Metropolitan Water Reclamation District *of* Greater Chicago

Press Release

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Pilot algae reactor at MWRD Stickney plant to test carbon offset, and nutrient recovery

Tucked in the shadows of vast treatment facilities at the Metropolitan Water Reclamation District of Greater Chicago's (MWRD's) Stickney Water Reclamation Plant is an unassuming greenhouse that is holding the key to sustainable wastewater treatment operations. It might look like a pop-up business, but it has long-lasting staying power and value.

Inside this greenhouse, MWRD staff and their research partner, Gross-Wen Technologies (GWT), have developed an experimental pilot algae reactor. Here MWRD and GWT are growing algae from wastewater to offset carbon emissions, while also recovering nutrients that can better protect downstream water quality.

It is the second time the MWRD and GWT have installed the technology that demonstrates how the MWRD can use algae to naturally uptake phosphorus and nitrogen from wastewater to support its growth through photosynthesis, utilizing the sun as its energy source. Following a successful research trial at its O'Brien Water Reclamation Plant in Skokie, this time around at Stickney, the MWRD is studying if it can successfully reduce its carbon footprint and meet its long-term goals of becoming carbon neutral.

Thanks to $100,000 in new grant funding from Imagine H2O's Fourth Annual Urban Water Challenge, GWT constructed the new revolving algal biofilm (RAB) system and greenhouse to analyze how the system can more efficiently recover nitrogen and phosphorus without the use of inorganic chemicals or energy-consuming aeration, which is the traditional method of nutrient removal.

"The pilot algae reactor makes both economic and environmental sense for our taxpayers and our planet," said MWRD President Kari K. Steele. "Testing experimental technologies to find ways to remove more ammonia using less energy in aeration tanks, while recovering both phosphorus and nitrogen, we are providing numerous benefits that include not only environmental benefits but furthering the science in this important and often overlooked area."

How it works

After solids are removed from the main treatment process, they are digested then dewatered through centrifuges. The extracted water, known as centrate, is conveyed to a nutrient recovery facility at Stickney where phosphorus is collected and converted into a slow-release fertilizer. The remaining water then flows to the greenhouse where it is cycled through the RAB's vertical conveyor belts. As wastewater is passed through the RAB, the algae grow on the belts by "eating" the nitrogen and phosphorus from the water. The algal biomass grows even more rapidly by taking carbon dioxide from the atmosphere. While the nutrient recovery facility can recover most of the phosphorus, the algae reactor can recover nitrogen and the remaining phosphorus. Centrate is usually returned to the head of the treatment process and can contain up to 15 percent of the WRP's ammonia loading.

MWRD Principal Environmental Scientist Kuldip Kumar has been working with algae harvesting to recover nutrients for nearly a decade. Now a new pilot algae reactor has been developed at the Stickney Water Reclamation Plant.

Product

The algae are mechanically scraped from the belts and can then be utilized as a raw material in the manufacture of a variety of products, such as algae pellets as a slow-release fertilizer, sustainable aviation fuel and bioplastics. Each of these products will reduce a reliance on petroleum. Furthermore, the algae can also be composted with biosolids and land-applied as a soil amendment, digested to produce biogas, or processed as aquaculture feed — all of which return the phosphorus to the nutrient cycle. With the right amount of sunlight, nutrients, water and carbon dioxide, the MWRD can harvest more algae.

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Pilot algae reactor at MWRD Stickney plant to test carbon, nutrients, *cont.*

Why it matters

Ammonia (a form of nitrogen) presents a challenge for water reclamation plants. It can originate from human waste or cleaning chemicals, and it is the MWRD's job to collect it in wastewater and convert it into nitrate through nitrification followed by denitrification, where the nitrate is reduced to nitrogen gas that is released into the atmosphere. The algae system in comparison assimilates (eats) ammonia and bypasses the nitrification/denitrification process. By removing ammonia via assimilation, the algae system can further reduce carbon emissions by limiting the nitrous oxide emissions which are generated during the conventional ammonia removal process. Nitrous oxide from treatment processes and treated water resulted in approximately one-third of the MWRD's 2021 carbon emissions.

If the pilot proves to be successful and can be scaled to the MWRD size, the MWRD can use the RAB system to reduce ammonia more efficiently by using less energy at blowers to pump oxygen. Not only will the MWRD not require as much electricity for its blowers, but it can also potentially reduce chemical costs.

"Our RAB, algae-based treatment process will allow the MWRD to continue its efforts in protecting water quality while also making a positive environmental impact by reducing carbon emissions," said GWT's President Dr. Martin Gross.

The MWRD will need to reduce its carbon footprint through different carbon offsets to meet higher standards set in the MWRD's 2021-2025 Strategic Plan. The MWRD is striving to reduce its greenhouse gas emissions by 28 percent by 2025 compared to 2005 baseline levels and has embarked on a milestone of 80 percent reduction by 2050, with additional stretch targets of 50 percent reduction by 2025 and achieving net-zero by 2050. These targets are aligned with the federal government's April 2021 announced economy-wide target of 50-52 percent reduction in greenhouse gas emissions by 2030 and a net-zero emission economy by 2050.

If the pilot study proves effective and scalable, the MWRD will consider expanding the RAB to treat more water on a larger scale following technical and economic analysis. By treating 2 million gallons of water per day, the MWRD believes it can reduce its carbon emissions by up to 5,000 metric tons of carbon dioxide equivalents per year.

A revolving algal biofilm system naturally uptakes phosphorus and nitrogen from wastewater streams to support the growth of algae through photosynthesis and energy from the sun. The MWRD is using this process to remove nutrients from the waste stream without the use of inorganic chemicals or energy-consuming aeration, which is the traditional means of nutrient removal.

"We thank Imagine H2O, our staff and our partners at Gross-Wen Technologies for selecting our Stickney Water Reclamation Plant to implement this groundbreaking research," said MWRD Vice President Kimberly Du Buclet. "If successful, the pilot algae reactor can lead to innovation that will reduce energy use, lower carbon footprints and improve resource recovery of valuable nutrients that we can reuse to build a more sustainable environment."

The RAB technology was developed by GWT's founders while performing research at Iowa State University. The system was initially developed to produce biofuels but was later adapted for treatment of municipal wastewater. The current pilot system can recover approximately 1.5 pounds per day of dry algae biomass which results in the capture of about 3 pounds of carbon dioxide per day.

The Imagine H2O support is another chapter of acclaim in the RAB's development. In 2020, the U.S. Department of Energy's (DOE's) Office of Technology Transitions (OTT) selected the MWRD and GWT to receive grant funding to continue developing the sustainable nutrient recovery system. Also in 2020, the international Water Environment Federation (WEF) bestowed the MWRD and GWT with the Ralph Fuhrman Medal for Outstanding Water Quality Academic-Practice Collaboration for advancing algae technology and research.