Impact of Antibiotics on Denitrifying Biofilm

Jeremiah Rocha, Chemical Concentration
Julie Swierenga, Civil/Environmental Concentration
Professor David Wunder, Calvin College, Summer 2013

Introduction

Nitrate contamination of drinking water supplies due to agricultural runoff is a prevalent problem, and it presents serious health concerns. Low µg/L concentrations of antibiotics have also been found in surface waters worldwide. This research focuses on how low concentrations of antibiotics affect the rate of denitrification in slow rate biofiltration systems which use biofilm to treat drinking water.

Objective

To understand the impact of low concentrations of antibiotics on the denitrifying ability of biofilm used in water filtration through assessment of denitrification rates and bacterial viability.

Methods

Experimental Set-Up
• Continuous-Feed Rotating Annular Bioreactors (CFRABs) were run for 7 days to simulate biofiltration of drinking water.
• Mineral water, acetate, nitrate, and antibiotics were fed through the CFRAB which was seeded with biofilm.

Figure 2. Experimental Set-Up: Mineral water was fed into the CFRABs from 55 gallon drums, while acetate feed was made in 7L batches.

Denitrification Analysis
• Nitrate sweeps were performed at the end of the 7 day run by incrementally increasing the nitrate concentration in the CFRAB.

Figure 2. Illustration of the nitrate sweep step-feed conditions. The final concentrations of nitrate were increased at 1 hour intervals, and the effluent concentration was measured after each step to determine nitrate utilization by the biofilm bacteria.

Results

Denitrification Rates
• Denitrification rates in a typical untreated drinking water NO₃⁻ concentration range (50 mg/L to 70 mg/L) was decreased by approximately 50% with low and high antibiotic concentrations.

Figure 6. Nitrate utilization in mg/L during each nitrate sweep. The highlighted region of the graph represents a typical NO₃⁻ concentration range for untreated drinking water (50 mg/L to 70 mg/L).

Bacterial Viability
• Based on Live/Dead results, low concentrations of antibiotics does not have a significant effect on the viability of the biofilm bacteria.
• Biomass in the reactor after the nitrate sweep showed an increase at both the low and high antibiotic concentrations.

Figure 4. Aluminum trays after combustion in volatile solids analysis.

Table 1. Summary of the bacterial viability results for each run. The mass of volatile solids per reactor slide, is provided along with the live:dead ratio.

Conclusions

• Low concentrations of antibiotics (3.44 µg/L and 34.4 µg/L) decreased the utilization of nitrate in a denitrifying biofilm by approximately 50% when present in water.
• Biomass in the reactor showed an increase with the introduction of low and high µg/L concentrations of antibiotics.
• Future community structure analysis will provide complementary data.

Acknowledgments
Mr. Bob De Kraker, Calvin College
Mr. Rich Huisman, Calvin College
Mr. Phil Jasperse, Calvin College
Ms. Lori Keen, Calvin College
Mr. Scott Prentice, Calvin College
Wyoming Wastewater Treatment Plant

References