HARMFUL ALGAL BLOOM MITIGATION TECHNOLOGIES

Electrochemical Oxidation

In collaboration with Clarkson University, 2024

NEW YORK STATE | Department of Environmental Conservation

Introduction: New York State's (NYS) waterbodies are vital community resources for recreation, drinking water, and more. In many places, nutrient pollution and other factors contribute to problems such as Harmful Algal Blooms (HABs), which have multifaceted effects on public and ecosystem health and the economy. In 2018, the New York State Department of Environmental Conservation (DEC) began conducting HAB mitigation pilot projects to test novel technologies to reduce the frequency or lessen the impact of HABs and to protect water quality.

DEC collaborated with Clarkson University to pilot electrochemical oxidation (EO) for mitigating persistent, lake wide HABs at Lake Neatahwanta (Fulton County, NY) and Oneida Lake (Oneida County, NY) in summers, 2021-2023. EO applies an electrical current to existing chloride ions in the lake water to effectively chlorinate and kill cyanobacteria cells and degrade cyanotoxins (indicators of HABs).

This work was funded through the NYS Environmental Protection Fund.

FOR MORE INFORMATION

References:

- https://pubs.acs.org/doi/full/10.1021/acsestengg.1c00344
- https://doi.org/10.1039/D4EW00490F

Call or email DEC with questions about this research project:

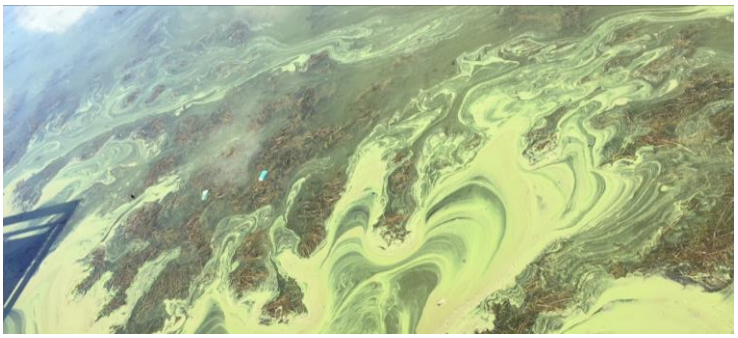
- (518) 402-8179, HABsInfo@dec.ny.gov

Harmful Algal Blooms:

- https://dec.ny.gov/environmental-protection/water/water-quality/harmful-algal-blooms

Project Objectives

- Test EO devices in lakes after successful lab trials completed in 2020
- Measure the ability and efficiency of EO to reduce cyanobacteria and cyanotoxin concentrations
- Measure the concentrations of disinfection byproducts (DBPs – products of chlorination that can cause health effects in humans and wildlife) formed during the EO process
- Investigate the impact of EO on non-target organisms such as phytoplankton and zooplankton
- Evaluate technology cost and energy consumption



A HAB on Lake Neatahwanta (top) and EO equipment mounted on a pontoon boat being tested at Oneida Lake in 2022 (bottom).

Project Outcomes

Findings:

- EO reduced phytoplankton (both green algae and cyanobacteria) and cyanotoxin concentrations by >50% and 80%, respectively, in treated water.
- 48,000 gallons of water were treated over eight hours, at a rate of 100 gallons per minute (equivalent to an Olympic-sized swimming pool every 4 days).
- DBPs (trihalomethane and haloacetic acid) were formed in the effluent by the EO process, but upon mixing with the lake were diluted to concentrations below thresholds of concern. The effluent exhibited no toxicity to non-target organisms in the lake, such as zooplankton and small fish, at optimum treatment levels.

Cost and Energy Consumption:

- For the study, EO electricity used was 0.004 kWh per gallon of water treated. This means that for a single treatment, the electricity required to treat a 30 ft deep 150-acre pond would cost about $1.2 million, at retail electricity rates of $0.2/KWh. Regrowth of cyanobacteria may require additional treatments, further increasing these estimated costs.
- This confirms that larger, deeper lakes, would have a more costly treatment, especially if repeat treatments were required.

Limitations:

- Physical screening is necessary to prevent destruction of non-target organisms. Zooplankton cannot be screened out and will be destroyed by the EO process.
- The highest reductions in cyanobacteria and cyanotoxins were observed at lower treatment rates.
- The pilot devices can only currently treat small volumes, so scalability to large lakes areas is uncertain.

Additional Effort Needed:

- Evaluate costs and benefits of upscaling EO to effectively treat larger HABs.

Use in NYS Lakes:

- Currently, this technology is not available commercially nor at a scale larger than the pilot demonstration.
- A SPDES permit is required for discharges > 1,000 gallons per day into a NYS waterbody.
- For potential future use, inquire with the NYSDEC Regional Permit Administrator regarding permitting requirements.

EO equipment in operation at 100 gallons per minute at Oneida Lake in 2022 (left). The electrochemical reactor vessel (right). Photo credit: Lewis McCaffrey