STARx^{TM} (Ex Situ Smoldering) for the Treatment of Contaminated Soils and Liquid Organic Wastes: Prototype Testing and Optimization

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Background/Objectives. STAR™ is a commercially available in situ remediation technology for NAPLs based on the principle of smoldering combustion. Using the contaminants as a fuel, a flameless, self-sustaining reaction is propagated through the soil, using minimal energy and destroying the NAPLs. The process is very robust and well-suited for treating a wide range of oily wastes or oil-contaminated soils with many potential applications to the oil and gas and chemical manufacturing industries.

This presentation describes the results from a collaboration between Savron and Chevron Energy Technology Company to develop STARx™, an inexpensive, modular, mobile ex situ smoldering system for contaminated soil piles. Prototype tests were combined with numerical modelling to optimize the design prior to field testing.

Approach/Activities. An engineered base system was designed to apply STARx™ via soil piles. These bases, called Hottpads™, are a low profile trafficable surface containing the ignition and air distribution systems for generating a self-sustaining smoldering reaction in the soil pile resting above. A prototype Hottpad™ was designed and tested at a research facility in London, Canada. 5 highly instrumented prototype tests were conducted with various piles of mixed heavy hydrocarbons and sands. Further optimization was pursued by employing a numerical model, which was previously developed to simulate STAR. The model was calibrated and validated against the prototype test results. Then more than 20 simulations were performed to evaluate the sensitivity of the treatment efficiency to injected air flux, hydrocarbon saturation, soil permeability, and pile configuration. It was also used to simulate scale-up of the application to representative field conditions.

Results/Lessons Learned. The prototype Hottpad™ successfully treated all of the soil piles, destroying ~150 kg of heavy hydrocarbons in under 24 hours of self-sustained smouldering in each test. The model was successfully calibrated and validated using the experimental data. Simulations revealed that the Hottpad™ treatment efficiency and rate was highly controllable via the chosen injected airflow rate. They also showed that the thoroughness of treatment is less sensitive to the heterogeneity of the hydrocarbon saturation than the soil. Moreover, the field simulation indicated that, for a soil pile of approximately 20-fold increased volume treated with six integrated Hottpad™ modules, the treatment rate is expected to increase proportionately while not significantly increasing the treatment time. Overall, this work provided key proof of concept and design information to allow the team to proceed to full-scale field application of the STARx™ Hottpads™.