Brownfield Remediation Powered by Renewable Energy

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ABSTRACT

Subsurface contaminant plumes are a plague upon the earth. Some 1900 plumes remain after the go-fast atom bomb projects of the Cold War. Countless gasoline station sites dot our cities, leaching heavy metals and chlorinated solvents into drinking water. Superfund-type cleanup is so expensive that many sites languish while toxins continue to spread throughout the ecosystem. Federal funding for remediation research stopped 15 years ago. The only solution now is to move bad soil from one location to another. New advances in stem cell manipulation offer promise to clean up solvent-infused earth with a minimum of excavation at greatly reduced costs. Dielectrophoresis is the means by which polar molecules, in a matrix having a different dielectric constant, can be made to migrate along electric field gradients. A unique configuration called "pills and pillars" facilitates remediation of solvents. Electric field gradients originating in the deeply-driven "pillars" motivate solvents molecules towards the slightly-buried "pill". When powered by renewable sources, such as solar panels, contaminants within a 1000 m^3 volume can be concentrated within a 1 m^3 volume at the pill, and then removed for disposal in a certified toxic waste repository. The pills and pillars are easily extracted for removal to a new site every 40 days. The solar panels are man-portable so that a single capital expenditure of a truck-mounted kit can serve multiple sites simultaneously, and sequentially. The low labor overhead, the greatly reduced excavation, and the re-use of hardware contribute to make this novel method of brownfield remediation far cheaper than traditional, presently-available methods. Computer simulations including both vadose zone diffusion (natural spreading out) and drift via dielectrophoresis, demonstrate the effectiveness of this approach. The next research step is to build a benchtop model to validate the simulation model, followed by field trials with partners in the environmental remediation industry.