TAP CASE STUDY

Tiny Bubbles Mean Big Energy Savings for Henry POTW

MICRO-BUBBLE AERATION IMPROVES ENERGY EFFICIENCY AT WASTEWATER TREATMENT PLANT

SUMMARY

With assistance provided through the Public Water Infrastructure Plant Efficiency Program, the City of Henry Publicly Owned Treatment Works (POTW) replaced their existing lagoon aeration system with Micro Bubble Diffusion (MBD) technology, resulting in significant energy cost savings and a reduction in the dissolved solids present in their treatment lagoons.

COMMITTED TO IMPROVEMENT

During the spring of 2020, the City of Henry, IL was in the process of upgrading its Publicly Owned Treatment Works (POTW). POTWs are facilities owned and operated by local governments which collect wastewater

Henry lagoons

from homes, businesses, and public spaces within their jurisdictions. They also treat that wastewater through a variety of physical, biological, and chemical means to restore water quality to a level safe for reuse and/or discharge into local waterways. As part of their commitment to facility improvement, the Henry POTW operator reached out to the Illinois Sustainable Technology Center (ISTC) Technical Assistance Program (TAP) for assistance with identification of energy efficiency improvements as part of the Public Water Infrastructure Plant Efficiency Program.

ISTC RECOMMENDATIONS

ISTC performed an assessment of the Henry facility in March 2020 and subsequently recommended three energy-saving measures: (1) shutting down the existing blower diffuser aeration system and installing micro-bubble aerators (Micro Bubble Diffusion technology, or MBD) in the lagoons; (2) coupling the MBD aeration system with an automated, programmable system to monitor dissolved oxygen (DO) levels in the lagoons and turn on micro-bubble units as needed; and (3) installing variable frequency drives (VFDs) on the 2nd Street lift station. Lift stations, also known as pump stations, lift wastewater to a higher elevation so it may flow by gravity, or so it may be pumped under pressure directly into a treatment area. VFDs vary the frequency of the power source for a motor by controlling the motor's speed and the amount of current it draws so it doesn't run at full power all the time. In this case, VFDs would allow the lift station's pumps to move the same volume of wastewater, more slowly, using less electricity and decreasing wear and tear on the system.

Upon implementation of recommendations, ISTC estimates the annual energy and operating cost benefits at 246,739 kWh of electricity and $21,688.

ABOUT HENRY, IL POTW

Location: City of Henry in Marshall County, IL
Population Served: 2500
Year Established: 1995
Number of employees: 3
Peak Flow Capacity: 0.500 MGD (millions of gallons/day)
Design Capacity: 0.280 MGD
Average Flow (2019): 0.231 MGD
Utility Provider: Ameren
Annual Consumption of Electricity (2019): 310,647 kWh
Annual Electricity Costs (2019): $27,291

The facility comprises a Blower and Maintenance Building (916 ft2) and two lagoons. Influent is pumped into the plant through a force main[1]. Influent flows into Lagoon 1 and is digested as it flows through the lagoon, into Lagoon 2. Further digestion occurs as the influent flows through the second lagoon and into a filter. Effluent is then chlorinated, dechlorinated (to remove excess chlorine from the water after treatment), and treated water of a quality safe for reuse is discharged into the Illinois River.

[1]https://www3.epa.gov/npdes/pubs/force_main_sewers.pdf

WHY MICRO BUBBLE AERATION?

POTW facilities commonly have lagoons in which wastewater containing organic contaminants and suspended solids (biosolids) is exposed to beneficial bacteria and mixed with air. The beneficial bacteria use the air to break down the organic matter into harmless by-products through aerobic digestion, helping to restore water quality for reuse. The means by which air is introduced to the bacteria-rich environment is referred to as the plant's aeration system.

At the time of ISTC's assessment, the Henry POTW was using a system consisting of two 50 horse power (HP) blowers to generate air within the lagoons to facilitate the digestion of organics. At one point, one blower continuously ran, operating 24 hours/day, 7 days/week (8760 hours per year).

Micro bubble aerators (also sometimes called micro bubble diffusers (MBD) or fine bubble diffusers), use less energy to operate than the more standard blower aeration systems. A single MBD uses between 1/8 to 2 HP depending on the model. Multiple MBDs can be placed throughout a lagoon to ensure adequate oxygen levels are achieved. Additionally, MBDs generate countless tiny bubbles that slowly rise to the top of the wastewater surface. The large number of slowly moving, small bubbles means there is greater surface area for oxygen transfer into the water for use by beneficial bacteria. As oxygen transfer efficiency increases, the beneficial bacteria in turn work more efficiently, all while using less energy than standard blowers.

Because not all biosolids in POTW lagoons are fully digested, there can be a build-up of organic material over time that necessitates dredging. Thus, by improving the efficiency of aerobic digestion of biosolids, micro bubble aeration may convey a further benefit to POTWs by reducing the amount of material that needs to be removed from lagoons through dredging, thereby reducing the associated costs.

IMPLEMENTATION OF MICRO BUBBLE DIFFUSION TECHNOLOGY AND IMPACTS

The operators of the Henry POTW decided to move forward with transition to micro bubble diffusion (MBD) technology, and engaged WTR Solutions, LLC for the installation of a system of eight MBD-12 model units, each using 2 HP motors. The MBD system was installed on June 20, 2020.

Example of micro bubble aeration floats
Credit: John Jacobs, WTR Solutions

Using the POTW's electricity bills from Ameren, electricity usage was compared for the same six months (January-June) in both 2020 (pre-installation of the MBD system) and 2021 (post-installation of the MBD system) to account for any potential seasonal variations in electricity consumption (Table 1).

Table 1: Comparison of Electricity Consumption Pre- and Post-MBD Installation

Year*	Cost	kWh
2020	$9,368.38	123,552
2021	$6,865.47	95,424
Savings	$2,502.91	28,128
Percent Savings	**26.72%**	**22.77%**

MBD system installed on June 20, 2020

*Years only reflect 6-months, from January to June, as this data was shared with ISTC.

The total number of kWh of electricity used decreased by 28,128, or 22.7%, for the same six-month period after installation of the MBD system, and the Henry POTW realized a cost savings of $2,502.91, a 26.7% cost reduction, based solely on the cost of electricity.

This reduction in kWh is equivalent to a reduction of 19.9 metric tons of carbon dioxide for the six-month January-June period, as calculated using the US EPA Greenhouse Gas Equivalencies Calculator.

ABOUT THE PUBLIC WATER INFRASTRUCTURE PLANT EFFICIENCY PROGRAM

The Illinois Environmental Protection Agency (EPA) Office of Energy, Illinois Sustainable Technology Center (ISTC) Technical Assistance Program (TAP), and the Smart Energy Design Assistance Center (SEDAC) work together to help local municipalities reduce the cost of water and wastewater treatment. SEDAC and ISTC provide free energy usage assessments to publicly-owned water treatment and wastewater treatment plants. Assessment reports will outline recommendations for energy efficiency improvements at each facility, including information such as upfront costs for equipment upgrades or retrofits, the estimated time it will take for the upgrade costs to pay off in energy savings, and the resulting energy and monetary savings that could result from upgrades and retrofits. Similar assessments would ordinarily cost municipalities between $6,000 and $12,000. Participating water and wastewater treatment facilities may be eligible for funding to assist with the implementation of recommendations through incentives from utility providers or grants from the IL EPA or other agencies.

WTR Solutions, LLC also examined the biosolids present in the Henry lagoons, using sonar imaging and an analysis of total and volatile solids present in the wastewater. Volatile solids can easily transform from solid to vapor without transitioning through the liquid phase, and are an indication of the organic material present in water (other suspended solids might include inorganic material, such as dissolved metals or salts). The more volatile solids there are in water, the less suitable the water is for drinking. The greater the total amount of solids suspended in water, the greater the need will be to dredge excess material accumulated in the lagoon.

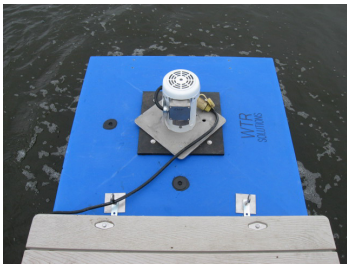
In July 2021, WTR Solutions reported to ISTC that the biosolids present are less compact in the Henry lagoons, and that the volatile solids have reduced by 63,000 lbs or 31 tons. Sonar results indicated total solids had reduced by 273,000 gallons. Since dredging costs $0.05-$0.07 per gallon, this reduction of solids could result in an additional savings of $13,650 to $19,110.

The original blower system is now being used as a backup system to the MBD, operated periodically to supplement aeration and deal with the amount of solids that had built up in one of the lagoons (prior to MBD installation). It may prove useful to install a variable frequency drive (VFD), or a "soft starter" on those older 50 HP blowers. A "soft starter" restricts the current supplied to a device, limiting the applied voltage to a motor, slowing down the inrush current and creating a gradual start for the motor. This would reduce mechanical wear and tear on the older blowers and also reduce the amount of energy associated with powering them up (though not with their operation, as a VFD would).

The cost of wastewater treatment can be a significant burden for municipalities, especially when the infrastructure is aged or inappropriately sized for the community it serves. This partnership is designed to help municipalities identify efficiency improvements to their systems and potential cost savings for their communities.

To learn more about the Public Water Infrastructure Plant Program or request an assessment, visit: https://go.illinois.edu/PWI-plant-program.

Micro bubble diffusion unit Credit: John Jacobs, WTR Solutions



Micro bubble diffusion unit within floating platform

NEXT STEPS

The City of Henry anticipates cost and energy savings will continue to justify the installation of the MBD. WTR Solutions continues to monitor MBD impact on suspended solid accumulation. The Illinois EPA and ISTC will continue to follow-up with the City to determine if additional recommendations are implemented and if further assistance is required.

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The Technical Assistance Program (TAP) makes companies and communities more competitive and resilient with sustainable business practices, technologies, and solutions. TAP works at the intersection of industry, science and government to help clients achieve profitable, sustainable results. **Find other fact sheets and more information about TAP at:**

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