Treatment of Oil Contaminated Water Based Drilling Mud in a Microbial Fuel Cell

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Abstract: In this study, the potential of a using a two chamber microbial fuel cell to treat the oil contaminated drilling mud was investigated. Bentonite based drilling fluid contaminated with oil was used in the anode chamber to be treated by bacterial decomposition. The degradation of the oil was tested by monitoring the transmission of UV-VIS ray through the contaminated solution for 3 days of operation. The circuit voltage (CV) of the system was monitored to assess the feasibility of electricity production.

1. Introduction

Drilling fluid is extensively used in the drilling industry to cool and lubricate the drill bit and string and to transport cutting and gases from the well bore as they are produced. The drilling mud is said to be contaminated when a foreign material enters the system and causes undesirable changes in its properties. During the numerous cycle of circulation, the fluid is bound to be contaminated with cuttings, oil and gases from the reservoir. Hydrocarbon based contaminants in the drilling fluid not only make it lose its properties but also make it a health hazard for workers and an environmental hazard if disposed-off without treatment. According to API (2000), in 1995 nationwide, 68 percent of drilling wastes were disposed onsite through evaporation and burial and approximately 8 percent of drilling wastes were disposed on the land surface through land spreading and surface discharge. Less than 1 percent of the drilling wastes were treated before disposal. The treatment of petroleum hydrocarbon contaminated soils by microbial degradation has been rather successful with most researchers reporting about 70% to 90% of removal efficiency. C. Alisi et al. (2009) reported an overall reduction of about 75% of total diesel hydrocarbons in 42 days in a simple aerobic biodegradation. The natural biodegradation can be enhanced by almost 120% with the microbial fuel cell technology, which supplies the microorganisms with an unlimited source of electron acceptor (J. M. Morris, S. Jin, 20012).

2. Objectives

Treatment of oil contaminated drilling fluid using the microbial fuel cell is an environment friendly method of waste treatment with the benefit of electricity production. The main objective of this study was to investigate the treatment of 3% bentonite water based drilling mud contaminated with 2% oil using the microbial fuel cell.

3. Materials and Methods

For the treatment of the oil contaminated drilling mud, 3% bentonite drilling mud, 2% engine oil and 500 mL of bacterial growth medium was used in the anode and water in the cathode. The volume of both anode and cathode was 500 mL. The anode was injected with a bacterial solution and was continuously stirred by a magnetic stirrer. Air was continuously injected into the cathode. The anode and the cathode were separated by a commercial cation exchange membrane (CMI-7000). Both electrodes are carbon fiber brush connected to a 1000-ohm external resistor. The degradation of the engine oil was tested by monitoring the absorbance of UV-VIS rays in the contaminated anodic solution using the UV Spectrophotometry. The pH, ORP, Resistivity and conductivity of the solution was continuously monitored for 79 hours. The circuit voltage (CV) of the system was also constantly monitored. The setup is shown in Fig. 1.

4. Results and Discussion: The absorbance data obtained from the UV-VIS spectrophotometry show a linear increase in the absorbance value of the anodic solution over the course of three operation days. Fig. 2 shows the absorbance of the material at a wavelength of 890.8 nm. This wavelength was chosen because, the transmittance of oil to this wavelength of light is almost 90% and the absorbance is almost negligible. Hence any increase in absorbance will mean a decrease in the proportion of the transmitting material. As we know, the absorbance is directly proportional to the concentration of absorbing material; hence the data suggests that there is an increase in the proportion of absorbing material (here, bentonite) and a linear decrease in the proportion of oil, which is a transmitting material. Fig. 3 shows the cell voltage developed during the 79 hours of operation. The maximum power density achieved was 10.51×10^{-3} mW/m^3 after 77.5 hours of operation.

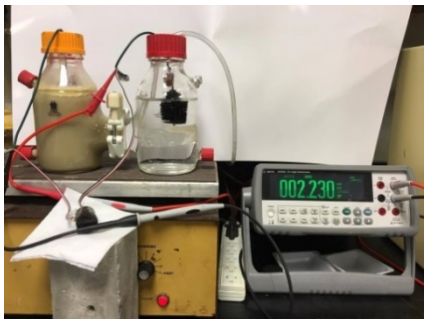

Figure 1. 1. Experimental Setup

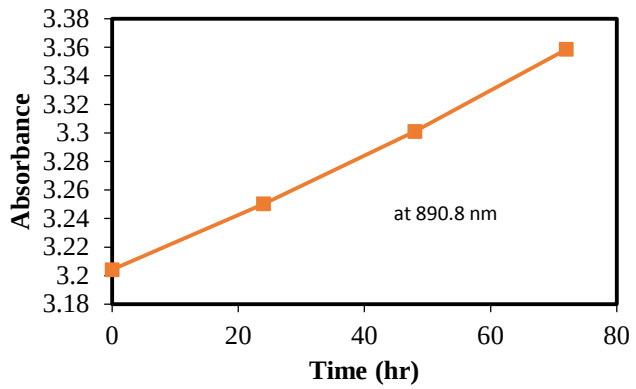

Figure 2. Change in absorbance of anodic solution with time

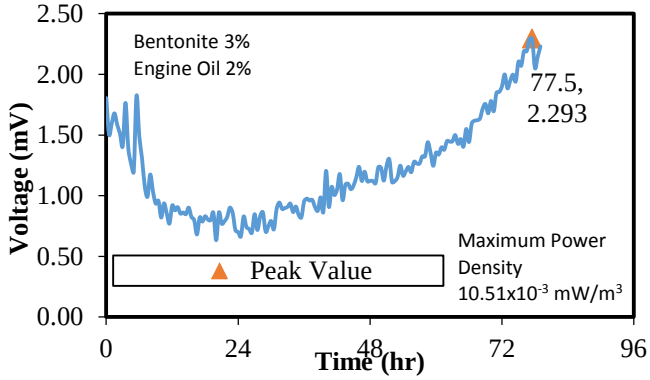

Figure 3. Voltage generated during microbial decomposition

5. Conclusions: The results presented above show that the treatment of water based bentonite drilling mud contaminated with oil is possible in a microbial fuel cell. The absorbance data show promising results. Increment in the contamination percentage can be another area of interest.

6. Acknowledgment: This study was supported by the Texas Hurricane Center for Innovative Technology (THC -IT) and Texas Hazardous Waste Research Center.

7. References

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