Executive Summary

Exploring nitrous oxide formation in biofilms

Assessing Nitrous Oxide (N₂O) Emissions from Biofilm Systems (U2R10/4873)

The Central Issue
Anthropogenic release of greenhouse gases (GHG) is an important contributor to global warming. While extensive research has addressed N₂O from suspended-growth systems, few studies have explored N₂O formation in biofilms. Biofilm is an assemblage of surface-associated microbial cells enclosed in an extracellular polymeric substance matrix. Biofilms behave differently from suspended growth systems due to internal substrate gradients. The objective of the research was to gain a better understanding of N₂O emissions from biofilm systems in wastewater treatment.

Context and Background
Nitrous oxide is a potent GHG that is a global concern due to its accumulation in the atmosphere. Water resource recovery facilities (WRRFs) are an important source of N₂O. However, little is known about N₂O formation in biofilms, which are becoming more prevalent in wastewater treatment.

The complexity of biofilms makes it difficult to predict their behavior, consequently making mathematical modeling an important tool in the study. The research process included lab-scale experiments and field campaigns of an integrated fixed film activated sludge (IFAS) nitrification process and a plant with denitrifying filters.

Findings and Conclusions
The research team addressed N₂O emissions from nitrifying biofilms, denitrifying biofilms, and combined nitrifying and denitrifying biofilms. Two main biological processes are responsible for N₂O production: nitrification by ammonium oxidizing bacteria (AOB) and denitrification by denitrifying microorganisms.

The research results suggest that the mechanisms leading N₂O emissions from nitrifying biofilms are complex, and emissions depend on a number of factors that may be difficult to quantify in real systems. Some of these mechanisms, such as biofilm thickness or density, are highly variable or difficult to control in a real system.
Executive Summary

Related WRF Research

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<th>Project Title</th>
<th>Research Focus</th>
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<td>Greenhouse Nitrogen Emissions from Wastewater Treatment Operations – Phase I (U4R07)</td>
<td>Characterizes the microbial pathways for N₂O formation from suspended growth systems. The report includes measurement of emission rates from several BNR and non-BRN plants across the U.S.</td>
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<td>Greenhouse Nitrogen Emissions from Wastewater Treatment Operations – Phase II (U4R07a)</td>
<td>Phase II report focuses on the impact of process conditions in a full-scale nitritation-denitritation process, anoxic-oxic cycling, inorganic carbon limitation on autotrophic N₂O production, and emission at lab-scale.</td>
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<tr>
<td>Methane Evolution from Wastewater Conveyance (U2R08a)</td>
<td>Methane emission from sewers is a suspected, but relatively undocumented source of greenhouse gas. Researchers detected notable but variable levels of methane emissions in forebays and wet wells. Continuous monitoring of methane in both the liquid and gaseous phase demonstrated the potential for significant methane emissions.</td>
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