The Use of Anammox Bacteria in Nitrogen Removal from Wastewater

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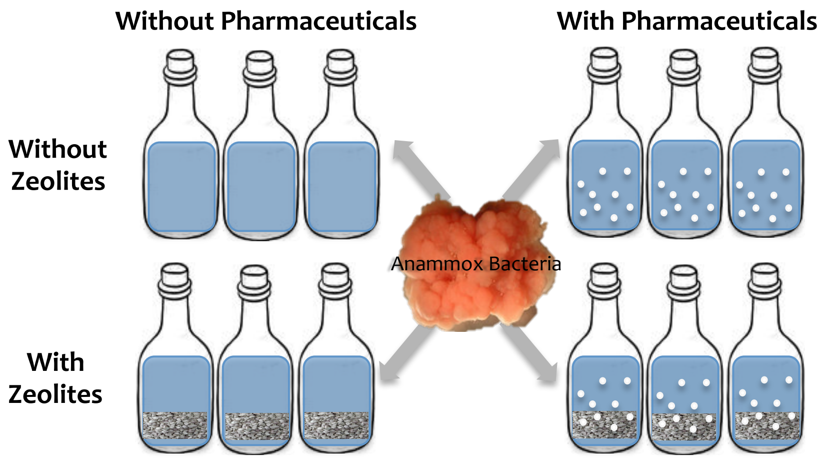
Background: The amount of reactive nitrogen in the environment has increased by 33 to 55 percent globally since the rise of the twentieth century and especially in recent decades.[1] Because nitrogen is generally a limiting nutrient in the environment, this increase in biologically available nitrogen has led to the acidification of freshwater systems as well as the eutrophication of aquatic ecosystems that results in hypoxia or anoxia.[2] Conventional municipal nitrogen removal involves a nitrification/ denitrification process where nitrification requires a significant amount of aeration and denitrification requires an additional carbon source. Because anammox bacteria are anaerobic primary producers that do not require aeration or an additional carbon source and directly convert ammonia and nitrite into nitrogen gas, using the anammox process is up to 90 percent more efficient than conventional nitrogen removal techniques.[3]

Objective: Better understand the use of anaerobic ammonia oxidizing (anammox) bacteria for inorganic nitrogen removal, specifically ammonia (NH_4^+) and nitrite (NO_3^-) in wastewater

Scope: How the anammox process works in conjunction with the rock, zeolite, as well as alongside pharmaceuticals commonly found in wastewater effluent

Experimental Set-Up: Four anammox conditions kept in a rotating incubator at 37 degrees Celsius monitored for a period of 19 days



Results:

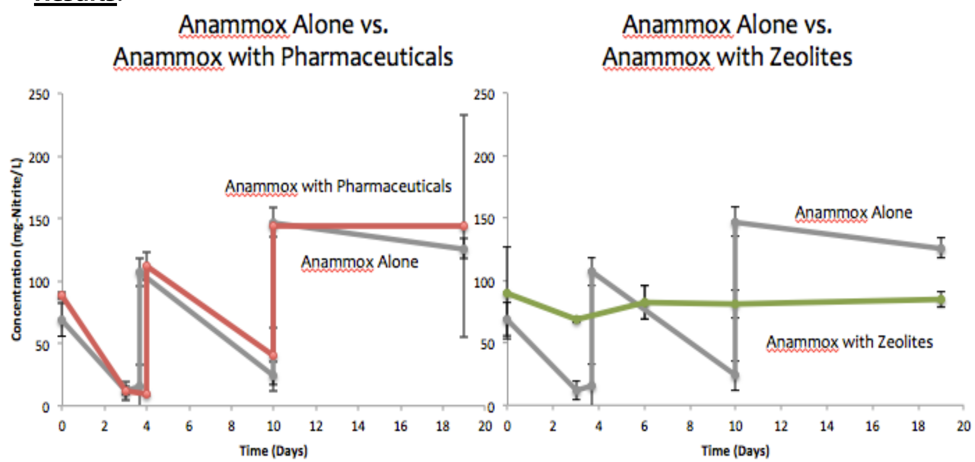


Figure 1: Comparison between the nitrite levels in anammox alone versus anammox with pharmaceuticals, and anammox alone versus anammox with zeolites over the 19 day experimental period

Conclusions: Because the nitrite levels in the anammox with pharmaceuticals is consistent with the nitrite levels in the anammox alone, it appears that ***pharmaceuticals have no impact on the anammox process***.

On the other hand, the nitrite removal was inhibited in the anammox with zeolites suggesting that ***zeolites affect anammox metabolism of nitrite***.

Future Work: Look more specifically at how anammox and zeolites work together by: 1. Testing different methods of mixing the anammox and zeolites together, 2. Performing detailed sorption studies to better understand the ion exchange between anammox and zeolites.

Analyze the microbial communities within each of the batch reactors by: 1. Utilizing flow cytometry to differentiate between intact and damaged cells, as well as for total cell counts, 2. Implementing RNA analysis to target anammox bacteria and to observe gene expression in the anammox communities.

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2. Camargo, J.A. & Alonso, A. (2006). Ecological and toxicological effects of inorganic nitrogen pollution in aquatic systems: A global assessment. *Environment International*, 32 (6), p.831-849. doi:10.1016/j.envint.2006.05.002
3. Hu, Z., Lotti, T., van Loosdrecht, M., Kartal, B. (2013). Nitrogen removal with the anaerobic ammonium oxidation process. *Biotechnol Lett*, 35, p. 1145-1154.