Inhibition of Anaerobic Biodegradation of Vegetable Oil in Freshwater Sediments by Fatty Acids: Relief of Inhibition by Ferric Hydroxide

Zhengkai Li and Brian A. Wrenn
Environmental Engineering Science Program
Washington University in St. Louis

The anaerobic biodegradation of vegetable oil in freshwater sediments is an important component of a proposed response alternative for vegetable oil spills that involves sedimentation of the floating oil by dense minerals. Previous research has shown that anaerobic vegetable oil biodegradation can be self inhibitory at high concentrations, and free fatty acids have been implicated as the toxic intermediates. Ferric hydroxide was shown to relieve the inhibition, but the effect does not appear to be due to physical or chemical effects, such as adsorption or complexation of the fatty acids. This research investigated potential biological effects of ferric hydroxide by measuring the kinetics of anaerobic biodegradation of canola oil, oleic acid, and acetate in oil-enriched river sediments. Oil-degrading microorganisms were enriched by incubation of sediments with canola oil (5.6 g oil/kg sediment) under methanogenic and iron-reducing conditions. The rate and extent of biodegradation was measured by monitoring the production of methane and carbon dioxide in the headspace of anaerobic microcosms and the accumulation of volatile fatty acids in the aqueous-phase of the sediment slurries. Sediments enriched under methanogenic conditions were sensitive to inhibition by free fatty acids, whereas sediments enriched under iron-reducing conditions were resistant to fatty acid inhibition, regardless of whether ferric hydroxide was present during incubations in which the effects of fatty acids were determined. These observations are consistent with modification of the structure of the microbial community to favor fatty-acid-resistant microorganisms during growth in the presence of ferric hydroxide.