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Voltage and Microbial Respiration: In Situ Hydrocarbon Remediation Sensors

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Background/Objectives. In Canada, petroleum hydrocarbon contaminated sites pose challenges for soil remediation due to long, cold winters affecting soil processes. In soil remediation, in situ approaches are preferred as they provide answers in a simple, cost-effective manner. During in situ remediation, hydrocarbon degradation and nutrient availability are typically measured to monitor microbial activity. Electrodes that assess electron deposition on the cathode can measure microbial activity in submerged soils and aquatic environments. In this experiment, we assessed if increases in measured voltage was linked to benzene degradation. Our overall objective, as part of the Sustainable In Situ Remediation Cooperative Alliance (SIRCA), is to develop in situ sensors able to provide real time estimates of microbial activity in the sub-surface, which will allow us to fine tune biostimulatory solution composition.

Approach/Activities. Microcosms were set up with a nitrate reducing media and benzene as the primary carbon source. The microcosms contained a sampling port, a graphite anode and cathode probe, and sealed wires exiting the microcosm for voltage measurements. A hydrocarbon degrading culture isolated from oil sands process affected water (OSPW) in Alberta (ie. the Ulrich culture) was used to inoculate the microcosms which were incubated over a period of five weeks. Microbial activity was monitored by; i) voltage using a voltmeter ii) voltage increase over time when resistance in the circuit, iii) benzene concentration by GC/MS, and iv) nitrate concentrations by ion chromatography. This experiment aims to link benzene degradation and nitrate reduction to microbial activity using the microbial probes. Future experiments will involve monitoring the above parameters in hydrocarbon contaminated soil microcosms.

Results/Lessons Learned. Both instantaneous voltage and voltage increases with time corresponded to benzene degradation. For example, voltage slope rates of 112 and 169 mv/h corresponded to a significant decrease in benzene, under nitrate reducing conditions. Instantaneous voltage increase by 100 mV in benzene degrading reactors whereas the media control declined by 100 mV. In two weeks, 25% of the benzene was degraded and this corresponded to a significant consumption of nitrate by the Ulrich cultures. Future work will be extending the use of these probes to treatability microcosms with soils contaminated with a mixture of hydrocarbons.