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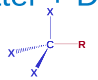
2004 EPA STAR Graduate Fellowship Conference *Next Generation Scientists—Next Opportunities*

Abiotic Fate of Disinfection By-Products in the Drinking Water Distribution System

Environmental Issue

Organic Matter + Disinfectant ➔



Disinfection By-Products

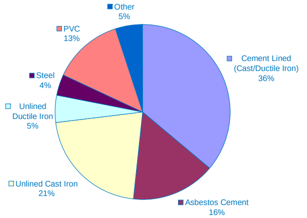
Presence of DBPs in Drinking Water

Compound	R- Group	Average Concentration (µg/L)
Chloroform	H	13.15
Trichloroacetic Acid	COOH	5.4
Dichloroacetonitrile	CN	1.2
1,1,1-Trichloropropanone	COCH3	0.6
Chloral Hydrate	COH	2.18
Chloropicrin	NO_2	0.12

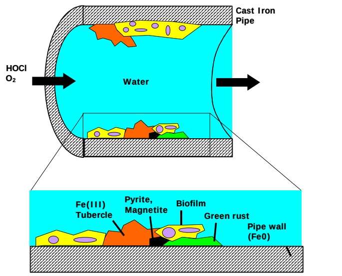
*Adapted from Krasner et al., (1989) *J. AWWA* **81**(8):41

As DBPs travel through the drinking water distribution system they come in contact with the pipe surface

Composition of pipe materials in the distribution system in the U.S.



There are over 65,000 miles of unlined iron pipe in place in the U.S. (AwwaRF, 1996)



Over time, the iron surface is corroded and tubercles are formed

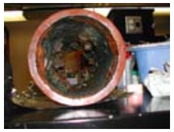
DBPs may react with iron pipe surface

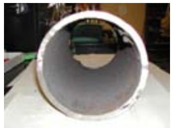
DBP + Reduced Fe ➔ **PRODUCTS** + Oxidized Fe

Scientific Approach

GOAL: Determine the major reaction pathways that affect the abiotic fate of DBPs in the drinking water distribution system

- Aqueous phase reactions
  - Hydrolysis reactions
- Surface reactions
  - Reduction reactions

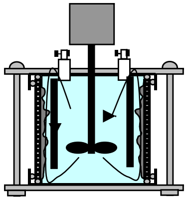




Variables to be studied:

- DBP Identity
- Iron corrosion mineralogy
  (Fe^0, iron corrosion products)
- Water quality parameters
  (pH, temperature, dissolved oxygen, residual disinfectant)

Batch and pipe reactors will be used



Highlights

DBP Hydrolysis Half-Lives at pH 7.5

Class	Compound	$t_{1/2}$ (days)
Halomethanes	Trichloromethane	249
Haloacetic acids	Trichloroacetic acid	890
Haloketones	1,1,1-trichloropropanone	5
Haloacetaldehydes	Dichloroacetaldehyde	128
Haloacetonitriles	Trichloroacetonitrile	2
	Dichloroacetonitrile	30
Halonitromethanes	Trichloronitromethane	11
	Dichloronitromethane	6
	Chloronitromethane	8

DBP Reduction at pH 7.5

Compound	Fe^0 k (L m^{-2} hr^{-1})	Pipe Solids k (L m^{-2} hr^{-1})
[a]Trichloroacetic acid	3.52	
[a]Dichloroacetic acid	0.056	
[a]Chloroacetic acid	0.0056	
Trichloromethane	0.00653	
Dichloromethane	NR[b]	
Dichloroacetonitrile	3.16	0.000139
Trichloronitromethane	22.31	0.0599
Dichloronitromethane	4.79	0.022
Chloronitromethane	7.23	0.000414
Nitromethane	22.78	

a. Reported in Zhang et al. (2004) *Accepted to ES&T*
b. No reaction observed

Impact

DBPs are transformed abiotically via aqueous phase and surface reactions

- Potential for DBP degradation in the drinking water distribution system
- Potential for change in DBP identity, concentration, and toxicity along the distribution system
- Potential for development of end of pipe treatment technologies for DBP removal

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