Sustainable Management of Tank Bottom Sludge from Refineries: Role of Bioaugmentation with n-Alkane and Naphthalene-Degrading *Burkholderia* Cultures

Jublee Jasmine and Suparna Mukherji

Centre for Environmental Science and Engineering, IIT Bombay, Powai, Mumbai-400076

Abstract

Massive amount of tank bottom sludge is generated in refineries during regular cleaning of oil storage tanks. Along with water and solids, a significant amount of oil/total petroleum hydrocarbons (TPH), tar and heavy metals remains associated with the sludge. Proper handling and disposal of this sludge is required to prevent soil and ground water pollution. Land farming and slurry phase treatment in bioreactors represent environment friendly and sustainable approaches for management of this sludge. This work was designed to explore the feasibility of facilitating such biological treatment processes through bioaugmentation with n-alkane and naphthalene degrading *Burkholderia* cultures enriched and isolated from oil contaminated sites. *Burkholderia cepacia* ES1 and *Burkholderia multivorans* (strains HN1 and NG1) were isolated using diesel and naphthalene as sole substrate, respectively. Earlier studies revealed that *B. cepacia* primarily utilized diesel range n-alkanes (C9-C26) as sole substrate by inducing high cell surface hydrophobicity. Both the *B. multivorans* strains utilized naphthalene as sole substrate and could not utilize n-alkanes in the absence of surfactants. Soxhlet extraction followed by gravimetry revealed that the sludge contained 9-10.5% TPH. The degradation of TPH in oily sludge in the bioaugmented slurries over 30 days was found to be in the range of 35-51%. Highest degradation was observed with the n-alkane degrader, *Burkholderia cepacia*. Degradation of TPH in the un-inoculated controls was 44±10%. Due to the large variability in the un-inoculated controls, TPH degradation in the un-inoculated controls and bioaugmented flasks were found comparable, irrespective of the culture used for bioaugmentation. In contrast, TPH loss in the controls where all microorganisms were killed with sodium azide was consistently low. The results indicate the presence and activity of indigenous microorganisms in the sludge that are possibly as effective as the aliphatic and aromatic hydrocarbon-degrading *Burkholderia* cultures.

Keywords: *Tank Bottom Sludge, Bioaugmentation, TPH, Microorganisms*

Introduction

A huge amount of oily sludge is generated every year in oil refineries during oil production, processing and storage. The amount is estimated as 20000-30000 tonnes per annum (Bhattacharya and Shekdar, 2003). Oil storage tanks are the largest source of oily sludge in oil refineries. As more sludge keeps accumulating over time, tank cleaning needs to be performed for recovering the useful storage capacity. Typically, oily sludge consists of 20-60% crude oil/TPH, 30-65% water and 5-40% solids, where the oil exists in either, dissolved, emulsified or sorbed state (Lazer et al., 1999). Physicochemical characteristics of the sludge vary according to the source and variation is also observed depending on further treatment and storage conditions. Typically oily sludge is contaminated with oil, grease, other organic materials and inorganics including heavy metals, such as, Ni, Cr, Zn, Pb, Mn, Cd, Cu (Al-Futaisi et al., 2007; Asia et al., 2006; Guolin et al., 2010; Mishra et al., 2001; Bhattacharya and Shekdar, 2003). The petroleum hydrocarbons include hydrocarbons and heterocyclics across various group types, aliphatics, alicyclics, aromatics, asphaltenes and resins (Biswal et al., 2009; Castaldi, 2003).

Handling and disposal of this massive amount of tank bottom sludge is a challenge for oil companies and refineries since improper practices may lead to soil and ground water contamination with the hazardous constituents present in this sludge (Wang et al., 2010). Release of volatile organic compounds (VOCs) from the sludge may also lead to air pollution. Biological treatment/bioremediation of oily sludge is the most economical and environment friendly treatment option (Vasudevan and Rajaram, 2001; Mrayyan and Battikhi, 2005; Verma et al., 2006; Das et al., 2011). Microbial activity can potentially lead to complete mineralization of organic contaminants