Thermally Enhanced Bioremediation of Hydrocarbon Impacted Subsurface

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Abstract. Petroleum hydrocarbon contamination of soils and groundwater is widespread, and low-cost remediation technologies are needed. Thermal remediation technologies (i.e., soil vapor extraction) have been developed to volatilize contaminants. Although often effective, the energy input required results in high cost. Bioremediation is an attractive low-cost alternative; however, degradation rates are typically slow. Temperature can increase the growth and metabolic activity of microbial communities involved in bioremediation. Therefore, it is possible that bioremediation rates could be enhanced via low-level heating, and overall remediation goals could be met more rapidly than for traditional bioremediation and at a much lower cost than for soil vapor extraction. To determine temperature effects on the natural attenuation of petroleum hydrocarbons, a microcosm study was completed. The site specific study focused on a former refinery in Casper, Wyoming. The microcosms simulated an anaerobic subsurface system using contaminated site soil, where methanogenesis (biologically-mediated conversion of contaminants to methane and carbon dioxide) was the pathway for biodegradation. Thus, biodegradation rates could be evaluated by monitoring methane production over a range of temperatures (4ºC – 60º). Preliminary results have shown that increasing subsurface temperatures by only 10ºC can increase degradation rates by an order of magnitude and temperatures of 22ºC and 30ºC were optimal for enhancing biogas production. Biological activity was also measured via measuring levels of adenosine triphosphate (intracellular energy carrier) over a range of temperatures. Results to date indicate that thermally-enhanced bioremediation is a promising technology. Future research includes measuring changes in the mass of total hydrocarbons as well as the mass of regulated contaminants (e.g., benzene), and characterizing the indigenous microbial community within the site soil responsible for degradation.

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