Drugs in Drinking Water: An Enhanced Biological Removal through Biofilm Thickness Management for Water Reuse Application

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Objectives

The objectives of this research are:

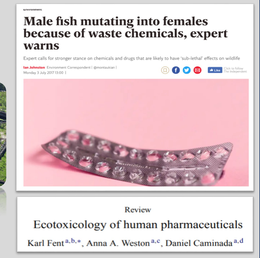
- To determine the biodegradability of targeted pharmaceuticals by the bacteria present in the full-scale biofilter.
- To investigate if targeted pharmaceuticals removal is enhanced through biofilm thickness management.

Motivation and Background

90%

of consumed prescription drugs ultimately end up in our waste water.*

*Kümmerer, K. (2001)



Male fish mutating into females because of waste chemicals, expert warns

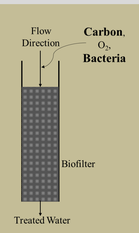
Expert calls for stronger stance on chemicals and drugs that are likely to have 'sub-lethal' effects on wildlife

Review

Ecotoxicology of human pharmaceuticals

Karl Fent[a,b,*], Anna A. Weston[a,c], Daniel Caminada[a,d]

Research Approach

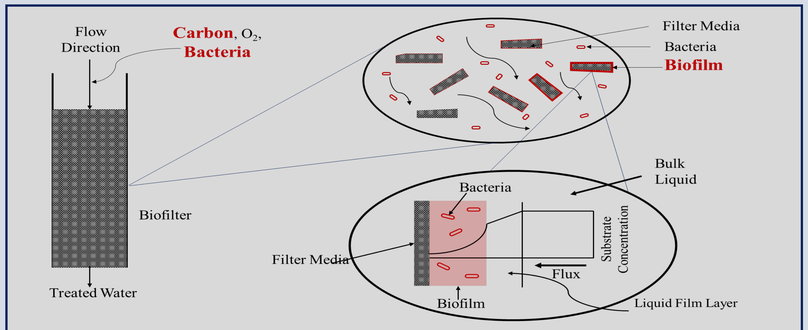


Project 4: Can **dual-media biofiltration columns** more effectively remove pollutants with promoted growth of thick-thin biofilms?

Project 3: How can thick-thin biofilm be produced on **GAC and Ceralite**?

Project 2: Is targeted substrate removal possible through **biofilm thickness** management?

Project 1: Are the targeted pharmaceuticals **biodegradable** by the bacteria present in the full-scale biofilter?



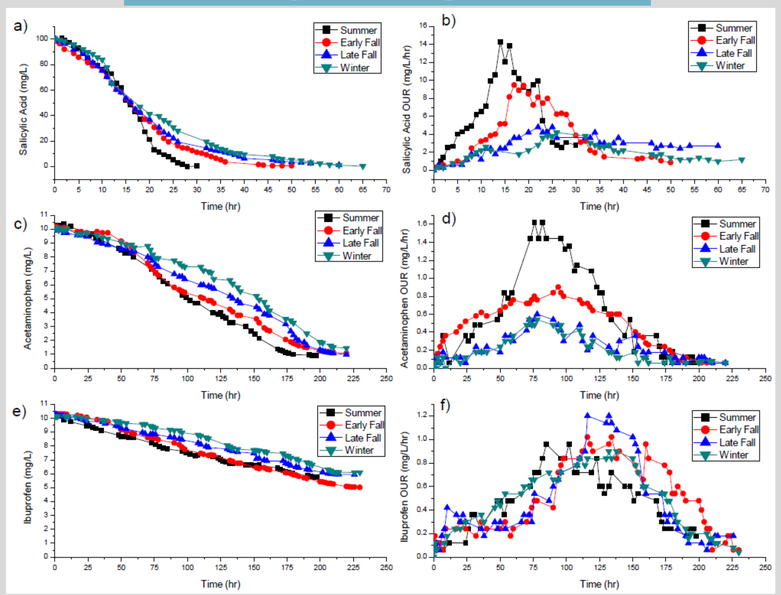
Methodology

Bacteria source: backwash water from a full scale drinking water biofilter

Carbon source: three pharmaceuticals-
1. Salicylic Acid (from Aspirin)
2. Acetaminophen
3. Ibuprofen

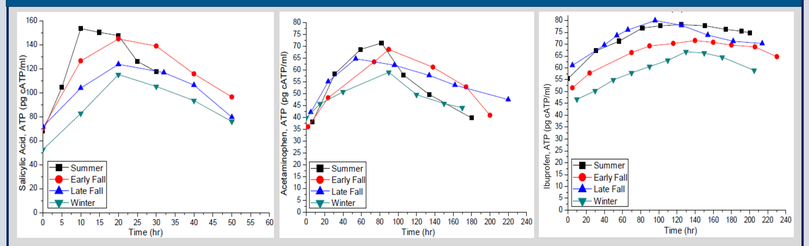
Results

Biodegradation Experiment



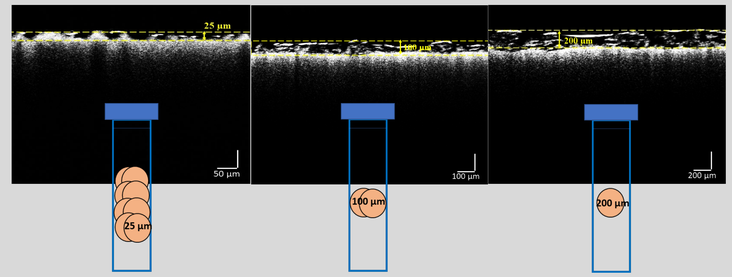
- Salicylic Acid degrades faster, showing complete degradation in 30 – 60 hours depending on the season.
- After 225 hours, Acetaminophen and Ibuprofen degradation is 90% and 40-50%, respectively.
- Much slower degradation by bacteria in backwash water collected in winter compared to summer.

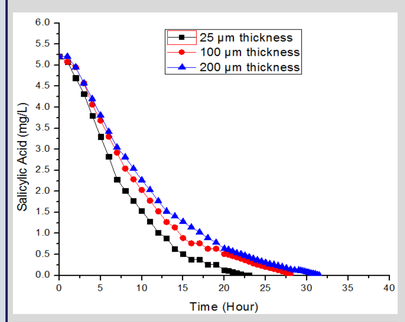
Results

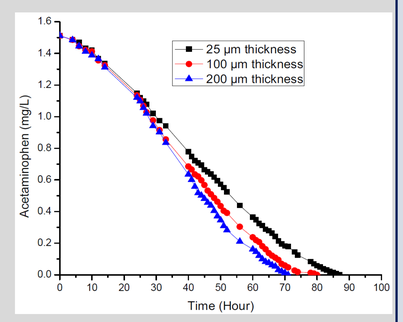


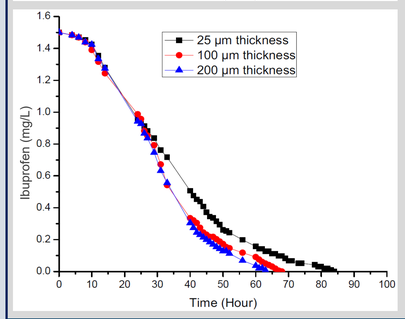
ATP can be a reasonable surrogate of Oxygen Uptake Rate!

Biofilm Thickness Experiment









- Salicylic Acid degrades faster by the thin biofilm.
- Unlike Salicylic Acid, both Acetaminophen and Ibuprofen degrade faster by the thick biofilms.
- Managing thick and thin biofilm can improve the overall removal efficiency of all contaminants.

Future Studies

- **Microbial community analysis** to investigate the shift of bacterial community during the degradation
- Managing thick and thin biofilm in the **pilot scale biofiltration column** to improve overall removal efficiency.