DEVELOPMENT OF BIOSURFACTANT-ENHANCED TECHNOLOGIES FOR REMEDIATION OF PETROLEUM-CONTAMINATED SITES IN WESTERN CANADA

(PTRC Project No. 01-10-040)

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Prepared for

Petroleum Technology
Research Center

2003

ABSTRACT

Subsurface contamination, as a negative effect of petroleum exploration, production and/or storage processes, can lead to various impacts and risks to the communities and to the industries themselves. To remove the contaminants and restore the subsurface, a great deal of remediation techniques have been developed and widely employed. Among them, the cost-effective and environmentally sound *in-situ* bioremediation is regarded as a promising one and has been used for cleaning up petroleum-contaminated sites. However, the efficiency of bioremediation decreases significantly when applied to Western Canadian cases because of the special national conditions (e.g. cold weather and low-permeability soil conditions).

In this study, a set of innovative biosurfactant-enhanced *in-situ* bioremediation techniques were developed to improve both microbial activities and media (soil) conditions within a western Canadian context. Through bench/pilot-scale experiments, they were demonstrated to be viable for where cold climate and complicated subsurface conditions exist. Biosurfactant production technologies were developed, which started with the isolation of petroleum consumable microroganims, and followed by the bacterial screening to locate indigenous microbial strains that readily adapt to cold-climate conditions and efficiently degrade petroleum products. A strain-regeneration / re-enhancement technology was developed to enhance capability and stability of the strains. Four bacteria strains with the high capability of producing biosrufactants were isolated. Two specific biosurfactants were then generated by culturing the isolated pure strains. The operation conditions were optimized through experiments to regulate

biosurfactant production. The production and naturally degradation of biosurfactants during the bioremediation of petroleum- contaminated soil were disclosed. The experimental results indicated that obvious linkages existed among microbial activities, biosurfactant production and contaminant degradation. The results underscored a better understanding of the interior mechanisms of bioremediation and the microbial ecology of biosurfactants production.

Bench- and pilot- scale reactors were designed and custom-manufactured for facilitating experimental studies of bioremediation enhancement. Furthermore, the performance of the newly-developed biosurfactants and related technologies were examined under various conditions at the Cantuar site in Saskatchewan, western Canada. The results indicated that the significant enhancement effectiveness of the newly-developed biosurfactants to the remediation process, and also demonstrated that the developed technologies are capable to be applied to real-world petroleum contamination problems for industrial partners. The proposed media-enhancement technologies would be especially useful for aged or complicated sites where contaminants are hardly removed from the soil. In general, this study would (i) help the industries to obtain improved technologies for site remediation, and (ii) help to reduce costs at the consulting, planning, design and operation stages associated with the site remediation practices. With the growing concerns of environmental problems caused by petroleum industries and the increasing demand for more effective remediation techniques in Canada, the research outputs would be able to bring significant environmental, economic and social benefits to Canadian petroleum industries.

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