Anaerobic degradation of phenol and bioregeneration of granular activated carbon

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Abstract

The objective of this research investigation is an evaluation of the effects of phenol concentration gradients on the concurrent anaerobic degradation of phenol and the anaerobic bioregeneration of granular activated carbon (GAC) using biomass acclimated to phenol. Previous research assessed the feasibility of the anaerobic degradation of phenol and the synergistic effects of granular activated carbon (GAC) on anaerobic microbial degradation of phenol. However, the results of this previous work indicated the need to further investigate the causes for variability of the bioregeneration rates. The hypothesis put forward was that bioregeneration is directly proportional to negative concentration gradients , i.e the equilibrium phenol concentration on the GAC is higher than the phenol concentration in the bulk liquid. The GAC, saturated with radiolabeled phenol, was transferred to three glass columns. A liquid stream containing non-radiolabeled phenol was recycled continuously through each of the columns. The concentrations of phenol in the recirculated stream varied from the equilibrium concentration of phenol of (125 mg/L) and concentrations of phenol below and above this equilibrium concentration. These columns were inoculated with a microbial consortium which was acclimated to anaerobically degrade phenol. Radiolabeled phenol was used to facilitate the development of a mass balance of the phenol and degradation products. Analytical techniques for this study included: specimen preparation for electron microscopy, protocols to detect and quantify radiolabeled gases produced in the laboratory-scale anaerobic fluidized bed reactors, liquid scintillation counting, gas chromatography, and high performance liquid chromatography.

The results of light and electron microscopic evaluations indicated that the microorganisms were growing both attached to the GAC surface and suspended within the GAC in the form of pellets. The bioregeneration of phenol was found dependent on the phenol concentration gradient. The observed bioregeneration was the highest for the column with the highest negative concentration gradient. The bioregeneration observed was the lowest for the column

in which the highest positive concentration gradient between the GAC and the bulk liquid occurred. Columns with intermediary concentration gradients behaved accordingly to expected. Therefore, the hypothesis that bioregeneration is directly proportional to negative concentration gradient was confirmed.

Application of centrifugal elutriation for aqueous suspensions

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Abstract

Centrifugal elutriation (counter-flow separation), a common technique in the medical field to fractionate cells, was tested for: (1) the feasibility of use in fractionating aqueous suspensions; and, (2) its application in dynamic sorption and desorption studies for hazardous organic compounds associated with aqueous suspensions. The suspensions were separated and could be held in the chamber due to the opposing forces of counter-flow fluid versus centrifugation in which particles reached a point of effective zero velocity in a specially designed chamber. When either the flow rate was increased or the centrifugal force-field was decreased, discrete fractions of particles were eluted from the chamber for collection.

For the feasibility studies, the test suspensions included: a mixture of three suspensions of uniform latex polymer microspheres (12–25 μm in diameter; density of 2.6 g/cm^3); a silty clay suspension, (0–40 μm in diameter; density of 2.6 g/cm^3); a biotic suspension of two algae species with similar densities but of different size; and, a suspension containing two ranges of particles of similar size but different densities. The latex microspheres were separated into three discrete fractions with an overall mass balance of 91%. *Chlorella pyrenoidosa* was separated from a mixed suspension with *Scenedesmus quadricauda* with recoveries from 92–98%. A suspension of biotic (*C. pyrenoidosa*) and abiotic (clay) particles was separated recovering 82% of the algae discretely. The technique of centrifugal elutriation proved to be a fast and efficient means of isolating discrete fractions of aquatic particles as a function of either size or density.

Studying the dynamic aspects of contaminant-particle interactions has been