# Attenuation of Micropollutants in Biological Drinking Water Filters

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## Outline

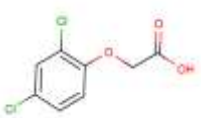
- Background
- Hypothesis
- Experimental Set-Up
- Analysis
- Research Plan
- Adsorption and Degradation Study

## Background

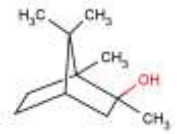
- Most drinking water plants operate abiotic filters
- Use GAC or ozone to remove trace organics not removed in conventional treatment process
- Many micropollutants have potential to be biologically degraded

## Micropollutants

- 2, 4-Dichloropheoxyacetic Acid (2,4-D)
  - Widely used broad-leaf herbicide
  - Regulated by EPA (MCL= 70 ppb)



- 2-Methylisoborneol (MIB)
  - Released by algal blooms
  - Non-toxic, significant aesthetic issues



Source: ChemID Plus

## Acclimation

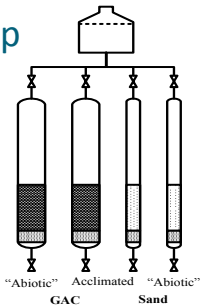
- Acclimated media is required for this experiment
  - Previous studies suggest microorganisms in filters may require up to 6 months to acclimate to utilizing MIB (Meyer, 2005)
  - Little data available for the acclimation period required for 2, 4-D

## Hypothesis

- When compared to sand, GAC achieves more consistent micropollutant removal in biofilters due to its capacity to utilize combined biodegradation and adsorption

## Experimental Set-Up

- 4 biofilters
- Sand - GCWW in Ohio
  - Acclimated (Sand B) and abiotic (Sand A)
- NOM Exhausted GAC- Solano County, California
  - Acclimated (GAC B) and abiotic (GAC A)
- Columns
  - Sand: ½ in. dia. glass
  - GAC: 0.6 in. dia. glass




(Zearley, 2009)

## Filter Media Preparation

- Sand and GAC media for abiotic filters were autoclaved in a TOC and micropollutant solution
- Phospholipid analysis was run on 4 media samples to determine initial biomass on filters
- Columns were packed to obtain 7.5 min EBCT

## Feed Water

- Dechlorinated City of Boulder tap water
- Initial influent concentrations
  - 100 ng/L 2,4-D
  - 100 ng/L MIB
  - 3 mg/L TOC
- Flow
  - Loading Rate: 1 gal/min/ft²
    - 4 mL/min per sand column
    - 7 mL/min per GAC column

## Analyses

- Samples analyzed to determine TOC, UV, and micropollutant removals
- Micropollutant removal determined using Liquid Scintillation Counting (LSC) with radiolabeled compounds
- Solid Phase Extraction (SPE)
  - Used to remove parent compounds from influent and effluent samples

Concentration= Pre-SPE Conc. – Post-SPE Conc.

## Research Plan

- Attenuation Study
  - Increase micropollutant concentrations at regular intervals
  - Once breakthrough occurs, or 500 ng/L concentration is reached, stop micropollutant feed
  - Monitor desorption and degradation

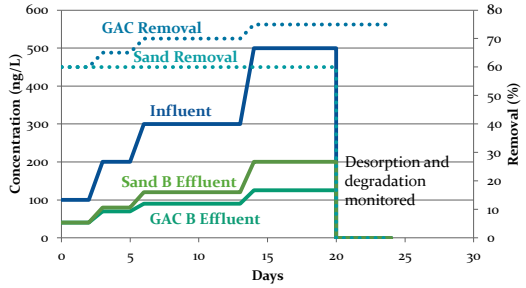
## Attenuation Timeline

| Days | Concentration of Micropollutants |
|---|---|
| 0-2 | 100 ng/L |
| 2-5 | 200 ng/L |
| 5-13 | 300 ng/L |
| 13-27 | 500 ng/L |
| 27-34 | 0 ng/L<br>Monitored attenuation and biodegradation |

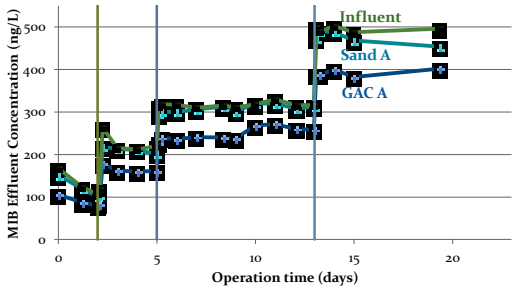
## Sampling Plan

- Samples were taken:
  - Immediately before influent concentration increase
  - Two hours after increase
  - 6 hours after increase
  - 24 hours after increase
- Then daily until next increase

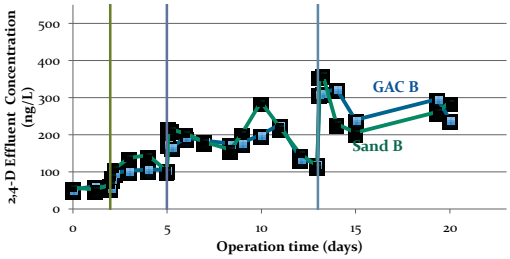
## Hypothesized Results



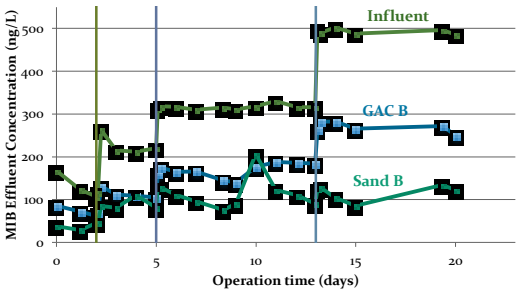

## Experimental Results



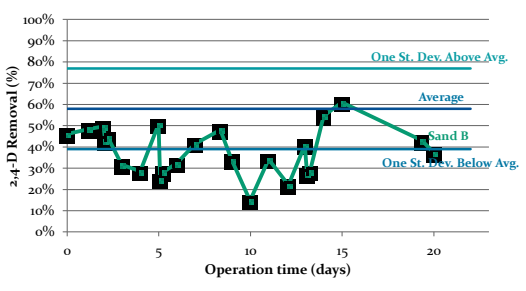

## Experimental Results for 2,4-D



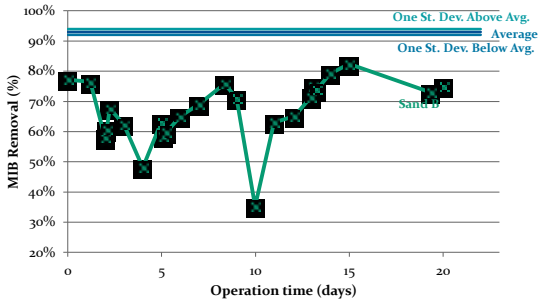

## Experimental Results for MIB



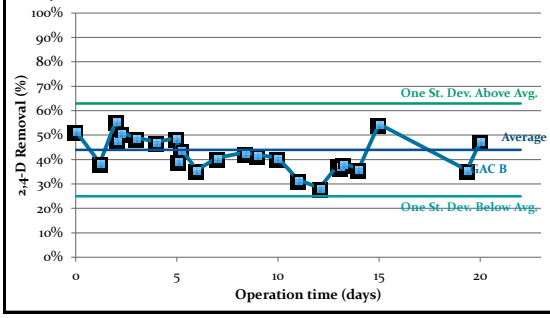

## Performance of Acclimated Sand for 2,4-D



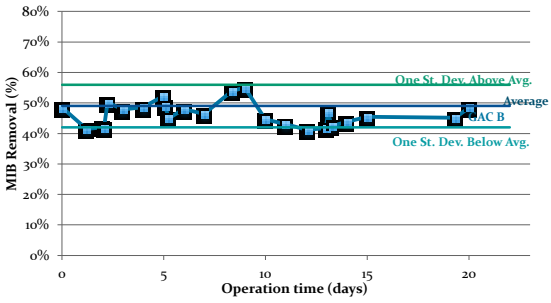
## Performance of Acclimated Sand for MIB



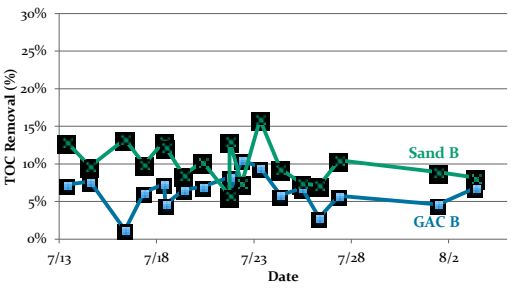

## Performance of Acclimated GAC for 2,4-D




## Performance of Acclimated GAC for MIB




## TOC Removal




## Conclusion

- Experiment still in progress
- Sand B did not show anticipated sharp decline in removal
- GAC B showed more consistent removal than Sand B
- Abiotic media showed no acclimation
- Removal remained constant regardless of influent concentration
  - 1st order degradation of micropollutants

## Future Work

- Micropollutant feed will be shut off
  - Attenuation and desorption will be monitored
- TOC concentrations will be varied at constant micropollutant feed concentrations
  - Goal: Publish paper on the effects of varying influent conditions in biological filters

## Potential Applications

- Biological filtration using GAC will provide high levels of removal during periods of pollutant fluctuations
- May be used in drinking water filters already in operation

## Acknowledgements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## Questions?