAF primary clarifiers treat both the screened raw sewage and the waste-activated solids that are combined at the head of each DAF unit. They were found to remove between 50% and 75% of the suspended material, depending on chemical addition.

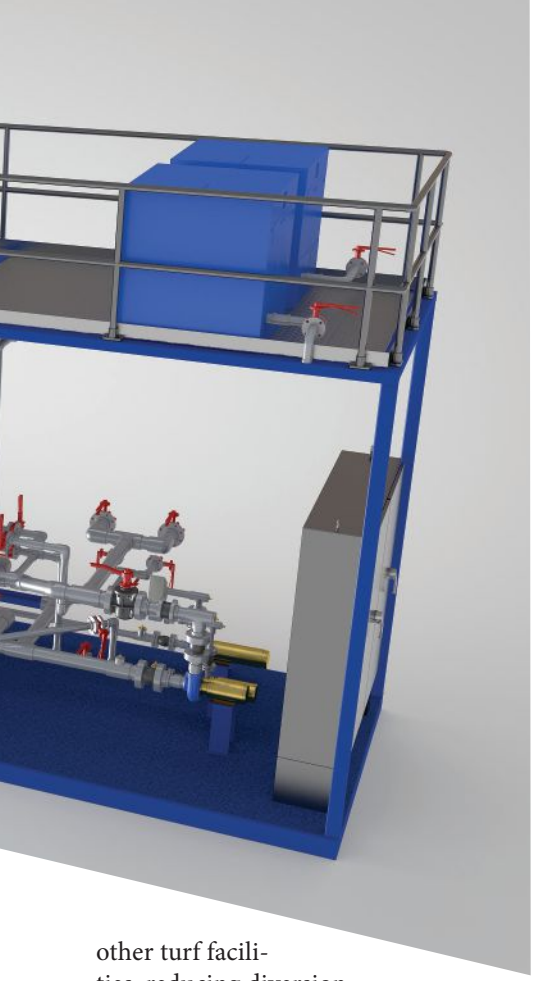
The Captivator system captures and converts biochemical oxygen demand to biogas. It can be the sole primary treatment for a new plant installation and, according to Evoqua, "helps to gain 65% more biogas while requiring only 44% aeration for chemical oxygen demand oxidation."

According to Evoqua, the Captivator system can help wastewater treatment plants to approach energy neutrality by diverting more organics for biogas production and reducing the energy requirements for aeration. Furthermore, it can help reduce the installation footprint for primary treatment and save considerable capital costs by eliminating the sludge thickening process.

The resulting reclaimed water irrigates the city's park, golf courses, and

SINCOR

Scinor's Thermal Induced Phase Separator (TIPS) ultrafiltration hollow-fiber membrane installed as a retrofit in a Temple, TX, water treatment plant



Evoqua Water Technologies XPRESS MBR is a small-flow bioreactor package plant that reduces energy and maintenance costs. It is pre-assembled in-house and shipped to clients.

other turf facilities, reducing diversion of water from sensitive habitats. With significantly reduced nitrogen levels, flora and fauna are returning to the river.

TIPS FROM SINCOR

Scinor manufactures its patented Thermally Induced Phase Separation (TIPS) ultrafiltration, hollow-fiber membrane for use in drinking water, wastewater, and industrial water treatment applications worldwide.

TIPS is manufactured from polyvinylidene fluoride (PVDF) making it more robust, chemically tolerant, and permeable than its competitors, says Joe Tardio, vice president of sales. It was developed by scientists at the Tsinghua University in Beijing. Tardio says TIPS is a direct retrofit product and has introduced competition into a previously closed market due to its superior membrane in direct retrofit configurations.

Tardio says traditionally, many end-users have been limited to selecting membrane treatment systems from proprietary system suppliers. When users wanted to replace an item, they had to return to the manufacturers of the installed product to replace it.

Tardio says this led to a proliferation of "open platform" or universal systems on the market, but the TIPS direct retrofit membrane offers a higher quality solution for all major membrane suppliers, he says.

TIPS is ideal for secondary and tertiary wastewater treatment, says Tardio. Scinor membranes can also be used to treat spent filter backwash from multimedia and primary membrane filtration systems. It is more chemically tolerant, mechanically stronger, more permeable, and has a longer service life and lower capital and operational costs, he says.

The company's largest US TIPS installation to date is at the Edward C. Little Water Recycling Facility in El Segundo, CA. The West Basin Municipal Water District, a wholesale water agency, built the water recycling treatment facility starting in 1992 following California's early drought period in the late 1980s and early 1990s. Built in phases, it now produces 40 million gallons per day from secondary wastewater effluent imported from the Hyperion Water Treatment Facility operated by the Los Angeles Bureau of Sanitation.

Among the designer waters the recycling facility produces for customers, it filters treated wastewater effluent by microfiltration and reverse osmosis membranes and disinfects it for use in maintaining a barrier against seawater intrusion and augmenting local well water supplies. Low-pressure boiler feed water is also produced from sewer water and filtered by microfiltration and reverse osmosis membranes. For high-pressure boiler feed water, the technique is the same but the water is passed through reverse osmosis membranes twice.

In 2017, West Basin contracted with Scinor to replace the 2,500 existing submerged polypropylene microfiltration membranes in the recycling facility. It had been operating at about 50% reduced capacity with high operational

FLUENCE

Fluence Corporation developed the membrane aerated biofilm reactor beginning in 2008. Its first US installation as a wastewater treatment plant is in Bordeaux, St. Thomas, US Virgin Islands.

costs and short service life. The replaced membranes, supplied by another manufacturer, installed in 2006, and subsequently replaced several times, were producing 6 million gallons per day. The Scinor TIPS membranes are now producing 9.5 million gallons per day, says Shivaji Deshmukh, assistant general manager.

Deshmukh says they've also seen decreased trans-membrane pressure and increased fiber integrity. "The volume of water we can now serve our customers has increased," he adds.

"We had to adjust our cleaning strategy because we couldn't use chlorine to clean the PVFD membranes," says Deshmukh. They are now using daily enhanced flux maintenance cleaning with combined chlorine residual to remove biofouling. Scinor membranes represent a big improvement but membranes are site-specific. "It all depends on the makeup of wastewater," says Deshmukh.

FLUENCE INTRODUCES MABR

Fluence Corporation Limited was formed in July 2017 when RWL Water and Emefcy Group merged. Headquartered in New York City, the new company combined Emefcy's newly developed wastewater treatment technology with RWL's portfolio of standard wastewater treatment technologies. Fluence is focusing on decentralized water, wastewater, and reuse solutions.

RWL was founded in 2010 and grew very quickly, with more than 7,000 references and customers in more than 70 countries as of the merger. Emefcy was an Israeli upstart company founded in 2007. It developed membrane aerated biofilm reactors (MABR).

Fluence sees MABR as "representing a cost-effective, decentralized treatment for reuse as well as being an affordable upgrade to a large existing installed base of conventional treatment plants aiming to achieve effective nitrogen and phosphorous removal." The MABR is modular and reduces energy usage by up to 90% compared to conventional treatment, according to the company.

Udi Tirosh, director of product management for Fluence in Israel, explains that MBR is used for screening with water passing through filters. In MABR, on the other hand, oxygen passes through the membrane. "It is very different in function and located at the entrance of the plant as part of the aeration of the reactor. The MBR is usually located at the back end," he says.

Tirosh explains that there are several reasons for its efficiency: The aeration process in the MABR is passive since air doesn't have to be compressed into diffusers. The air is blown into an open-ended submerged sleeve at very low pressure. The only pressure required is to replace air loss through the sleeve, which is minimal—30 millibars, or below 0.5 psi. In other applications, it is usually 6 to 7 psi. "This is the biggest energy savings," he says.

Other savings can be found in denitrification. Normally, circulation from the aerated zone to the anoxic zone requires a pump and is quite energy intensive. This is avoided in the MABR. "We don't recirculate nitrate," says Tirosh. Ammonia and other nitrogen compounds are turned into nitrogen in the aerobic-anoxic process in one compartment with two different types of bacteria. One turns ammonia into nitrite; the other type has no access to oxygen so it turns the nitrite into oxygen and nitrogen gas. This saves a lot of energy, he says.

Tirosh says there are also savings in the operation of the MABR. There is no

(or significantly less) need for a carbon source such as acetic acid for denitrification. And the MABR doesn't need a professional operator to control it.

Tirosh says development began ten years ago at Emefcy with the original vision being the development of a microbial fuel cell to treat water and produce electricity. "We found out the challenge is complex and difficult to get electricity. Meanwhile, we developed a membrane for aerating water. Several years later we began to develop MABR, and it is now our major business," he says.

"It is the first technology of its kind built in Israel and we are now searching for markets," says Tirosh. Likely markets include those where there is a need for nitrogen removal and areas sensitive to energy consumption.

A commercial plant has been operating in Israel since September 2016 in a rural area of Jezreel Valley with 1,000 homes, agricultural fields, and dairy farms. It was built to comply with a new state-level regulation requiring the local community to reduce the nutrients in the discharged effluent stream for reclaimed water.

The first installation in the US was built and commissioned in Bordeaux, St. Thomas, US Virgin Islands, as a municipal wastewater treatment plant that serves approximately 200 houses. This installation replaced an old plant that didn't meet regulations or industry standards.

The Virgin Islands Waste Management Authority wanted a new treatment facility that could treat current and future sewage flow and produce high-quality effluent that could be discharged in the Bordeaux area or be used as reclaimed water for agricultural irrigation in the future.

Tirosh says the price for electricity is quite high there—about 32 cents per kilowatt-hour (kWh). The plant has been in operation since December 2016 and has saved 85% of the energy the old plant used, he says.

The plant was operating and came back online a few hours after Hurricane Irma struck the island in October 2017. It suffered very slight damage to the pretreatment screen, Tirosh says.

Tirosh says Fluence is seeking markets in China. The government has imposed strict requirements for wastewater and lake water. "It is a natural market for us. A lot of new investment is going into rural China where distributed wastewater systems are needed," he says.

On March 25, 2018, Fluence announced it and its local Chinese partner, Jiangsu Jinzi Environment Company, were awarded a contract to deliver its MABR technology to a 1,000-cubic-meter-per-day (m^3/day) wastewater treatment plant for the local government of Zhenfeng County, Guizhou province, China. Fluence and its partner have orders for six additional MABR plants in China.

STANFORD INSTALLS MABR

Fluence's second US MABR installation is in the miniature wastewater treatment plant at the Codiga Resource Recovery Center on the campus at Stanford University. It is now in the start up and optimization phase and will reach a steady state soon, says Sebastien Tilmans, director of operations.