Microbial Fuel Cell (MFC) for Remediation of Oil Contaminated Soil

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Abstract: In this study, adopting microbial fuel cell (MFC) technology for remediation of oil contaminated soil was investigated. Engine oil and vegetable oil were used to represent organic pollutants. The result showed that 69.1% and 37.9% of the engine oil and vegetable oil contaminants were degraded in 10 days, and up to 0.6 V of open circuit voltage was generated during the MFC operation.

1. Introduction

Remediation of petroleum hydrocarbon contaminated soil near the surface and along the coasted region is a major challenge. Soil microbial fuel cell (MFC) is a new technology for organic contaminated soil remediation. By embedding an electrode in the anaerobic soil, where both of organic substrates and bacteria for the substrate degradation are present, and by connecting the electrode to the other electrode in the aerobic environment, the degradation of the organic substances was investigated. At the same time, energy can be generated in the form of electrical current. Similar approach has been used by Huang et al. (2011) for degrading phenol contaminated soil. Also, anaerobic remediation by the MFC technology was used for the degradation of organic matter in the sediments (Hong et al. 2009).

2.Objective

The objective was to investigate the feasibility of using the MFC technology to remediate oil contaminated soil.

3.Materials and Methods

Microbial fuel cell was built using the pervious method (Prashanth et al. 2009), the operation volume for each chamber was 700 mL (Fig.2). Saturated sand was packed into the anode chamber. 1% of engine oil and vegetable oil was injected into the anode chamber respectively to represent the organic pollutant in the soil. A mixture of bacteria and nutrients were also injected. The degradation of the engine oil was tested by gas chromatography, and the degradation of the vegetable oil was calculated by the amount of its product-biosurfactant produced. Both the amount in the liquid phase and the amount adsorbed in the soil phase were calculated. Amount of engine oil and biosurfactant adsorbed in the soil surface was calculated from their sand adsorption isotherm respectively (Harendra and Vipulanandan 2006; adsorption isotherm for engine oil not shown here). Air was injected into the cathode chamber to provide electron acceptor. Open circuit voltage (OCV) of the system was measured constantly.

4.Results and Discussion

The OCV reached about 0.6 V for both engine oil and vegetable oil contaminated sand during 10 days operation of the MFC. 1% vegetable oil contaminated sand had much slower raise in the OCV compared to engine oil contaminated sand. For engine oil contaminated soil, with 0.36 g/L and 1.44 g/Kg-soil of engine oil existed in the water phase and the soil phase of the anode chamber, a total of 69.1% of engine oil was reduced after 10 days. For vegetable oil contaminated soil, 0.07 g/L and 1.94 g/Kg-soil of biosurfactant existed in the water phase and the soil phase of the anode chamber respectively. By converting the weight of biosurfactant to the weight of vegetable oil, 37.9% of vegetable oil was reduced after 10 days.

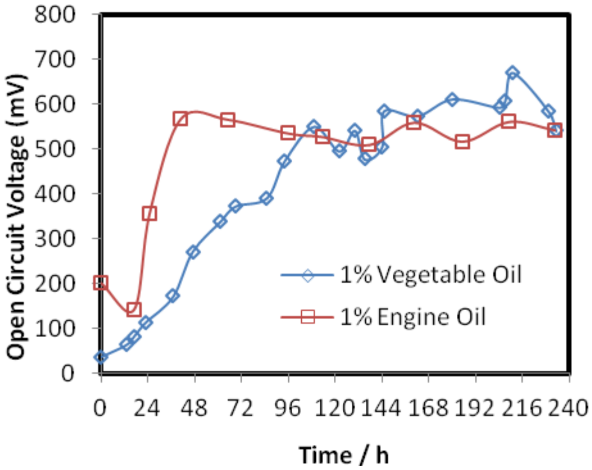

Fig.1 Open Circuit Voltage of Microbial Fuel Cell with Oil Contaminated Soil in the Anode Chamber

Fig.2 Microbial Fuel Cell with Oil Contaminated Soil in the Anode Chamber

Table 1 Reduction of Oil in the Anode Chamber of MFC Packed with Saturated Soil after 10 Days

	Initial Weight	**Water Phase**	**Soil Phase**	**Total Reduction**
Vegetable Oil	5.46 g-vegetable oil/kg-soil	0.07 g-biosurfactant/L	1.94 g-biosurfactant/kg-soil	37.9%
Engine Oil	5.23 g-engine oil/kg-soil	0.36 g-engine oil/L	1.44 g-engine oil/kg-soil	69.1%

5. Conclusions

Up to 0.6 V of OCV was generated in the soil MFC with both engine oil and vegetable oil contaminated sand. 69.1% and 37.9% of engine oil and vegetable oil were reduced after 10 days operation respectively. This indicated the possibility of applying soil MFC technology for hydrocarbon contaminant remediation, with energy generation.

6. Acknowledgements

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7. References

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