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Remediation of Petroleum Impacted Soils with Electron Beam Irradiation

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Pollution of soil by heavy hydrocarbons (HH, C12-C40) is a major global environmental issue. Heavy hydrocarbons pose a significant remediation challenge because they are recalcitrant and relatively immobile in soils, and hence will persist in the environment for a long time. Electron beam has the potential to both crack and polymerize hydrocarbons at lower temperatures than similar energetic methods for HH remediation such as thermal desorption and pyrolysis. Electron beam remediation must be proven fast, efficient, and economical at large scales. To this end, the present research has several objectives: show reduction in mass of heavy hydrocarbons in soil for proof of concept; assess impact of testing parameters (such as radiation dose); and design an experimental setup to evaluate soil treatment, both in a batch configuration and in a continuous configuration.

Samples with initial HH contamination ranging from 2% to 10% (w/w) were irradiated with an 18kW, 10 MeV RF LINAC in various configurations. Configurations including stationary and moving soil containers were developed to irradiate samples ranging in size from 100 g to 3 kg. Various doses were tested from 50 kGy to 2000 kGy to assess the energy cost and effectiveness of various levels of remediation. Beam penetration profiles and HH reduction profiles in the soils were measured. Similar soil samples were also thermally desorbed and pyrolyzed to compare energy input to irradiation at similar maximum temperature (˜420°C) and to characterize chemical reduction mechanisms during irradiation. Treated and untreated samples were characterized using colorimetry and gas chromatography (GC-FID) performed with hydrocarbon solutions in dichloromethane.

Tests showed effective HH mass reduction, which resulted in TPH reduction (below 0.1%, satisfying environmental regulations) in both batch and continuous treatments. Temperature Programmed Desorption and Oxidation (TPD/TPO) showed evidence of both volatilization and char formation as the means of heavy hydrocarbon mass reduction.

Country/Organization invited to participate

United States of America

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