

Trihalomethanes (THMs): from precursors to management strategies

Maria Valdivia-Garcia (EngD candidate)



Engineering and Physical Sciences Research Council





The Industrial Doctorate Centre for the Water Sector

Outline 1. Background 2. Findings i) Seasonal changes ii) Dissolved Organic Carbon (DOC) character iii)THMs management 3. Conclusions



Background Trihalomethanes (THMs) in drinking water?

Dissolved Organic Carbon + (DOC) + (or chloramine) Disinfection by products (THMs) Chloroform: CHCl₃ Bromodichloromethane: CHBrCl₂ Bromoform: CHBr₃ Dibromochloromethane: CHClBr₂

 $CH_4 + CI-CI \rightarrow CH_3CI + HCI$

Potentially carcinogenic in humans!!



THMs health effects

International Agency for Research on Cancer (IARC)/WHO "Chloroform and bromodichloromethane have sufficient evidence of carcinogenicity in animals but inadequate in humans"

> max. levels UK guidelines: No more than 100 µg/L in any three month period

US, Canada: No more than 80 µg/L as annual average





Main objective of the Project: Characterize the precursors of THMs (DOC) to improve drinking water processes that will reduce its formation

Factors: DOC quality, location, temperature, treatment type of disinfectant, etc.



2. Findings i)Seasonal changes ii)DOC character iii)THMs management



Seasonal changes: THMs are influenced by ambient temperature, with peak concentrations in August-September



Correlation analysis for THMs and climatic factors



a) THMs and ambient T → strong and significant correlation

b) THMs and rainfall \rightarrow no correlation

c) Raw water DOC and rainfall → statistically almost insignificant correlation



Findings ii) DOC character



DOC character: Hydrophilic fraction of DOC



Total Phenolic compounds: **5-8%** of DOC

Total carboxylic acids: 20-30% of DOC

Trihalomethanes formation potential (THMFP): Phenolics vs Carboxylic acids (?)

Phenolic compounds percentage per mg DOC at each treatment point (June)



Post GAC: Post granulated activated carbon Phenolic compounds represent less percentage of DOC , and are preferentially removed during treatment



Carboxylic acids (35) percentage per mg DOC at each treatment point (June)



Carboxylic acids are a significant percentage of DOC, and are enriched in treatment (i.e. this DOC is difficult to remove).



DOC character: THMFP from carboxylic acids vs phenolic compounds



Although carboxylic acids are more abundant in DOC, they have much lower THMFP than phenolic compounds.



THMFP for different phenolic compounds at different temperatures



📕 5 °C 📕 15 °C 📒 25 °C

THM formation is highest if there is a $-OCH_3$ group on the phenolic ring Temperature effect is same as observed in potable water data



Findings iii) THMs management



THMFP of carboxylic acids and phenolic compounds using batch Silver impregnated activated carbon (Ag-GAC) adsorption



Phenolic compounds with –OCH₃ groups are easily removed using Ag-GAC (~50-63%) compared to carboxylic acids (8.3-23%)



3. Conclusions:

- Temperature, DOC and halides are important factors for THMs formation
- Carboxylic and phenolic compounds are important components of residual DOC in treated water in Scotland and difficult to remove
 - Ag-GAC filtration could be an important alternative for phenolics and carboxylic acids removal from drinking water in Scotland and thus minimize THMs formation



Thank you !



Engineering and Physical Sciences Research Council



