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Prefer **oral presentation**

Hybrid ion-exchange (IX) and algae for high strength side stream wastewater treatment

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Algae-based wastewater treatment systems have the potential to reduce the energy cost of wastewater treatment processes by utilizing solar energy for biomass growth and nutrient removal. NH_4^+-N concentrations as high as 200- 300 mg/L are known to inhibit algae growth. Many research studies on the treatment of centrate after anaerobic digestion have been published recently. However, in these studies the centrate was diluted for the growth of algae due to the high NH_4^+-N concentrations, which are toxic to algae. Alternative solutions are necessary to treat high NH_4^+-N strength wastewater without addition of freshwater.

Zeolites are natural hydrated aluminosilicate minerals that have been used to reduce ammonium inhibition on microorganisms due to their high affinity for ammonium ions. It is possible to use the ion-exchange (IX) capacity of zeolite to reduce the toxicity of ammonia to algae. Importantly, the zeolite, which becomes saturated with ammonium, can be reused as a slow release fertilizer. The objectives of this research were to evaluate the impact of zeolite dosage on the nutrient removal efficiency for high strength wastewater and develop mathematical models to predict the performance of hybrid IX and algae growth systems with varying doses of zeolite.

Batch reactors with different dosages of zeolite combined with centrate from a pilot anaerobic digester treating waste activated sludge were set up in the 21±2°C constant temperature room in duplicate. Wild type algae *Chlorella* were added into each reactor after 24 hours. Reactors with only algal biomass were also set up as controls. A mathematical model accounts for IX kinetics between counter-ionic species NH_4^+ and Na^+ and algal growth under multiplicative limitation were developed. A multiplicative model is used to describe microbial kinetics when algae are exposed to inhibitory substrate and light intensity conditions. The multiplicative theory in this paper assumes the algal growth rate is a function of the electron donor and light intensity, given by the Andrew's equation combined with the Chalker model.

Results indicated that over 95% of IX activity between NH_4^+ and Na^+ occurred within 24 hours after the addition of zeolite. The decrease in NH_4^+ concentrations eliminated the ammonia toxicity to algae at both dosages (60 g/L ad 150 g/L). The combined IX and algae growth in IA-60 and IA-150 reduced the NH_4^+-N concentrations from 1180 mg/L to 37.6 mg/L and 10.5 mg/L, respectively. The NH_4^+-N adsorbed by zeolite released to the liquid phase when aqueous NH_4^+-N was taken up by algae. The saturated zeolite can be regenerated along with algae growth. As the zeolite dose increases from 60 g to 150 g, the rate at which the concentration changes is faster since there are more IX sites for uptake (Figure1).

Algae biomass increased from 700 mg/L to > 2000 mg/L after 8 days. However, the control reactor without the addition of zeolite showed an inhibition of algae growth. The hybrid IX and algae process was feasible for the treatment of high strength wastewater. The harvested algae could be used for the production of protein, polymers or biofuels.

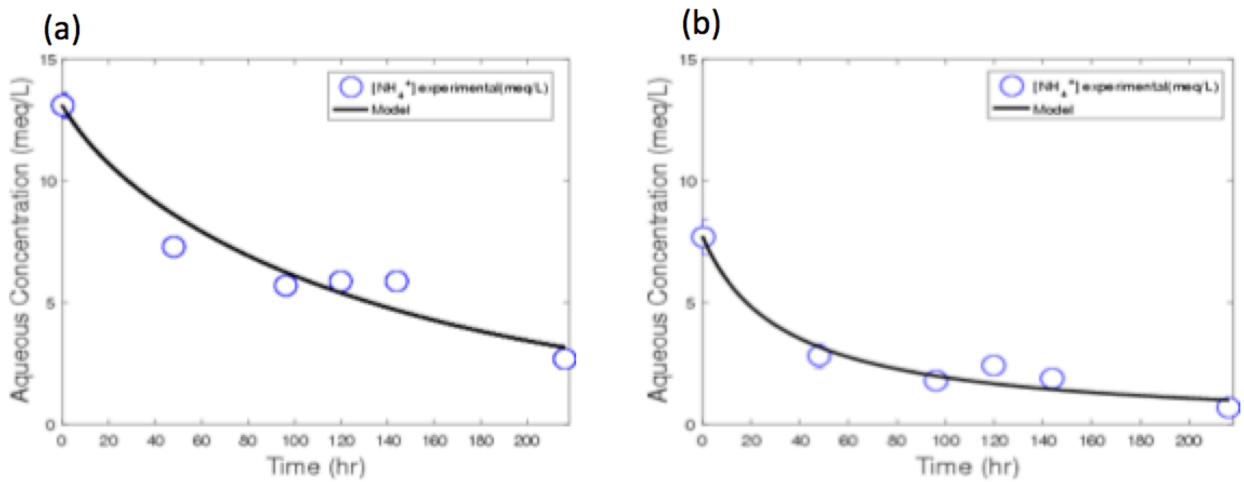

Figure 1: Aqueous NH_4^+-N versus time for zeolite dosages of (a) 60 g/L and (b) 150 g/L, respectively.