Retrofitting an old, coarse-bubble aeration system with an ultra-fine bubble diffused air system provides the city of Geneva, New York, with more efficient aeration and increased treatment capacity while decreasing system power costs. The city, which operates a 4 million gallons per day (mgd) (175 Us) activated sludge wastewater treatment plant, recently completed a plant upgrading. The plant, originally constructed in 1970, treats mainly domestic wastewater, but experiences periodic high organic matter (BOD) concentrations that are attributed to landfill leachate discharges. High infiltration/inflow (I/I) rates also occur in the spring and fall due to wet weather and an aging sewer system.

The heart of the treatment system is two 36' x 93' x 15' (11 m x 28.4 m x 4.6 m) water depth aeration basins. The basins were originally equipped with floating aerators, but in 1978 they were replaced with six 25-horsepower (18.7 kW) stationary mechanical surface aerators in each aeration basin. Normal operation requires that one aeration tank be operated during the summer months and two tanks in the winter. Estimated electricity use for the aeration process ranges from 20 to 40 percent of the total plant utility budget.

Due to the age of the aeration equipment and the need to provide additional aeration capacity to meet wastewater flows and loads, the question facing the city was: Should the existing system be upgraded with similar equipment or should alternative methods of aeration be used? The city chose to install an innovative diffused-air system in one of the aeration systems to provide comparative performance data. Later, the other basin was equipped with the new diffused-air system, and full-scale tests were performed.

The project was undertaken as a demonstration project and was partially funded by the New York State Energy Research and Development Authority (NYSERDA), a member of EPRI’s Municipal Water and Wastewater Project.

The Old Way

Mechanical surface aerators have two functions. First, they introduce oxygen into wastewater by driving air into the water or splashing the wastewater into the air, thereby increasing the contact area between the water and the air. Second, they mix the tank contents to keep activated sludge solids in suspension.

Mechanical aerators are reliable and relatively easy to maintain. Their disadvantages, however, are (1) they are not very energy efficient and (2) they have operating limitations in adjusting aerator output to match varying wastewater loads that occur hourly, daily, or seasonally.

The New Way

The existing mechanical aerators were replaced with a diffused-air aeration system. The new system includes low-pressure blowers, an air piping network, and air diffusers located in the bottom of the aeration tanks. Two 60-horsepower (44.8 kW) electric motor driven blowers with variable speed drives were provided.

Many types of air diffusers are available, but for the Geneva Project, innovative ultra-fine bubble, membrane panel diffusers were selected. This equipment produces bubbles that measure about 1 millimeter (mm) in diameter, as compared to other diffusers that have a 2 to 5 mm bubble size. The small bubbles have a much larger surface area-to-volume ratio.

Figure 1. Comparison of bubble sizes
providing more oxygen transfer surface area. Small bubbles also have a lower buoyancy, resulting in a slower rise rate and allowing a longer contact time with the wastewater. The bubbles are formed by discharging air through porous plastic membranes. The membranes are housed in 4' x 12' (1.2 m x 3.7 m) panels, anchored to the floor of the aeration tanks (see photo). The panels cover 54 percent of the floor area of the tanks. Uniform air distribution is provided, ensuring good mixing.

The manufacturer added center frame bars and replaced the membranes and the problem was corrected. Panels in the other set of tanks that had center bar supports did not experience this problem.

The Bottom Line

Energy savings were achieved at the Geneva Plant by replacing mechanical surface aerators with a diffused air system using ultra-fine bubble diffusers. Savings were achieved in two ways: First, because of the high oxygen-transfer efficiency of the membrane panel diffusers, less air is required and smaller blowers and motors can be used. Second, the output of the aeration blowers can be regulated by adjustable speed drives to meet changing waste loads.

The total cost of installing the diffused air system at Geneva was $390,000. Approximately two-thirds of the cost, or $256,000, was funded by NYSERDA. Retrofitting the aeration system will reduce the plant electricity cost by about 40 percent because of the high oxygen transfer efficiency attainable with the new systems.

Agency Profile

NYSERDA manages a comprehensive energy research program to help secure New York State's future energy supplies. NYSERDA's mission is to develop innovative solutions to some of the state's energy and environmental problems.

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