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Microbial Remediation of Spilled Petroleum

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***Abstract*: Microbial biodegradation is a bio treatment method for attenuating crude oil contaminated environment. Petroleum contaminating of both terrestrial and marine environments have persisted as a result of the increasing demand on liquid petroleum globally which has led to the need to clean up spilled petroleum using eco-friendly method. Current challenges associated with bioremediation of spilled petroleum include resistance of asphalthenes to biodegradation. The microbial remediation of spilled petroleum has been proved to be cost effective, eco-friendly and sustainable. However, these microbes have been found to thrive under certain environmental/nutritional conditions which influence their behavior towards spilled petroleum. Bioremediation by oil eating microbes are acknowledged to be the most co-friendly and sustainable technology in the present world, thus this paper briefly reviews of the various oil eating microbes existing today to remediated the remains of crude oil contaminants in the environment.**

***Keywords*: Microbial biodegradation, Crude oil, Oil eating microbes, Spilled petroleum.**

1. Introduction

Crude oil contamination of soil and water from industrial emission and human as health, soil and ground water are often contaminated due to inevitable spillage during oil exploration, transportation, extraction, refining and also from leaking underground stages tanks and pipelines [1]. Every year, an average of about 35 million barrels of petroleum is transported across the seas around the world and this renders the marine ecosystem vulnerable to pollution [2]. Bioremediation is a biotechnological approach which uses biological agents, i.e., microorganisms [bacteria, fungi, yeast] to decontaminate the environment. In this process, microorganisms are stimulated by addition of growth substances, nutrients, terminal electron acceptor/donor or donor or both to degrade the hazardous pollutants to substances that are safe to the environment [3], [4].

2. Composition of crude oil

Petroleum hydrocarbon molecules can be grouped into four broad categories:

a) Saturated (branched, unbranched and cyclic alkanes).
b) Aromatic-ringed hydrocarbon molecules such as monocyclic aromatic hydrocarbons (MAHS) and polycyctic aromatic hydrocarbons (PAHS).
c) Rasins (polar oil surface structures dissolved in saturated and aromatic [5].
d) Asphalthenes dark brown amorphous solids colloidally dispersed in saturated and aromatics [6].

Light petroleum hydrocarbons such as gasoline, kerosine and diesel fuel are volatile and easily biodegradable. So that they rarely persist in marine environments, although they may remain longer in terrestrial environments if buried in sediments, soils, ground water or marshes where oxygen levels are very low [7]. However, heavy petroleum hydrocarbons are biodegraded slowly. In general, lighter fractions of petroleum are more soluble in water than heavier ones [8].

3. Various microbes eating crude oil

The number of microbes present in the soil and their catabolic activity plays a vital role in degrading microorganisms present in the soil such as bacteria, fungi, protozoa, algae, actinomycetes here varying capacity to degrade the hydrocarbon [9], [10]. Bacteria are the most predominant among them.

Table 1
Bacteria [11]-[15]

Bacteria	Act on
Pseudomonas sp.	Hydrocarbons, kerosene, diesel
Cycloclasticus sp.	Polycyclic aromatic hydrocarbons
Alcanivorax sp.	Alkanes
Mycobacterium sp.	Pyrene
Proteus sp.	Diesel
Bacillus sp.	Diesel
Ralstonia	Benzene, toulene
Haemophilus sp.	Pyrene

4. Process of oil degradation by microbes

Many environmental factors influence the breakdown of carbohydrate by microorganisms. Especially in marine environment, low phosphorous and nitrogen levels may limit growth of oil degrading microorganisms. Oil eating microbes feed on the hydrocarbons present in oil. The hydrocarbons composed of numerous amounts of hydrogen and carbons. The microbes break these hydrocarbons which ultimately combine oxygen in warm temperature to give up CO_2 and H_2O [16], [17]. The PAHs found in oil are particularly resistant to microbial biodegradation, by the intrinsic stability of the aromatic ring. Polycystic aromatic hydrocarbons form a great hazard as many are toxic or carcinogenic and persist in the oil polluted environments.

Effective PAH breakdown involves whole communities of both bacteria and eukaryotes [25]. Some of the species of marine bacteria consuming oil are Marinobacter, Oceanospiralle, pseudomonas, and Alkanivorax. These are the bacterial species that depend solely on oil. Microbial remediation of heavy metals takes place in three different ways. Firstly, by the biosoption or bioaccumulation process in which microbes integrate the metal contaminants into its cellular structure. Secondly by the process of extracellular precipitation or uptake by purified biopolymer and thirdly by other specific molecules [18], [19].

5. Biosorption

Extracellular material containing cationic metals such as Fe, Zn, Cd can immobilise metal through binding to anionic functional groups present in all cell surface. Slime layers composed of carbohydrate, polysaccharide which helps in the extracellular binding. Several binding mechanism such as van der Waals forces, covalent bonding, redox interactions, electrostatic interactions help bind metal ions to the cell surface. Bacteria act as good biosorbents due to active chemosorption sites and high surface to volume ratio [20], [21].

6. Oilzapper technology in India

Oilzapper is a cost effective technology developed by Tata Energy Research Institute (TERI), New Delhi. It is an indigenous drill cutting/oil sludge degrading bacteria which could degrade different fractions of total petroleum hydrocarbons present in crude oil spills to CO_2, water and exo friendly dead biomass [22], [23].

7. Biosurfactant molecules

Biosrfactant molecules production by microbial cells help in bioremediation by heavy metals and complex metals such as Pb, Zn, Cd through electrostatic interactions and increase metal solubility resulting in the formation of metal salts which are less soluble such as phosphate precipitation and sulphide [22]-[24].

8. Conclusion

Oil degrading microbes modify their cell membrane, produce biosurfactants and eject toxic pollutants from their protoplasm in order to survive petroleum contaminated areas. There are more oil degrading aerobes than anaerobes and most of these are terrestrial in habit. These microorganisms make crude oils completely degrade or inaccessible as like all other natural hydrocarbons. Hence it plays a vital role in making our environment cleaner and greener in a very safe way.

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