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Development of New Treatment Technology for Sulfolane Impacted Groundwater utilizing Enhanced Heat Irradiation

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Background/Objectives

Sulfolane is an organic chemical ($C_4H_8O_2S$; tetrahydrothiophene 1,1-dioxide) that has been used for various petrochemical purposes, including extracting aromatic compounds from hydrocarbon mixtures such as petroleum naphtha, pyrolysis gasoline or coke-oven light oil. It also has been used in the sweetening process of sour gas at gas processing plants as a solvent for removal of sour gas components (e.g. H_2S).

Sulfolane is a highly-polar compound with very stable and recalcitrant properties such as low Henry's constant, high solubility, low retardation factor, and thermal stability. As a result, Sulfolane presents as a problematic pollutant to groundwater through spill and release mechanisms, posing a significant risk to groundwater aquifers and/or surface water bodies.

Currently there are only few remediation technologies commercially available to address Sulfolane (such as oxidation, bio-remediation and/or photocatalytic irradiation). However, due to the recalcitrant properties of Sulfolane, these technologies have typically been ineffective and expensive when large mass reductions are required (i.e. >100 mg/L).

The objective of this presentation is to discuss findings of a study to develop a technically and economically sustainable remediation technology to remove sulfolane impacted water utilizing novel enhanced stimulators and low energy heat irradiations such as electromagnetic (EM) wave or induction heating. The stimulators possess unique functionalities such as enhanced heat efficacy, photo catalytic properties, magnetic separation effects, and oxidization reactions, etc. The fundamental mechanisms of this technology can also be applied to address dissolved contaminants and non aqueous phase liquids (NAPL) such as petroleum hydrocarbons, chlorinated compounds from dry cleaning operations, historic wood treatment chemicals such as creosote and other organic/solvent related contaminants.

Approach/Activities

To-date this work has been performed in laboratory scale testing. In this case, sulfolane was used as the organic pollutant, and then diluted into a distilled water medium. First, the stimulators are mixed with contaminated water and exposed to EM irradiations for controlled/specified time intervals. Liquid chromatography and mass spectroscopy (LC-MS) was used to characterize and analyze the treated water. Findings of the testing indicated that the combination of EM irradiations and stimulators significantly increased the instantaneous temperature beyond the boiling temperature and exhibited photocatalytic and chemical reactions.

Results/Lessons Learned

In the treatment combinations, we were able to achieve a significant mass reduction in an average 86 wt.% of sulfolane with various combinations of enhancement. One of the benefits associated with the proposed approach is that the method can treat the impacted material in a very short time frame (several minutes in the lab-scale) with reduced infrastructure compared to thermal desorption or water treatment facilities. We are in process of developing ex-situ and in-situ process and fabricate a prototype unit for batch operations in the field. In addition, different types of contaminants are also being investigated such as petroleum hydrocarbons, wood preservatives, and chlorinated compounds.