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Document Number:

79) VIII-E.8.k

Docket Number:

DBP NOA

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VIII-E.8.k

Control of DBPs

DBP Speciation

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EPA ORD Cincinnati

Stakeholder Meeting
May 20, 1997

Results from Current Projects

- Shift toward more-brominated species
- Enhanced coagulation effective for control of regulated and unregulated DBPs
- Bench to pilot scale up of enhanced coagulation
- Secondary effects of enhanced coagulation may be significant
- NF membranes achieve significant removal of DBP precursors
- Bench to pilot scale up of membranes is OK for organic/inorganic/particulate control and for cleaning requirements, but not for long-term production
- Microbial foulants are significant in membrane operation
- Fouling is significant, even with low turbidity waters, but may be improved by ozone/biological filtration
- In biological filters, biomass development and control of TOC, DBP precursors and ozone BPs depend on media type, backwashing conditions and ozonation
- Biomass-based model prediction of DOC biodegradation in biological filters
- EPANET model prediction of chlorine residuals and TTHM concentrations in distribution systems

Current Projects

Ozonation and Biological Filtration for Control of Precursors (RM.D.2a)

Recipient: University of Cincinnati

- Study • Biomass and bacterial populations on filter media
- Model biodegradation of DOC
 - Evaluate biological filter operation
 - TOC, DBP precursors, ozone BPs
 - pH, temperature, media type, backwashing conditions, preozonation
 - Monitor full-scale biological filters

Status: 3 years completed, 2 year supplement awarded

Removal of DBP Precursors by GAC and Membranes (RM.D.4)

Membrane Scale Up and Fouling (RM.D.5)

In-house

- Study • Membrane performance: TOC, DBP precursors, TDS, particles, bacteria
- Evaluate operational parameters: flux
 - Assess pretreatment requirements: conventional, biological
 - Compare NF membrane types
 - Field sites
 - Evaluate membrane fouling: organic, inorganic, microbial
 - Autopsies
 - Assess chemical cleaning requirements
 - Evaluate bench to pilot scale up

Status: On-going

Analyses of HAA9

In-house

Status: Method development/evaluation

Issue: Variable esterification and extraction of more-brominated HAA3

Current Projects

Enhancement of EPANET Distribution System Water Quality Model (RM.M.16)

In-house

Water Quality Impacts of Dead Ends (RM.M.22)

Recipient: University of Cincinnati

Mixing in Storage Facilities (RM.M.23)

In-house

Multi-Component Kinetic Models for Chlorine Decay and DBP Formation in Distribution Systems (RM.M.24)

Recipient: to be selected

- Study • Distribution system modeling
 - Assess chlorine residuals and DBP concentrations in distribution systems
 - Field verification
- Status: On-going

Removal of Multi-Contaminants from Drinking Water by Membrane Processes (RM.D.7b)

Recipient: University of Central Florida

- Study • Evaluate NF and low pressure RO
- Evaluate pretreatment: conventional, MF, UF
- TOC, DBP precursors, pesticides, aerobic endospores
- Field sites

Status: Bench studies complete, field studies upcoming

Mutagenicity Screening Studies of Drinking Water Mixtures (HE.D.16)

In-house

Study • Ames testing, GC/MS identification (ORD Athens, GA) of treated-water DBPs

- Chlorine
- Evaluation of Finnish carcinogenicity model using chlorine
- Field sites

Status: On-going

Current Projects

Evaluation of Ozone-Bioreactor System vs Membrane Separation for DBP Precursor Removal (RM.D.7c)

Recipient: University of Colorado, Colorado State University

Study • Evaluate high porosity packed bed bioreactor and NF

- Evaluate pretreatment
- TOC, DBP precursors, bromide, bromate
- Field sites

Status: Complete, awaiting reports

Evaluation of Disinfection and Optimization in Full-Scale Treatment (RM.M.5)

Recipients: Jefferson Parish, LA

Study • Ozone and biological filtration, filter media comparison

- Post chlorine, post chloramine

Status: Complete, awaiting reports

New Projects . . .

Enhanced Softening for Precursor Control (RM.D.1)

Recipient: To be selected

Study • Mechanisms of control of DBP precursors and TOC

- Lime/lime soda, with/without coagulation
- Secondary effects

Status: Award in FY97

Ozonation and Enhanced Coagulation for the Control of DBPs (RM.D.2b)

Recipient: To be selected

Study • Order of processes: ozonation, enhanced coagulation, biological filtration

- pH effects
- TOC, DBP precursors, ozone BPs, bromate
- Secondary effects

Status: Award in FY 97

Bank Filtration for the Control of DBP Precursors

Recipient: To be elected

Study • Evaluate soil types, pumping rates, residence time

- TOC, DBP precursors, pesticides, possibly pathogens

Status: Award in FY 97

Ozone By-Product Formation (RM.D.6a)

In-house

Study • Conditions that affect formation of aldehydes, keto acids, AOC, BDOC, bromate, carboxylic acids, oxidation of DBP precursors, inactivation of pathogens

- pH, temperature, time, NOM, ozone concentration

Status: Start in FY 97

Research Direction

- Incorporation of HAA9 into occurrence, formation and control studies
- Identification and minimization of membrane foulants.
- Optimization of biological filtration. To what extent can ozonation and biological filtration meet Stage 2 requirements?
- To what extent can enhanced/optimized coagulation and ozonation meet Stage 2 requirements?
- Scale up of ozonation
- Better understanding of the distribution system as a treatment process.
Modeling disinfectant residuals, DBP stability and formation in distribution systems. Understanding the role of biofilms in distribution systems.
- To what extent can improved biological filtration minimize distribution system biofilms?
- Better understanding of the control of pesticides by membranes, GAC, ozonation and biological filtration
- Identification of unknown DBPs. What makes up the unaccounted for TOX?
What is the speciation of the unknown TOX?