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Removal of Lead and Oil Hydrocarbon from Oil Refining-Contaminated Wastewater Using *Pseudomonas* spp

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Abstract

The main objective of this study is to investigate the potentiality of using three bacterial species (*Pseudomonas fluorescens* (PF), *Pseudomonas penicillimobilis* (PP) and *Pseudomonas* sp. (PQ)) for the removal of lead and crude oil from oil-contaminated wastewater of an oil refining company, Alexandria, Egypt before discharging into open environments. Bacterial candidates were employed in a batch mode as free-living individuals or mixture. Bioremediation assays were run with three different oily wastewater/bacteria ratios (1:1, 1:2 and 2:1). At each batch, residual concentration (RC) of the selected parameters (Pb²⁺, oil content, BOD and COD) were determined and their removal efficiencies (RE %) were calculated. Results revealed high removal efficiency for Pb (90.97% from initial concentrations 307.9 mg/l) and oil (56.8 and 68.8% from initial oil concentrations 25 and 500 mg/l respectively) from physically treated oil refinery wastewater. In addition, partial removal of COD (30.98% from 720 mg/l) and BOD (18.98% from 590 mg/l) was achieved. *Pseudomonas fluorescens* (PF) was the most active reaching the highest removal of most of the tested parameters and wastewater/bacteria ratio of 1:2 was the most convenient while the ratio 2:1 was the least suitable and was inhibitory in most cases for the contaminants removal. Results highly recommend using *Pseudomonas* spp especially *Pseudomonas fluorescens* (PF) as efficient, low cost remediation method in oil refineries and similar industries where metallic and organic contaminants are included. It is also suggested treating wastewater using fixed *Pseudomonas fluorescens* in a continuous system, which can greatly enhance bacterial performance for biodegradation of organic and accumulation of inorganic contaminants.

Key Words: Accumulation, Biodegradation, Industrial Wastewater, Lead, Organic Matter, Petroleum Oil, *Pseudomonas* spp

1. Introduction

Because of the severity of heavy metal contamination and potential adverse health impact on the public, tremendous efforts have been made to purify waters containing toxic metal ions. Many industries such as coating, automotive, aeronautical, oil refining and steel generate large quantities of wastewater containing various concentrations of lead and other heavy metals (Stelman *et al.* 2008). Lead (Pb²⁺) is widely used in applications such as storage battery manufacturing, printing, pigments, fuels, photographic materials and explosive manufacturing. Permissible limits for lead in drinking water given by the U.S. Environmental Protection Agency (USEPA) is 0.015 mg/l and for wastewaters is 0.1 mg/l given by both USEPA and Bureau of Indian Standards (BIS). According to the World Health Organization (WHO), the accepted range of Pb²⁺ in water is 0.01 ppm (Shamma 2009).

Lead is present in natural deposits and may enter soil through (leaded) gasoline leaks from underground storage tanks or through a waste stream of lead paint or lead grindings from certain industrial operations. Emitted lead into the atmosphere can be inhaled, or ingested after it settles out of the air. It is rapidly absorbed into the bloodstream and is believed to have adverse effects on the central nervous system, the cardiovascular system, kidneys, and the immune system (Lane *et al.* 2005). Petroleum refineries discharge large volumes of water including cooling, surface water runoff and sanitary wastewaters. The quantity of wastewaters generated and their characteristics depend on the process configuration, which is approximately 3.5–5.0 m³ of wastewater per ton of crude generated when cooling water is recycled. Polluted wastewaters generated from oil refineries containing approximately 150–250 biochemical oxygen demand (BOD), 300–600 mg/l chemical oxygen demand (COD), phenol (20–200 mg/l), oil (100–300 mg/l) in desalted water and up to 5000 mg/l in tank bottoms, benzene (1–100 mg/l), benzo(a)pyrene (less than 1 to 100 mg/l), heavy metal (0.1–100 mg/l for chrome and 0.2–10 mg/l for lead) and other pollutants. Refineries also generate solid wastes and sludges ranging from 3 to 5 kg per ton of crude processed, 80% of which may be considered hazardous because of the presence of toxic organics and heavy metals. Accidental discharges of large quantities of pollutants can occur because of abnormal operations in a refinery and potentially pose a major local environmental hazard (Shamma 2009).

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