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Research Article

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The role of algae in degradation of petroleum wastes-A study

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ABSTRACT

Different algal species were screened and petroleum degrading algae was isolated for degradation of oil in oily water sewer, contaminated rain water sewer, sanitary waste pipes and blow down streams. TOC, TSS, BOD, COD etc. have been studied to quantify the total oil degradation. Algae has many advantages because of its cost effectiveness and heat generation is minimal is case of algal cultures. So, we need to shift our focus on algal degradation of petroleum wastes.

Keywords: Algae, degradation, petrochemical waste, oil spill

INTRODUCTION

Petroleum industry not only caters to the daily energy requirements but also supports nation's economy. Around 600,000±200,000 metric tons of natural crude seepage occurs either accidently or due to human activities [1]. The 2 million barrels crude oil spill from oil tanker in Exxon Valdez led to death of many marine animals. Synthetic methods have been found to be inefficient in petroleum degradation which led to the development of bioremediation. Pollutants from soil, waste water, oil spills, water etc. can be removed using bioremediation. Bioremediation was used initially for the removal of heavy metals like hexavalent form of chromium etc.

Bioremediation is the use of bacteria, plants, fungi, algae and other living organisms for removal of pollutants or conversion of pollutants into less harmful forms. It relies entirely on enzymatic activities of living organisms, usually microbes, by catalyzing the degradation process. This property of microbes is due to the presence of additional genes which provides them with extraordinary metabolic diversity. Either biostimulation or bioaugmentation can be one of the two approaches towards oil spill cleaning.

CURRENT TECHNOLOGIES

Around 200 bacteria, cyanobacteria, algae and fungi genera which represent more than 500 species and strains can degrade petroleum wastes [2]. Oil spilled in the oceans has been cleaned by the use of the bacterial strains of *Pseudomonas spp*. Sulfur reducing bacteria degrades alkylbenzenes C1-C5.Petrochemical hydrocarbons from polluted marine water has been found to be degraded by (OHCB) obligate hydrocarbonoclastic bacteria[3]. *Alcanivorax* also degrades hydrocarbons to a great extent. *Marinobacter* is capable of degradation of marine hydrocarbons with high efficiency due to its metabolic diversity imparted by the extra 1500 genes as compared to *Alcanivorax. Cladosporium resinae*, a fungus, can degrade 20 to 40% of the petroleum wastes when added to a mixture of hydrocarbons. Yeasts have also been used for the petroleum waste degradation. Protozoans however can't degrade petroleum wastes.

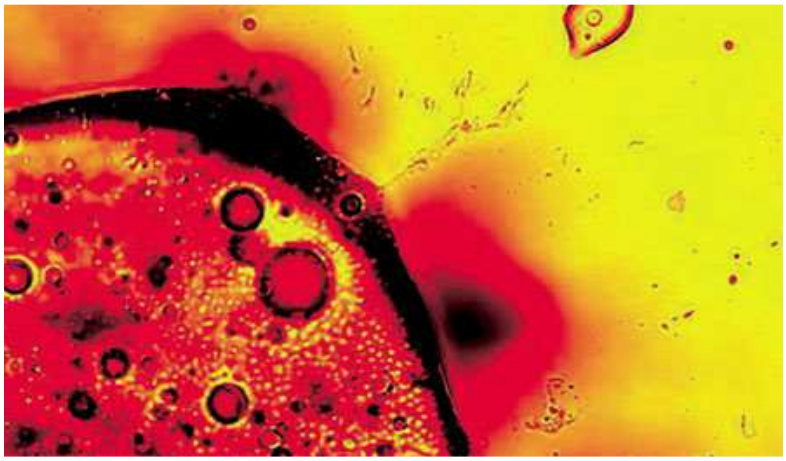

Figure 1: Bacteria cleaning oil spills

Figure 2: Shows oil spill in sea

ALGAL DEGRADATION OF PETROLEUM WASTES

The use of algae for petrochemical degradation started with the isolation of *Prototheca zopfi* by which is capable of degrading crude oil and a mixture of hydrocarbons [4]. It can degrade about 10 and 40% of motor oil and crude oil respectively. Relatively harmless products like resins and asphaltenes are produced at the end of the degradation process. This was followed by the discovery of, one red alga, one brown alga, five green algae, two diatoms andnine cyanobacteria for their ability to oxidize naphthalene [5]. They also found that *Dunaliella sp.*, *Oscillatoria spp.*,

Amphora sp., Porphyridium sp., Microcoleus sp., Agmenellum sp., Anabaena sp., Coccochloris sp., Nostoc sp., Cylindretheca sp., Aphanocapsa sp., Chlorella spp., Chlamydomonas sp., Ulva sp., and *Petalonia* all were capable of oxidizing naphthalene. A number of microscopic algae species that occur in river nile can grow on crude oil [6] and degrade the oil to release carbon dioxide and water. n-alkanes and polycyclic aromatic hydrocarbons are retained. *Fucus vesiculosus* is another alga which is equally capable of degrading petroleum wastes.

Figure 3: *Fucus vesiculosus,* a brown algae which degrades petroleum wastes

TYPES OF WASTES

A number of wastes with their given properties have been listed in the following tables:

Table 1: The different parameters of oily water sewer

Parameter	Concentration (mg/l)
Total oil	1400
TSS	200
BOD5 at 20°C	600
COD	1200
Total sulfides	2
Phenols	6
pH	6.5-8.5
TDS	5000

Table 2: Different parameters of CWRS

Parameter	Concentration (mg/l)
Total oil	180
TSS	7
BOD5 at 20°C	6
COD	18
TDS	161
pH	7-8

Table 3: Different parameters of sanitary waste pipes

Parameter	Concentration (mg/l)
Total oil	5
TSS	200
BOD5 at 20°C	400
COD	300
pH	7-8

Table 4: Different parameters of Blow down streams from cooling towers

Parameter	Concentration (mg/l)
Total oil	10
TSS	10
TDS	780
pH	7.0-8.5

Table 5: Different parameters of Blow down streams from neutralized regeneration effluent

Parameter	Concentration (mg/l)
Total oil	10
TSS	10
TDS	780
pH	7.0-8.5

EXPERIMENTAL SECTION

1. Collection of samples: Soil samples should be collected aseptically and the collected sample should be stored in a sterile container.
2. Preparation of a standard Knops solution (which contains 1g of Calcium nitrate, 0.25g of monophosphate potassium, 0.125g of potassium chloride, 0.25g of magnesium sulfate and traces of ferric chloride) and EPA media for fresh water algae. ASP-2 media can be used for marine algae.
3. Screening and isolation of petroleum degrading algae by adding the petroleum wastes and performing assays to check for the relative amounts of wastes.
4. Enrichment with nitrogen, phosphates, different vitamin B types etc. and check for enhancement in degradation.
5. GC to detect the concentration of oil and BOD, COD, TSS and TOC studies were conducted.
6. Optimization of media by performing ANOVA test, regression analysis and chi square tests using statistical software like SPSS, SAS etc. It can also be done using response surface method.
7. After optimization has been accomplished, scale-up can be done from lab scale to photo bioreactors.

CONCLUSION

For the degradation of petrochemical wastes, use of bacterial species like *Pesudomonas spp.,* sulfur reducing bacteria etc. has been practiced so far. Focus needs to be shifted on use of algae because it is economically viable. Moreover, the scale can be done easily from lab scale to photobioreactors as compared to bacteria.

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