Combine Optimization of Surfactant Enhanced Recovery and ISCO Alkaline Activation to Treat a Brazilian Latosol Soil Contaminated with DRO Diesel

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Background/Objectives. Persistent contamination cases related to petroleum hydrocarbons (PHCs) trapped in soil as secondary source to groundwater are still a challenge in the context of many cases in Brazil.

Due to this situation, the application of surfactants in soil flushing has shown to be an effective alternative to enhance remediation conducted by extraction or to reduce contaminant mass to allow a subsequent chemical oxidation in situ to achieve remediation targets. In this context, a treatability test was implemented using two plant-based non-ionic surfactants to determine the most efficient reagent and optimal concentration in mass removal of a soil contaminated with PHCs. Response Surface methodology (RSM) based on Box-Behnken statistical experiment design (BBD) was applied to analyze the experimental variable factors as flow mL/min, washing time/min and surfactant concentration.

Approach/Activities. The soil sample used was collected from LV56 unit in Bauru Region described as of medium texture (clay-sandy) and dystrophic red latosol subgroup, containing approximately 50% clay. Tests of soil flushing performance were conducted in laboratory scale using glass columns. 5 kg of a clean Brazilian red latosol, which properties were previously set, were contaminated with 5 mL of Diesel fuel from a gas station. Then, 12 parts of 150 g contaminated soil were placed in different columns. Each column was submitted to flush the soil with 4 L of surfactant water solutions during residence time of 4 hours (flow rate of 5 mL/min) with different concentrations of each surfactant (control test: 0.5 g/L, 1.0 g/L, 2.0 g/L, 3.0 g/L and 4.0 g/L). The two biodegradable surfactants V3 and V10 tested have specific properties that allow groundwater interface tension reduction, enabling the mobilization and solubilization process among PAHs and TPH components sorbed onto the soil. All surfactant solutions were analyzed after the flushing test for PAH and TPH (from C10 to C40) to analyze mass removal to determine the most efficient conditions. After selecting the most efficient condition, the data were plotted in a statistical model to model the residence time of the optimal flow rate in a discharge application, based on 3D graphical analysis and statistical data, which will provide optimization and trends for Future tests requiring less time and reagents, but allowing the same conclusions to be drawn.

Results/Lessons Learned. Data generated in column tests showed promising results, reaching the mass removal of TPH above 70% w/w of soil contaminated with DRO diesel. To date, the results of the first V3 surfactant tested have shown increased desorption in samples applied at concentrations of 3 g/L and 4 g/L of bulk removal resulting from a further 70% w/w. Considering the cost-benefit ratio, the optimum concentration range between 3 g/L and 4 g/L was the best removal condition achieved, since the removal rate attends many cases and costs will be less than 4 g/L of concentration. Analyzes of the second surfactant, V10, are underway. The results will show which is the most efficient and optimized dosage for each specific study condition. In addition, a treatability test with activated alkali sodium persulfate is being conducted with column effluent to oxidize the mass of contaminants extracted from Soil and to evaluate the possible regeneration of the surfactant used.