Treatment of Oil Contaminated Water Based Drilling Fluid through Microbial Fuel Cell

S. Pokharel[1] and C. Vipulanandan[1], Ph.D., P.E.
[1]Center for Innovative Grouting Materials and Technology (CIGMAT)
Department of Civil and Environmental Engineering
University of Houston, Houston, Texas 77204-4003
Email: spokharel2@uh.edu, cvipulanandan@uh.edu Phone: (713) 743-4278

Abstract: In this study, the potential of a using a two chamber microbial fuel cell to treat the oil contaminated drilling fluid was investigated. Bentonite based drilling fluid contaminated with 1 % engine oil was used in the anode chamber to be treated by bacterial decomposition. The degradation of the engine oil was tested by monitoring the resistivity, pH, and ORP of the contaminated solution for 72 hours. The open circuit voltage (OCV) of the system was monitored to know about the electricity production. The resistivity of the contaminated solution changed from 2.01 Ωm to 2.06 Ωm, the pH changed from 5.92 to 7.00 and the ORP changed from 234 mV to 151 mV in the 72 hours of operation. The maximum power density generated was $4.1x10^{-8}mW/m^3$.

1. Introduction:

A drilling fluid, or mud, is any fluid that is used in a drilling operation in which that fluid is circulated or pumped from the surface, down the drill string, through the bit, and back to the surface via the annulus (Growcock and Harvey, 2005). There are three types of drilling fluids; Gaseous drilling fluid, Aqueous drilling fluid and Non-aqueous drilling fluid. The American Petroleum Institute (API) estimates that approximately 1.21 barrels of total drilling waste are generated for every foot drilled in the United States. Of this, nearly 50% is solid drilling waste. The accumulated volume of solid drilling waste generated yearly is approximately 139,961,305 barrels. Disposal without treatment of drilling waste will affect the soil ecosystem and may also affect the underground water quality if disposed on land. The four hierarchical steps in waste management recognized by the EPA are; source reduction, recycling, treatment and disposal. Water based drilling fluid do not generally possess environmental treats but their contamination with oil can have huge environmental effects if disposed without treatment. 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.

2. Objectives:

The objective of this study was to investigate if 1% engine oil contaminated water based drilling fluid can be treated using the microbial fuel cell.

3. Materials and Methods:

For the treatment of the oil contaminated drilling fluid, drilling fluid (3% bentonite) contaminated with 1% engine oil was used as the anode solution. Water was used as the cathode solution. The volume of both anode and cathode used was 500mL. The anode was injected with a bacterial solution and nutrients and was continuously stirred by a magnetic stirrer. Air was continuously injected into the cathode. The anode and the cathode were separated by a cation exchange membrane. The electrode used in both chambers was carbon fiber brush. The degradation of the engine oil was tested by monitoring the resistivity, pH, and oxidation reduction potential (ORP) of the contaminated solution for 72 hours of operation. The open circuit voltage (OCV) of the system was also constantly monitored. The results obtained were compared with the 0% contamination values.

4. Results and Discussion:

The resistivity of the 1% contamination solution changed from 2.01 Ωm to 2.06 Ωm, which the resistivity of the uncontaminated solution after 72 hours of bacterial decomposition (Figure 1). The pH of the uncontaminated solution was measured to be 6.90. The pH of the 1% contaminated solution changed from 5.92 to 7.00 after 72 hours of bacterial decomposition (Figure 3). The ORP of the uncontaminated solution was measured to be 183 mV. The ORP of the 1% contaminated solution, which was 234 mV, changed to the 180 mV after 24 hours of operation but has been further

reducing (Figure 2). After the acclimation period of 17 hours there was a surge of voltage which kept decreasing after that, indicating a decrease in the bacterial activity. The maximum power density achieved was $4.1x10^{-8}mW/m^3$.

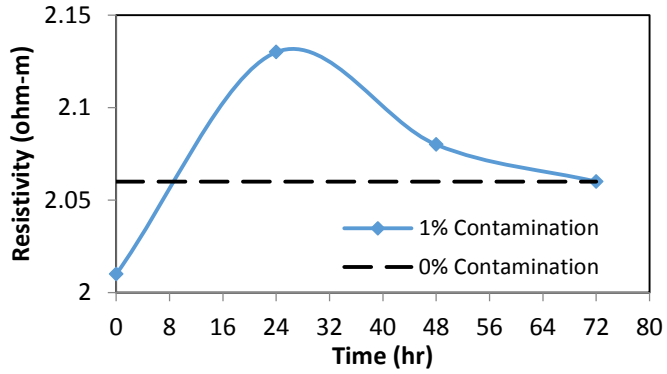

Figure 1. Change in resistivity after microbial decomposition

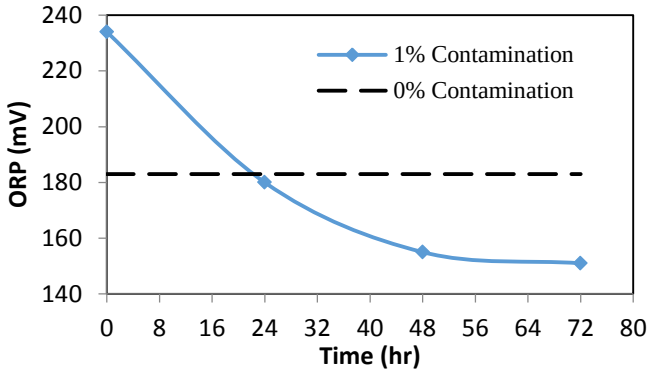

Figure 2. Change in ORP after microbial decomposition

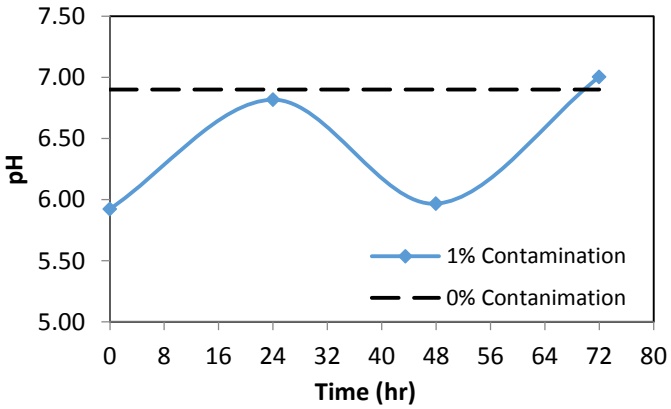

Figure 3. Change in pH after microbial decomposition

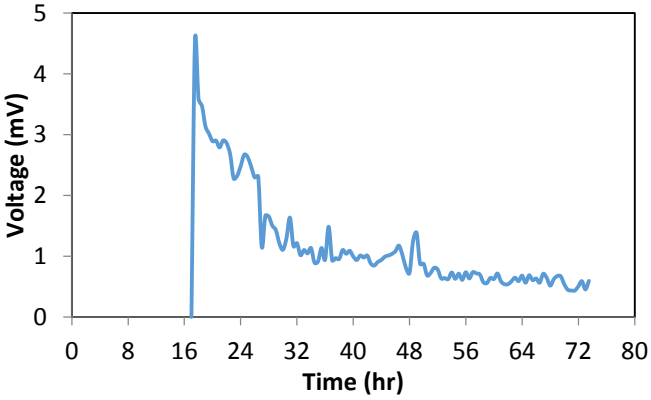

Figure 4. Voltage generated during microbial decomposition

5. Conclusions: The resistivity, pH, ORP values of the contaminated drilling fluid after treatment in the microbial fuel was almost similar if not same to the values for the uncontaminated solution. The results presented above show that the 1% engine oil contamination in the drilling fluid can be treated with the help of the microbial fuel cell. The power generation is the above study was not significant, but that depends on a lot of factors ranging from the choice of electrodes to the cathode solution.

6. Acknowledgements: This study was supported by the Center for Innovative Grouting Materials and Technology (CIGMAT) and Texas Hurricane Center for Innovative Technology (THC-IT), University of Houston, Houston.

7. References

1. Growcock. F, Harvey. T, (2005). "Drilling Fluids". Drilling Fluid Processing Handbook, ASME. Pages 15-68.

2. Vipulanandan. C., Sivananthan. P., (2015). "Recycling Oil Contaminated Drilling Mud Using Microbial Fuel Cell". *Proceedings-Texas Hurricane Center Conference,*