What does TOC mean to my drinking water treatment plant?

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Outline

Learning Objectives
Introduction: EPA Regulations & BWWB
Methods
Previous Findings
Results
Conclusions
Learning Objectives Revisited
Future of this study
Learning Objectives

- What is TOC and how does it relate to DBPs?
- Key EPA regulations.
- Introduce the basic process for treatment optimization studies.
- Determine which coagulant is the best at TOC removal.
Introduction: Drinking Water Regulations

Total Organic Carbon (TOC) is defined as a measure of the total amount of organic matter that is present in the water.

In the drinking water industry, it is used as a measurement of water quality and given strict guidelines for removal through the Stage 1 DBPR.

| TOC Table - Required % Removal of TOC Source Water |
|---------------------------------|--------|--------|--------|
| 2.0 to 4.0 (mg/L)               | 35.0%  | 25.0%  | 15.0%  |
| 4.0 to 8.0 (mg/L)               | 45.0%  | 35.0%  | 25.0%  |
| > 8.0 (mg/L)                    | 50.0%  | 40.0%  | 30.0%  |
Research suggests that TOC has a direct effect on DBPs that are formed during the treatment process as well as in the distribution system.

High TOC $\Rightarrow$ Increase chlorine demand $\Rightarrow$ High DBPs
Introduction: Drinking Water Regulations

Stage 2 Disinfectants/Disinfection Byproducts Rule (DBPR) will be implemented in 2012 further tightening regulations on DBPs, specifically total trihalomethane (TTHM) and haloacetic acid (HAA) compounds found in finished drinking water.
Introduction: BWWB

Location: South-eastern United States
Population: Serve an estimated 600,000 customers
Maximum Treatment Capacity: 190 MGD
Introduction: BWWB

- The BWWB is located in Birmingham, Alabama.

- Birmingham residents enjoy a humid, subtropical climate with average summer highs in the 90’s and average winter lows in the mid 30’s.

- Rainfall is distributed somewhat evenly throughout the year with October being the historically driest month.
Four Conventional Surface Water Treatment Plants:

- Shades Mountain Filter Plant
- Western Filter Plant
- Putnam Filter Plant
- H.Y. Carson Filter Plant

Two Lakes used for source water:

- Inland Lake
- Lake Purdy

Map of BWWB Treatment Plants
Shades Mountain Filter Plant

Oldest and Largest Plant

Max Flow Rate of 80 MGD

46 Sand & Anthracite Filters
Carson Filter Plant

Newest of the four plants - built in 1972

Max Flow Rate of 26 MGD

16 Sand & Anthracite Filters

Current operations utilize alum, hydrated lime, coagulant and filter ionic polymers, potassium permanganate, chlorine gas and sand/anthracite filters.
Pilot Plant

- Mobile
- SCADA
- Max rate of 14,000 gpd (10gpm)
- Full analytical lab for analysis
- Two identical treatment trains
Pilot Plant

Rapid mix and sedimentation basin

Filters
Pilot Plant

- Treatment trains include:
  - raw water tanks
  - rapid mix chambers
  - flocculation basins
  - sedimentation basin
  - three dual media filters
  - finished water tank

- The twin design enables researchers to test two separate treatment methods concurrently.
Pilot Plant

- The PP contains all other online and bench-top equipment used for analysis found at the full scale plant.
  - turbidimeters
  - pH and temperature probes
  - streaming current monitors
  - particle counters
  - conductivity meters
  - TOC analyzers
  - spectrophotometers
Methods

**Important water quality parameters include:**
- Total and Dissolved Metals (Manganese, Iron, Copper)
- Chlorate, Chlorite, Nitrate, Nitrite, Sulfate, Sulfite
- TOC
- Alkalinity
- Turbidity
- pH
- Temperature
Previous Findings: SMFP

In 2008 and Spring of 2009, the Pilot Plant was used to perform an extensive evaluation of the current treatment process at SMFP.

Results from this study suggested that a simple change in the coagulant would be an effective way to optimize full scale operations by increasing TOC removal and thereby decreasing regulated DBP values.

- Alum to Ferric
- TOC Removal
- DBP values
Results: CFP

After many numerous failed trial runs, an optimum configuration and dose for ferric was determined.

Lime addition to raw water

- No pre-oxidant needed
- Ferric to rapid mix
- Filter aid to filters
- Chlorine and pH adjustment post filtration
Conclusions

Operators can effectively use TOC as an indicator for making key process control decisions such as chemical type and dose.

As long as there is sufficient alkalinity in the source water, ferric sulfate is superior over aluminum sulfate for TOC removal.

At both treatment plants, ferric sulfate has the ability to not only meet but far exceed the Stage 2 DBP Rule.
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