OPINION

Using the biodegradation model BIOB, assess the biodegradation of oil from the Alaska North slope in microcosms

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Mann T. Using the biodegradation model BIOB, assess the biodegradation of oil from the Alaska North Slope in microcosms J. Environ. Microbiol. 2022; 4(2):1-2.

ABSTRACT

We describe the specifics of the BIOB numerical model, which can simulate the biodegradation of oil trapped in sand. The model simulates bacterial growth in the presence of nutrients and the subsequent consumption of hydrocarbons using Monod kinetics. The Exxon Valdez oil biodegradation in laboratory columns was simulated using the model. In order to explore oil bioremediation through natural attenuation and nutrient amendment, samples from Eleanor Island, Knight Island, and Smith Island were obtained and deposited in laboratory microcosms for a period of 168 days. Using a parameter estimation tool based on genetic algorithms, the kinetic parameters of the BIOB model were determined by fitting the experimental data (GA). While EL107 and KN114A's parameter values were comparable, SM006B's values were different from those of the other two sites. In particular, biomass growth on SM006B was four times slower than on the other two islands. The specific surface area per unit mass of sediment was much lower at SM006B, according to grain size analyses from each site, which suggests that the surface area of sediments is an important controlling factor for microbial development in sediments. Due to the lag period in microbial growth, BIOB was able to capture the early slow biodegradation in particular. According to sensitivity analysis, SM006B was sensitive to beginning biomass concentration because of its slow growth rate, whereas oil biodegradation at all three locations was sensitive to nutrient content. Additionally, analyses were done to compare the half-lives of various chemicals to the total number of Polycyclic Aromatic Hydrocarbons (PAHs).

Key Words: *Kinetic Parameters; Hydrocarbons; Monod kinetics; Nutrient Amendment Biodegradation; Polycyclic Aromatic*

INTRODUCTION

The Prince William Sound Exxon Valdez oil disaster in 1989 contaminated about 2000 km of the Gulf of Alaska's coastline. Over 1600 kilometres of the Gulf of Mexico's coastline were harmed by the more recent Deepwater Horizon oil disaster. One technique for removing oil from the environment that is both efficient and environmentally acceptable is bioremediation, which depends on speeding up the oil's normal rate of biodegradation.

It is possible to study bioremediation by carrying out laboratory- or field-scale studies that determined the minimum nitrate concentration necessary for the maximum biodegradation of n-heptad cane in sand columns while monitoring oxygen consumption and carbon dioxide production.

They claimed that a concentration of 2.5 mg Nitrate-N/L results in the greatest amount of biodegradation. When the influent nitrate con-tent was zero, they also theorised that biomass would recycle nitrogen. Cells were lysed (broken apart) to release nutrients for use by other cells in growth and biodegradation. investigated how the supply and source of nutrients affected the biodegradation of crude oil. They discovered that whether the nutrient supply was intermittent or constant, the extent and pace of oil biodegradation remained unaffected. Researchers looked into the biodegradation kinetics of individual parts and PAHs. Their research showed that the prediction of natural or enhanced biodegradation of PAHs cannot be based on single compound kinetics, as this assumption would overestimate the rate of disappearance and does not account for the inhibition due to competitive interactions between the compounds.
The biodegradation of 19-year-old, weathered oil in PWS caused by EVOS at three separate islands was investigated in laboratory tests by Venosa They found that the oil that had aged the most was also the most biodegradable. Numerical models could be developed using the

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Received:- 06-April-2022, Manuscript No. puljem-23-5998; Editor assigned:- 08-April-2022, Pre-QC No. puljem-23-5998 (PQ); Reviewed:- 12-April-2022, QC No. puljem-23-5998 (Q); Revised:- 15-April-2022; Manuscript No. puljem-23-5998 (R); Published:- 20-April-2022, DOI: 10.37532/puljem.22.4 (2).1-2

experimental data from laboratory-scale trials to develop a better understanding of the kinetic processes involved in biodegradation.

Researchers have frequently predicted the outcomes using numerical models. employed the USGS solute transport and biodegradation code BIOMOC along with the USGS universal inverse modelling code UCODE to calculate the amount of BTEX dissolution and biodegradation at a site near Bemidji, Minnesota.

The time scale of biodegradation of the Deepwater Horizon oil spill in the Gulf of Mexico was estimated using a computational model that was built for the biodegradation of oil droplets as opposed to dissolved oil. The increased bioremediation of groundwater contaminated by acenaphthene, methylbenzofurans, and dimethylbenzofurans was modelled using the model, which showed that small oil droplets biodegraded faster because of their larger surface area per unit mass. The viability and effectiveness of several remediation scenarios were investigated using the calibrated model. They developed a mathematical model to simulate the biodegradation of residual hydrocarbon in their simulations, which showed that even with several conceptualizational simplifications, they were still able to demonstrate the ability of their model to detect key processes required for an effective remediation scheme. By fitting the model to experimental data of oxygen, CO2, and residual mass of heptadecane acquired from two columns, they were able to determine the biodegradation kinetic parameters. Using the same characteristics, they were able to correctly forecast the biodegradation for three additional columns. This study's objective is to provide the BIOB numerical model, which simulates the biodegradation of oil trapped in sediments, and to estimate its parameters using the findings of experimental studies. Under various environmental circumstances, biodegradation will be predicted using the estimated parameters. Automatic fitting is done using a parameter estimate method based on genetic algorithms. Finally, it is determined how sensitive the model prediction is to the kinetic parameters of the BIOB model.