Engineered Material
for
Removal of Ammonia from Water

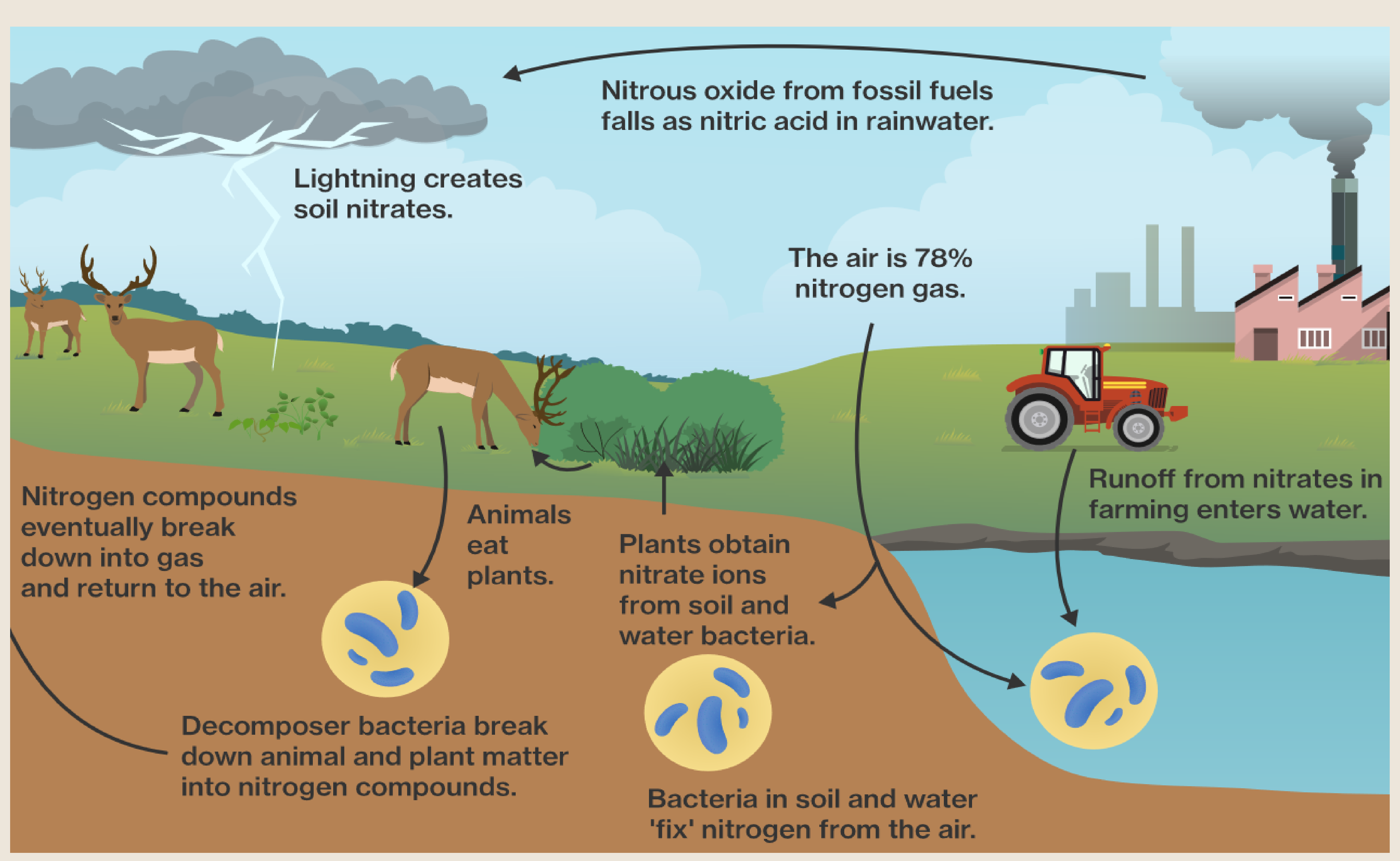
Author: Louis Chapman
Coauthors: Danielle O'Hagan Kennedy
Marcia Silva

Introduction

When rivers and streams become overloaded with nutrients, they undergo expedited eutrophication, a process which leads to the proliferation of algae and threatens the health of our ecosystem. Modern practices in agriculture and industry lead to high volumes of this nutrient discharge into the rivers. Areas with high volumes of discharge are known as point sources. Wherever possible, we use available technologies to remove contaminants from the run-off in these locations. Current methods of ammonia filtration such as nitrification and oxidation require installation of large tanks at the point of filtration, incurring high up-front costs. Furthermore, these options cannot be implemented in colder climates, necessitating the development of alternative filtration mechanisms. This study is part of an initiative to alleviate issues seen in streams with high nutrient concentrations.

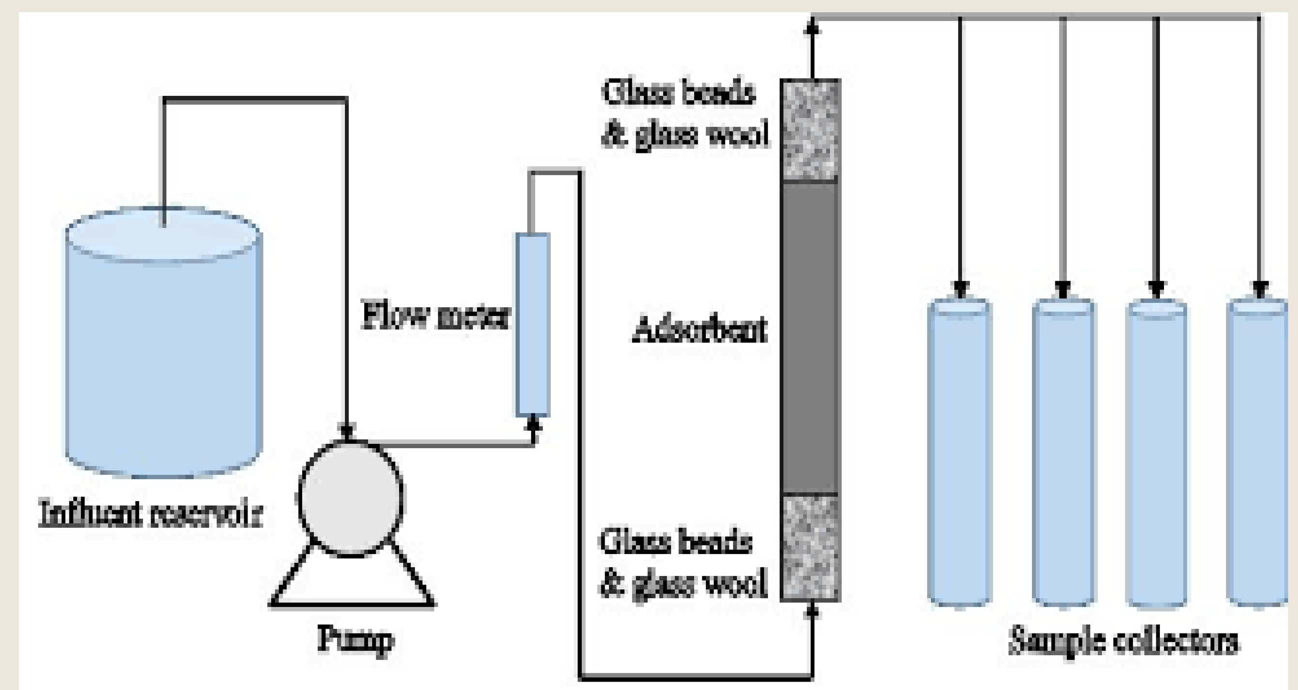
Abstract

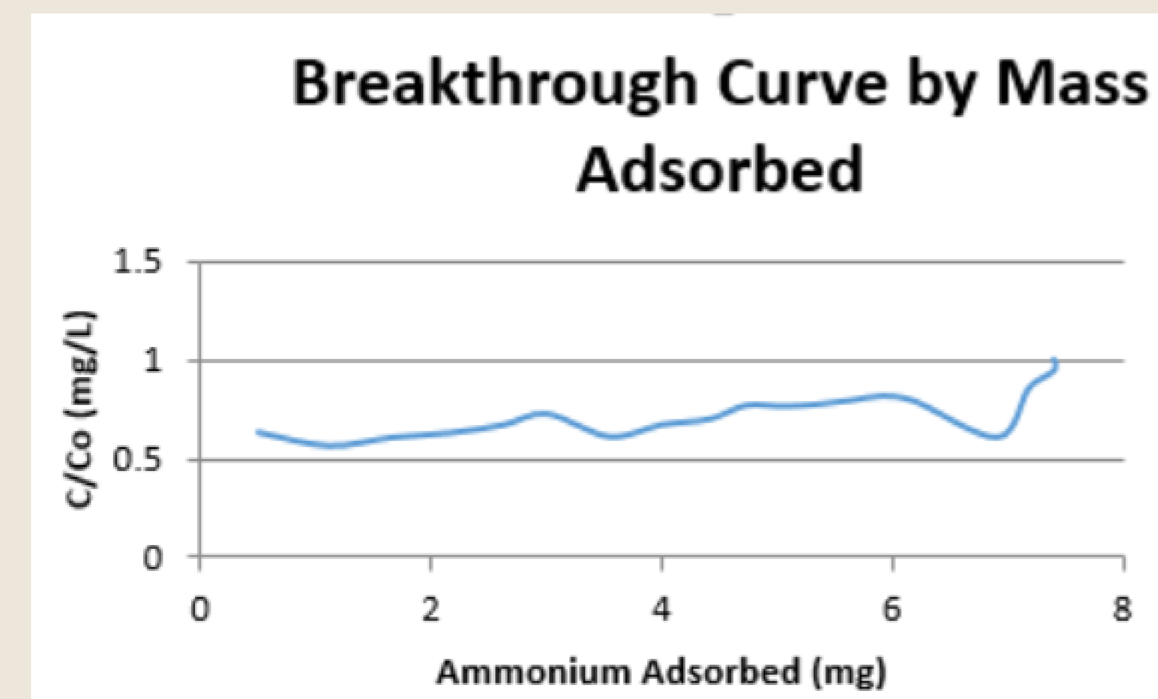
This project focuses on development of a modified natural material designed for targeted removal of ammonia at point sources. Our chosen material can operate in cooler climates where nitrification cannot. It can be engineered to accept ammonia over other pollutants, making it a good choice for use in waters with multiple contaminants. This study aims to optimize the adsorption kinetics of the filter and ensure its suitability for application in an environmental setting. This research illustrates the potential of engineered materials in addressing climate issues around the world.



Method

Ammonium ions can be targeted for removal through a mechanism called ion-exchange. The chosen filter readily accepts cations, molecules like ammonium which hold a net positive charge. Ion exchange is reversible; exhausted material can be restored so that it may be used again. Once installed, the material would require periodic regeneration, which incurs significantly lower upkeep costs than replacing the filter. The material will only require replacement once physically deteriorated.





Experimental Design

The chosen material occurs naturally and is found abundantly around the world. The raw material can filter ammonia without a need for additional steps. However after a two-step modification process involving cleaning the particle and impregnating with a metal precursor at high temperatures, the performance of the filter increases significantly. Neither of these steps incur a prohibitive cost, and both can be executed on a large-scale basis.

We challenge the modified filter with ammonia solutions of known concentration and compare to the performance of the raw material to measure its performance as a filter. These tests involve recording the amount of ammonia adsorbed in both static and dynamic conditions. After regeneration, the filter is challenged again with ammonia solution. This ensures that the material does not see a dramatic decrease in performance over its life span. Finally, we deploy the filter at a point source and record ammonia levels both upstream and downstream of the filter. This ensures the material performs as well in the field as it did in a lab setting.

Conclusions

This material acts as an alternative to nitrification in cooler climates. Costs at installation and throughout the products life are low in comparison to other methods. The material's ability to be quickly and cheaply restored make it a viable alternative to nitrification in all climates.

Acknowledgements: Alice Lecus for assistance and general guidance in the lab.