Water Treatment Optimization for Cyanotoxins
A Comprehensive Performance Evaluation Approach

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The Operator’s Dilemma:

Potential for HABs in source water
EPA Health Advisories

I know that the answer is here somewhere, but what do I need to do at my plant?

EPA Guidance Manuals
Operator Training Manuals
AWWA, WRF research reports, other literature

6/6/2017 U.S. Environmental Protection Agency
Area-Wide Optimization Program (AWOP) solution:

- Develop approaches to assess why a treatment plant doesn’t perform as desired.
- Develop knowledge/skills to help operators make changes at their treatment plants and achieve desired performance levels.
- Measurable improvements at individual plants
- Use existing facilities and enhanced process control.
HAB CPE Development Pilot Project

• Partnering with Ohio EPA
• Series of 4 pilot HAB CPEs at Ohio WTPs
• Develop protocol for conducting a HAB CPE by modifying the existing microbial CPE framework
• Transfer capability to conduct CPEs to Ohio EPA staff, and other states (long-term)
• Ohio EPA HAB water treatment experience at plant level
https://www.epa.gov/ground-water-and-drinking-water/cyanotoxins-drinking-water
Case Study #1: Western Lake Erie System

• Conventional treatment (coagulation, flocculation, sedimentation)
• PAC
• NaMnO₄ pre-oxidation
• Sodium hypochlorite disinfection
Microcystin Data
Jar test conducted on August 3, 2016

- Total Microcystin
- Extracellular Microcystin

<table>
<thead>
<tr>
<th>Method Description</th>
<th>Microcystin Concentration (μg/L)</th>
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<tbody>
<tr>
<td>0 = Augmented raw</td>
<td>30</td>
</tr>
<tr>
<td>1 = Augmented stirred raw</td>
<td>30</td>
</tr>
<tr>
<td>2 = Augmented coagulated with ACH @ 24 mg/L</td>
<td>0</td>
</tr>
<tr>
<td>3 = Augmented coagulated with ACH @ 24 mg/L &amp; NaMnO₄ @ 1.2 mg/L</td>
<td>0</td>
</tr>
<tr>
<td>4 = Augmented coagulated with ACH @ 24 mg/L &amp; NaMnO₄ @ 3 mg/L</td>
<td>0</td>
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Plant profile sampling

![Graph showing plant profile sampling results across different treatment stages. The x-axis represents different treatment steps: Raw water, Pre-sedimentation basin (post-NaMnO4), Clarifier 1, Clarifier 2, Clarifier 3, Applied/Top of filter, Transfer well/combined filter effluent. The y-axis represents RFU or µg/L. Different treatments are color-coded: Chlorophyll [RFU], Chlorophyll [µg/L], Phycocyanin [RFU], Total MC [µg/L], Extracellular MC [µg/L].]
Major Unit Process Evaluation

Water Flow Rate (MGD)

- PAC Feed (potential) (A2) - 9.6 MGD
- Flocculation (A) - 9.0 MGD
- Sedimentation (B) - 9.8 MGD
- Conventional Filtration (C) - 14.5 MGD
- Cyanotoxin Oxidation (B) - 6.3 MGD

Plant Design Capacity - 9 MGD
Peak Instantaneous Flow - 6 MGD
Case Study #1 Lessons-Learned:

• Value of plant profile in understanding capability of each unit process

• Difficulty in estimating PAC capacity – isotherms underreport due to competing organics in actual raw water

• Performance-limiting factors identified were not necessarily tied to HABs and have a more continuous impact on plant operations
Case Study #2: Inland Lake System

- In-stream reservoir
- Conventional treatment with softening (lime and soda ash)
- PAC addition at raw water intake
- Chlorine gas disinfection
Major unit process evaluation

Microcystins Adsorption & Destruction

- PAC Feed (Intake) (A1): 1.04
- PAC Feed (rapid mix) (A2): 1.34
- Microcystin Oxidation (B1): 2.78
- Microcystin Oxidation with safety factor of 2 (B2): 1.39

Plant Design Capacity - 1.0 MGD
Peak Instantaneous Flow - 0.8 MGD
Case Study #2 Lessons-Learned

- Performance-limiting factors identified were not necessarily tied to HABs and have a more continuous impact on plant operations
- Difficulty in estimating PAC capacity
  - Jar testing protocol to help with MUP evaluation
  - Further studies at EPA research lab
Thank You!

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