Effects of Different Charged Geologic Materials on Metabolic Activity

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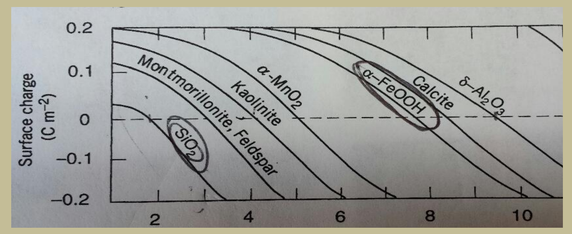
Introduction and Background

Wastewater treatment systems utilize different geologic materials as a surface for attachment of bacteria to break down and convert organics into a film that stays attached to the surface. Different surfaces and their related charges can affect the metabolic activity of the bacteria; if it inhibits growth of microbes , they cannot be generated faster than they are leaving the tanks. In this experiment, as shown in Figure 1, the surfaces I use under pH of 7 are positively-charged Al_2O_3 and calcite as well as negatively-charged sand. Bacteria take energy to degrade these nutrients and convert it to ATP/energy. The higher the energy extracted from the substrate, the easier it is to overcome the effect of a charged surface. When a substrate is difficult to degrade, available energy already acquired goes to creating energy as electrons to degrade the nutrients and perform other tasks. The ultimate goal of this research is to compare the effects of surface charges on bacterial growth over time.

Figure 1
Effect of pH on surface charge
Stumm, Werner, and James J. Morgan. *Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters*. New York: Wiley, 1996. Print.



Methods

• Fixed bed reactors in an incubator and attached to pumps operating at the same flow rate into an effluent flask.

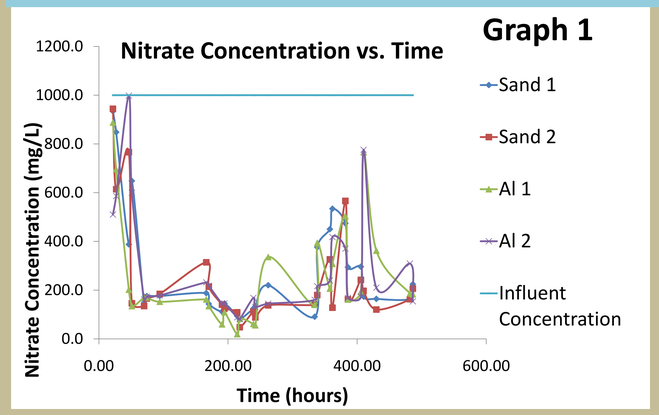
• The reactors are packed with the surfaces of varying charge and bacteria are added to the inlet port of the reactors using a syringe.

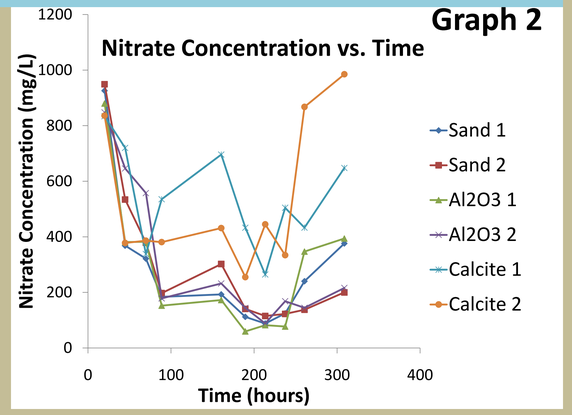
•A benzoic acid based growth media is the influent pumped through the reactors.

•A nitrogen component is part of the growth media as the electron acceptor for bacterial growth.

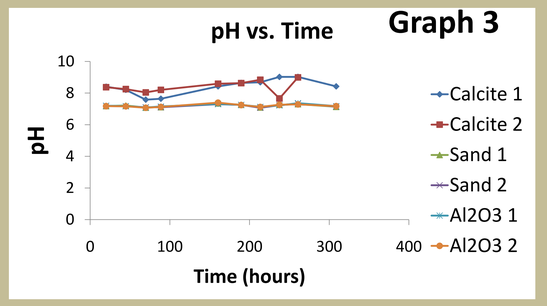
• Samples are taken twice a day for duration of 2 hours.
• The HPLC is used to measure the benzoic acid (organics) concentrations.
•Nitrate levels are measured by the nitrate probe because they exhibit degradation by the bacteria as the electron acceptor.

Results and Conclusion

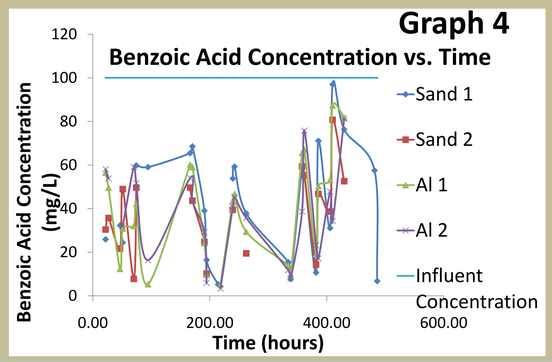




• Nitrate levels determined by some external influence due to the exact same dip trend between all surfaces within Graph 1 and Graph 2.
• Nitrate utilization is occurring in both the sand and aluminum oxide surfaces throughout both trials
• The noise within the Graph 1 makes it difficult to decipher an exact trend, though the nitrate seems to reach a minimum concentration at approximately nine days and increases towards the influent concentration thereafter.



• pH values remain at 7.2 throughout both trials with sand and Al_2O_3 (right environmental conditions for bacterial growth).
• pH of calcite of the pH, Graph 3, remained higher than 7.2 at an average pH of 8.4.
• Inhibited growth is represented in Graph 2, where calcite concentrations were typically higher than sand or Al_2O_3 and not as much bacterial growth occurs.



• Benzoic acid concentrations show dip trends every four days.
• Biomass accumulates to the point where a biofilm layer is formed at rapid growth rates.
• A lower growth rate results as there is not enough substrate for all the excess bacteria.
• Continues throughout as this biofilm layer keeps forming once bacterial growth slows back down.

Acknowledgements

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