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EFFECT OF PETROLEUM POLLUTION AMOUNT ON BIOLOGICAL TREATMENT OF HYDROCARBON COMPOUNDS IN SANDY-LOAM SOIL

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Abstract

Biological treatment of sandy-loam soil polluted with different levels (19, 28 or 37 g/kg) of petroleum has been investigated. The soil were supplemented with a mineral sol and a mixed culture of petroleum degraders in association with the native microorganisms. The soil was periodically moistened and tilled. The petroleum degraders and residues were then monitored and estimated over time periods. Significant bacterial and fungal growth was observed from 10^5 and 10^4 CFU/g on the 1st week to 10^{10} and 10^6 CFU/g on the 4th week, respectively. On 4th week, the biodegradation in the soil contaminated with a primary petroleum concentrations of 15, 22 and 29 g/kg achieved the following levels: 27.3 %, 22.8 % and 17.8 % (total petroleum); 96.3 %, 65.2 % and 54.2 % (n-alkanes-(NA)); 98.0 %, 59.0 % and 57.0 % (pristane-(PR)); 35.0 %, 20.0 % and 16.0 % (phytane-(PH)); and 29.3 %, 18.5 % and 11.4 % (polycyclic aromatic compounds (PAC)), respectively. The biological degradation was inversely proportionate to the increase in the petroleum pollution level and vice versa. Low molecular weight compounds were more biodegradable than high molecular weight. The biodegradability of hydrocarbons was as follows: NA> PR> PH> PAC.

Keyword **:** Biological treatment, Sandy-loam soil, Petroleum pollution, Hydrocarbon

Introduction

Petroleum on our planet is widely used in chemical industries and energy production. Uncontrolled disposal of petroleum products has a negative impact on land and water. Petroleum pollution may occur as a result of oil spills from oil storage tanks, cracked oil pipelines, oil refineries and petrochemical plants, oil transportation accidents and the explosion of oil structures, etc. (Zhang *et al*., 2012; Ahmed & Fakhruddin, 2018).

Soil contamination with petroleum is an important issue that has received international attention nowadays because it causes serious impacts on humans and the environment (Laffon *et al*., 2016). With an growing interest in conserving ecosystems, many chemical and physical processes have been used to remove petroleum pollution from soil. Nevertheless, these methods are costly and only transfer pollution from one location to another (Gargouri *et al*., 2015).

Biological treatment of oiled soil was established as an effective, economical, diversified and environmentally friendly process (Guerra *et al*., 2018). This process takes advantage of the ability of microorganisms to degrade and remove organic chemicals, and endeavor to enhance rates of natural biological degradation. The method is based on improving the bioprocesses of treating or reducing levels of hazardous substances in the polluted places. The basis of biological treatment of organic chemicals is the mineralization of pollutants into final innocuous compounds of carbon dioxide and water (Xu *et al*., 2018). Consequently, bioremediation is a good, effective, environmentally harmless and inexpensive alternative compared to physical and chemical treatment processes that mainly depend on burning, evaporation and stabilization of pollutants. Bio-treatment of oiled soil usually includes two strategies: biological augmentation (adding petroleum degraders to the soil) and biological stimulation (adding nutrients and other microbial growth limiting substances) that can be achieved separately or together (Ali, 2019).

Studies have shown that the effectiveness of biodegradation of petroleum hydrocarbons in the soil system depends on several factors like the history of oil pollution, type of soil, oil composition and level, and environmental parameters that include temperature, salinity, pH, nutrient, oxygen, moisture content, etc. (Varjani & Upasani, 2017).

The concentration of oil is the important factor that determines the rate and potential for biodegradation of hydrocarbons. Salleh *et al*. (2003) showed that the efficiency of the microbial degradation of petroleum sludge appeared in the petroleum concentration from 1.25 % to 5 % and was better at the concentration of 5 %. Concentrations of petroleum above 5 % reduce the number of microorganisms due to toxic effect. Tarabily & Khalid (2002) explained that the efficacy of oil degraders is completely stopped by increasing the petroleum level from 50 %. As well as oil toxicity, high levels of oil may prevent the growth of microorganisms by disturbing the ratio of carbon-(C): nitrogen-(N): phosphorous-(P) and prohibiting the exchange of oxygen. High concentrations of volatile hydrocarbons are harmful to petroleum degraders as a result of their high toxicity (Xu *et al*., 2018). Salleh *et al*. (2003) reported that the rate of microbial degradation of hydrocarbons depends on the composition and concentration of the petroleum. In biological treatment, the petroleum concentration impacts biodegradation, and a very high or very low concentration reduces the biodegradation performance. Chen *et al*. (2017) has shown that the increase in petroleum concentration leads to a decrease in the biodegradation of the bacterial consortium as free or immobilized.

Although many studies and reviews have addressed the effects of environmental factors on the biological treatment