By Robert Laing

Revitalizing the Feng-Shan Reservoir

Using a reservoir-diffused aeration destratification system in Taiwan to control blue-green algae

The Feng-Shan Water Reservoir is a 173-acre, 92-ft maximum depth body of water located near Kaohsiung, Taiwan. A tributary from a river that is downstream from hundreds of pig farms feeds the reservoir. The farmers were dumping their pig manure directly into the river, and the government was powerless to do anything about it.

The reservoir had an 11- to 17-hour retention time before entering the drinking water treatment plant. Polluted incoming water moved straight across the surface to the water treatment plant inlet in less than three hours. The reservoir had a heavy growth of blue-green algae, giving the drinking water a severe bad taste and odor.

Oxygen just below the surface to the bottom was 0.0 mg/L. Ammonia averaged 1.8 mg/L for five years before the project began and had a maximum value of 3.6 mg/L.

Taiwan's government wanted to rid the water of the bad taste and odor. To accomplish this goal, Clean-Flo Intl., Inc. guaranteed to increase bottom oxygen in the deepest water to 3.6 mg/L and reduce ammonia by 70%. Clean-Flo designed the project to remove 1.9 mg/L ammonia at highest flow.

Method

To accomplish these goals, Clean-Flo designed a flow barrier across 75% of the center of the reservoir, causing water to pass through the entire reservoir before reaching the water treatment plant. Clean-Flo designed a bacterial culture media to span the surface of the reservoir at 15 locations. This is a multi-layered porous polyethylene material that floats at the surface and extends 4 ft down into the water, held in place by floating cables fastened across the reservoir.

Two-hundred 0.75-hp oil-less piston compressors are located in five buildings on the shoreline (compressors per building). Weighted air line connects from the compressors to approximately 400 microporous diffusers evenly spaced on the bottom of the reservoir. Small bubbles rise from the microporous diffusers at the bottom, creating a nonturbulent flow of 60 million gal per minute of water to the surface.

When the water reaches the surface, it spreads out 0.1 in. thick and flows across the surface. As the water passes through the bacterial culture media, microorganisms lodged on the surface feed on ammonia and phosphorus.

Dicer Environmental Engineering Service, Koahsiung, prepared the engineering proposal for Taiwan's government. Dicer performed all construction work at the jobsite, with the barrier, culture media and inversion/oxygenation system under the supervision of Clean-Flo.

Results

By the time Dicer installed diffuser No. 400 in the reservoir, the blue-green algae had disappeared, completely removing the bad taste and odor from the drinking water. The Water Treatment Co. reduced chlorine consumption from 50 mg/L down to 9 to 10 mg/L and reported a resulting savings of $583,000 per year in water treatment costs.

Bottom oxygen fluctuated initially and then stabilized at 3.6 mg/L. While Dicer installed the Clean-Flo continuous laminar flow inversion/oxygenation, pig farmers increased the amount of pig manure dumped in the river, increasing the ammonia level from the five-year average of 1.8 to 3.6 mg/L.

During the test run, the level of incoming ammonia continued to increase steadily to 7.2 mg/L. The Clean-Flo system removed an average of 2.9 mg/L ammonia, far exceeding the design despite the increased level of incoming ammonia. The Water Treatment Co. excused Clean-Flo from the 70% removal requirement. Considering the increased level of incoming ammonia, the company conceded that Clean-Flo based its design on the five-year average before treatment and could not have anticipated the increased ammonia.

Solutions Summary

Blue-green algae was less present in the Feng-Shan Reservoir after continuous laminar flow inversion/oxygenation, solving the Water Supply Co.'s taste and odor problem. Passing the water through bacterial culture media, with the help of the inversion system, reduced incoming ammonia to 2.9 mg/L. Nonturbulent inversion of the reservoir once every two to three hours increased bottom oxygen from 0.0 to 3.6 mg/L.

The process of continuous laminar flow inversion/oxygenation is a useful tool for blue-green algae-infested reservoirs and lakes. It removes bad taste and odor from finished drinking water. In combination with bacterial culture media, ammonia can be reduced. This process reduces the chemicals needed in the water treatment plant to produce finished drinking water.

The inversion and oxygenation do not affect blue-green algae in any way; they simply remove the nutrients that blue-greens feed on and move the algae to the bottom of the reservoir, where it will not receive sunlight.

To cover the increased ammonia level, Clean-Flo has added 176 diffusers. WWD

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ARTICLE SUMMARY

Challenge: Taiwan's Feng-Shan Reservoir had heavy pig manure loads and blue-green algae growth, resulting in bad-tasting, foul-smelling drinking water.

Solution: With the help of an inversion system, water passed through bacterial culture media to increase bottom oxygen and reduce ammonia.

Conclusion: Blue-green algae and ammonia were less present in the reservoir after continuous laminar flow inversion/oxygenation, removing the unpleasant taste and odor from local drinking water.

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