Technical Briefing:
THM & HAA Prevention with ZLD & >4 Log Removal

Problem

Trihalomethanes (THMs) and Haloacetic Acids (HAAs) are Disinfection By-Products (DBPs) which are formed when drinking water is chlorinated. THM and HAA compounds are produced when chlorine reacts with Natural Organic Matter (NOM) which is also commonly referred to as Dissolved Organic Matter (DOC) in water. Typically, the greater the DOC, the higher the chlorine demand, and the greater the THM and HAA formation that occurs in drinking water.

US EPA regulations require less than 80 ppb of THMs and less than 60ppb of HAAs in drinking water. The prevention of THMs & HAAs is not easy if you use the wrong tools.

The problem of NOM or DOC is aggravated by current municipal practices which use pre-chlorination and/or other oxidative processes such as permanganate or ozone. These oxidative processes break down the DOC to smaller compounds that more readily form THM and HAA. Therefore, oxidative pre-treatment processes must be eliminated.

Other 'band-aid' solutions include the use of high-cost chloramines to reduce the THM & HAA formation. The use of Chloramines is undesirable as it creates problems in the distribution system and promotes the formation of biofilm in the pipelines. Other undesirable solutions that add unnecessary complexity, cost and waste is Ion Exchange and Dissolved Air Flotation (DAF).

To prevent THM and HAA formation NOM must be removed before chlorine is added.

Solution

The ***Cuf***® (Continuous Ultra Filtration) process is the solution to remove DOC/NOM with the use of Free Chlorine to achieve the MCL requirements for THM and HAA.

Cuf® is the only process that performs Ultra-Coagulation (greater DOC removal with less coagulant), eliminates **all pre and post treatment**. Common coagulants, such as Ferric Chloride, Alum or ACH are added in the ***Cuf***® to perform Ultra-Coagulation. This achieves greater DOC removal than other technologies and removes other contaminates that react with free chlorine (ie. heavy metals, etc.). Ultra-Coagulation reduces chlorine demand by ~75%. The ***Cuf***® process also removes color, pathogens, heavy metals, phosphorus, taste, odor, etc.

The ***Cuf***® platform is a stand-alone solution for THM & HAA prevention for drinking water that is also capable of Zero Liquid Discharge and greater than 4 Log Pathogen removal at an all in operating cost

structure of less than $0.04/1000 gallons.

The ***Cuf***® process **eliminates** the need for Pre-Chlorination, Chloramine, Permanganate and Ozone processes.

The superior features, benefits, and cost structures for ***Cuf***® are detailed in '*Why* ***Cuf***®*?*'

DOC3090R1 – Why ***Cuf***®

THM & HAA Prevention Case Study 1

In California, ***Cuf***® was applied to a potable groundwater containing high color, and compared to the existing Ozone/Carbon process as shown in the table below. Ozone increases chlorine demand, THMs and HAA formation and creates bromate from the naturally occurring bromide.

Parameter	Ozone Process	***Cuf***® Process
Color Removal (Spec 7 cu)	165 cu → 7 cu	165 cu → <5 cu
TOC Removal	12 ppm → 11 ppm	12 ppm → 6 ppm
Chlorine Demand	12 ppm	4 ppm
TTHMs Formed (MCL 80 ppb)	40-50 ppb	0.7 ppb – 1.5 ppb
HAAs Formed (MCL 60 ppb)	10-30 ppb	2-3 ppb
Bromate (10 ppb)	80 ppb	Non-detect

Reference TP Logbook

THM & HAA Prevention Case Study 2

The ***Cuf***® process successfully completed a 90-day pilot program for the implementation of a 3 MGD plant. Water was pumped from the Rio Grande River to the reservoir and then pumped directly to the ***Cuf***®. Performance data was compared to the existing Clarifier/Sand filter plant. Chlorine demand was reduced from 12 ppm to 5 ppm (reduced by 60%).

Parameters	Raw Water (mg /L)	Filtrate (mg/L)
Total Organic Carbon (TOC)	4.49	2.98
Iron	0.56	0.013
Turbidity (NTU)	5-35	0.02-0.04

Disinfection Method	TTHMs (ppb)
Cuf® with 1 ppm Chlorine, Primary	15
Cuf® with 4 ppm Chlorine for 2 ppm Residual	36
Existing Plant with Chloramines	46

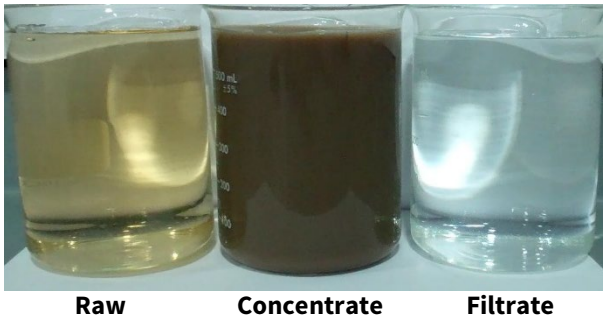
DOC4032R8 – Drinking Water – Surface Water Pilot without Pre-Treatment

THM & HAA Prevention Case Study 3

The 1 MGD *Cuf*® system was commissioned and brought online October 2015. The need and cost of large coagulation basins, mixers, clarifiers and the EDR are eliminated.

The *Cuf*® operates on demand removing color, Fe and the majority of DOC which significantly reduces chlorine demand by 75% over baseline. Reduction in DOC and chlorine residual solves THM & HAA formation problems.

Parameters	Inlet	Outlet
Blend Ratio	50/50	Clear Well
Color	85 CU	5 CU
DOC	3.3 ppm	< 1.0 ppm
Iron	400 ppb	< 10 ppb
Flux	480 GFD	5 psi TMP
THMs	N/A	38 ppb
HAAs	N/A	18 ppb
Coagulant	14 ppm	Non-detect



Raw **Concentrate** **Filtrate**

DOC4030R7 – Drinking Water – Zero Liquid Discharge