Int. J.MAr.Sci.Eng., 3(2), 99-104, Spring 2013
ISSN 2251-6743

Effect of remediation strategy on crude oil biodegradation kinetics and half life times in shoreline sediment samples

[1]L. Mohajeri; [1]H. A. Aziz; [2]M. H. Isa; [3]M. A. Zahed; [4]S. Mohajeri*

[1] School of Civil Engineering, Universiti Sains Malaysia, 14300 Nibong Tebal, Penang, Malaysia
[2] Civil Engineering Department, Universiti Teknologi PETRONAS, 31750 Tronoh, Perak, Malaysia
[3] Department of Civil Engineering, Auburn University, Auburn, AL 36849, United States
[4] School of forestry and wildlife sciences, Auburn University, Auburn, AL 36849, United States

Received 2 February 2013; revised 10 March 2013; accepted 19 March 2013

ABSTRACT: Bioremediation, the process by which microorganisms degrade organic compounds to non-toxic or less toxic substances, has been widely used for cleanup of coastal ecosystems after oil spills. In this study, the hydrocarbon degradation rate and half lives in three bioremediation strategies (natural attenuation, biostimulation, and bioaugmentation) were compared in weathered crude oil (WCO) contaminated sediment samples. Three initial WCO concentrations of 3, 30 and 60 g WCO per kg sediment were investigated. Kinetic evaluations were carried out in a 90-day laboratory scale experiment. All oiled sediments showed decreasing WCO concentrations over time. After two weeks, the rate of degradation in the natural attenuation experiments stayed approximately constant. Bioaugmentation demonstrated higher oil removal than biostimulation or natural attenuation. The results indicated that first order kinetics can describe bioremediation of crude oil in sediments. The values of R^2 (coefficient of determination) varied from 0.9552 to 0.9965. The first order kinetic constant for the reactors at different WCO concentrations was between 0.0014 and 0.0159/day. The half life of WCO in sediment reactors was different for each applied method. The minimum WCO half life for natural attenuation, biostimulation and bioaugmentation was 408, 69 and 44 days respectively.

Keywords: *Biodegradation; Petroleum; Nutrients; Kinetic; Half-life*

INTRODUCTION

When an ecosystem is contaminated by petroleum and/or oil products, a catastrophic change occur in the physical and biogeochemical characteristics of the environment. Both physical and chemical treatments can be applied for soil cleanup, but they are often extremely expensive. Moreover, they are harmful to the environment, as they may damage the structure of the soil (Aghamiri *et al.,* 2011; Wang *et al.,* 2011; Couto *et al.,* 2010).

Biodegradation occurs at slow rate, but it can be enhanced by introducing nutrients and inoculating bacterial consortium that can degrade hydrocarbons in the contaminated environment. Bioremediation technologies have been successfully used to remove crude oil from contaminated sediments (Mohajeri *et al.,* 2011; Kumar *et al.,* 2011, Prince, 2010; Yousefi Kebria *et al.,* 2009). Through the bioremediation process, under appropriate conditions, contaminants are converted to harmless products such as water and carbon dioxide by using the different metabolic abilities of microorganisms. The rate and extent of bioremediation are affected by the nature of the contaminated environment and the interactions between microorganisms (Di Toro *et al.,* 2006; Margesin and Schinner, 2001).

Since studies on biodegradation kinetics are critical for understanding the bioremediation process, a number of studies have been published regarding the effects of environmental factors on the bioremediation kinetics of crude oil. The factors influencing bioremediation are described by the amount of substrate removed with time and the yield curve representing the transformation of the compounds by the microbial culture in the laboratory and sometimes in the field (Roncević *et al.,* 2005). Chen *et al.,* (2008) investigated the effects of several factors on the biodegradation kinetics of polycyclic aromatic hydrocarbons (PAH). The results showed that salinity and inoculum size were significant factors while PAH concentration, nutrient addition, and temperature were insignificant. Another study showed that pH, soil nitrogen content, and airflow greatly influenced the biodegradation of oil in soil (Pala *et al.,* 2006). The kinetics of oil biodegradation in soil was studied by Abioye *et al.,* (2010). The rate of oil degradation enhanced with bioavailability of

*Corresponding Author: *mohajerileila@yahoo.com*