

AWARD WINNING ENERGY SAVINGS

By Parviz Amirhor & John Riccio

Massachusetts
WWTP undergoes a
\$2-million upgrade,
reduces energy &
operating costs



A fine bubble diffused aeration system was part of a \$2-million upgrade in the Clinton WWTP to help reduce energy consumption.

In January 2013, the American Council for an Energy-Efficient Economy (ACEEE) and the Alliance for Water Efficiency (AWE) bestowed an award upon the Massachusetts Water Resources Authority (MWRA) for its “exceptional efficiency programs that save both energy and water.” The MWRA’s Long-Term Sustainability Program, which was the basis for the award, was initiated almost 30 years ago when the Massachusetts Legislature created the MWRA to provide wholesale water and sewer services to residential and industrial users throughout the metropolitan Boston area.

Efforts to reduce energy use in water and wastewater treatment plants are a natural outgrowth of the global focus on energy efficiency. Concerns over greenhouse gases and potential fuel shortages are two reasons for this, but money is a major factor as well. According to the U.S. Environmental Protection Agency (EPA), energy use can account for as much as 10% of a local government’s annual operating budget. With pumps, motors and other equipment operating 24 hours a day, seven days a week, water and wastewater facilities can be among the largest consumers of energy in a community, according to EPA.

This reality has never been lost on the MWRA, which serves 2.5 million people and more than 5,500 large industrial users in 61 communities. In acknowledging the award from the ACEEE and AWE, MWRA Executive Director Fred Laskey said, “MWRA is, at its core, an environmental agency, and we will continue to work aggressively to use our resources efficiently and reduce the environmental impacts of our daily operations.”

The MWRA’s focus on efficiency helped the Clinton Wastewater Treatment Plant (WWTP) identify an issue it needed to address. A system-wide energy optimization study commissioned by the MWRA found that the mechanical aerators at the MWRA-owned and -operated facility could be far more efficient. They also were more than 20 years old and nearing the end of their useful life. This study led to the design and construction of an energy-efficient fine bubble diffused aeration system at the Clinton plant.

About the Plant

The Clinton WWTP receives wastewater flows from the central Massachusetts towns of Clinton and Lancaster. Designed to process an average daily flow of 3 million gal per day (mgd) and a peak hourly flow of 12 mgd, it provides advanced treatment that includes seasonal nitrification and phosphorus removal.

The Clinton WWTP consists of an influent lift station, preliminary and primary treatment,

and secondary treatment. The secondary treatment couples a trickling filter system with an activated sludge process. The high-rate trickling filters reduce the biochemical oxygen demand (BOD) loading before the wastewater enters the activated sludge process. They also provide stability and resistance to shock organic loads.

The effluent from the trickling filters is pumped through the intermediate lift station to the activated sludge system, which consists of two trains of aeration tanks. Prior to the recent upgrade, each train included three aeration tanks equipped with two-speed motorized (43- to 60-hp) surface mechanical aerators. The mixed liquor suspended solids flow from the aeration tanks to the secondary clariflocculators, where they are settled. The clarified effluent undergoes chlorination and dechlorination, and then is discharged into the South Nashua River.

Energy Optimization Upgrade

The Clinton WWTP is one of the MWRA’s oldest facilities. Built in 1898 and in continual operation since then, it received major upgrades in 1956 and 1992. From 2009 to 2011—the subject years for the energy optimization study—it was found to be the fifth-highest user of energy in the MWRA system.

Engineering firm Fay, Spofford & Thorndike Inc. (FST), which performed evaluation, design and construction phase engineering services of the aeration system upgrade, determined that the plant could save a significant amount of energy by converting the existing mechanical aerators to a fine bubble diffused aeration system.

The power consumption for the three existing mechanical aerators operating at low speed (43 hp) was estimated at 96.23 kW or 843,000 kilowatt-hours per year, which amounted to more than 40% of the total power consumption by the Clinton WWTP. Based on the average BOD loadings and nitrification demand, the average power consumption by a fine bubble diffused aeration system was estimated to be 32 kW or 280,000 kilowatt-hours per year. FST determined that the new system would result in more than 65% savings when compared with the energy consumed by the mechanical aerators. With the addition of a \$177,000 rebate from National Grid, the plant’s electric utility, the Clinton WWTP was expected to fully recoup its estimated \$625,000 investment in less than seven years.

Fine Bubble Diffused Aeration System

The fine bubble diffused aeration equipment in three aeration tanks consists of air supply, transfer and distribution systems. The air supply system



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consists of aeration blowers housed in enclosures on top of the walkways located in the center of each aeration tank. There are five aeration blowers, each driven by a 40-hp variable-speed AC motor. Compressed air from the blowers is transferred to the aeration basins through stainless steel pipe, flow control valves and flowmeters. The compressed air then is distributed throughout the bottom of the tanks by distribution grids and fine bubble diffusers. There is one diffuser grid for each tank. Each grid is provided with a moisture blowout device, which allows for removal of fluid collected in the air system during inactive periods and before starting aeration anew.

The three aeration tanks also are equipped with dissolved oxygen (DO)/temperature probes and pH probes. These probes, which have both local and remote read-outs, continuously monitor the DO, temperature and pH in the aeration tanks. There is one DO/temperature probe and one pH probe in each tank. The aeration blowers are controlled by a dedicated local programmable logic controller system that adjusts the speed of the variable frequency drives for each blower to control the airflow rate to each aeration tank depending on the tank DO reading.

The new system avails plant operators with far better controls and visual inputs of the process through a SCADA system. An operator interface screen at the local panel and a second operator interface terminal in the operations building allow the operations staff to view the process values and trending information and make adjustments to the airflow rate. The local interface panel is networked to an operations building interface panel by a fiber-optic cable and Ethernet communications.

The Outcome

Construction of the fine bubble diffused aeration system was part of a \$2-million upgrade to the Clinton WWTP. Construction began in April 2012 and was completed in less than a year. In its first six months of operation, the system has performed as expected and is well on its way to fulfilling the predicted energy savings and return on investment. In fact, the annual cost savings may be higher than initially expected, adding to the MWRA's legacy of saving energy and reducing costs in its facilities. ^{www}

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