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Photolysis/Biodegradation of PCB and PCDD/PCDF Contaminated Soils

IT Corporation

Technology Description: This process is a two-stage photolytic and biological soil detoxification process that has application to treatment of soils contaminated with polychlorinated biphenyls (PCBs) and 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). The process may be used in-situ for treatment of shallow soil contamination or as an ex-situ, on-site treatment for excavated soils.

The first step in the process is to degrade the organic contaminants by using ultraviolet (UV) radiation. The source of the UV radiation may be either artificial UV light or natural sunlight. Alternatively, advanced oxidation processes such as iron catalyzed hydrogen peroxide (Fenton's Reagent) may be used to provide primary contaminant degradation. Both photolysis and chemical oxidation are expected to convert contaminants to more biodegradable compounds. Biological degradation, the second step, is then used to further degrade organic contaminants. Biodegradation is enhanced by the addition of microorganisms and nutrients to the UV treated soil. Residues from the process are surfactants and the end metabolites of the biodegradation process.

Waste Applicability: The IT Corporation photolysis/ biodegradation process is designed to destroy organics, particularly 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and polychlorinated biphenyls (PCBs), other polychlorinated organics and polynuclear aromatic hydrocarbons in soils.

Test Results: Bench-scale UV photolysis testing was performed on three soils; one containing 200-300 ppb 2,3,7,8,-TCDD and two containing 200-10,000 ppm aroclor 1248 PCB contamination. Tests were conducted independently using a medium pressure mercury lamp, or a 10 Hertz (Hz) pulsed lamp and sunlight, employing surfactants at 0 to 5% of the weight of the dry soil. Results of the PCB experiments are summarized in Table 1. Tests performed on TCDD contaminated soils showed no significant apparent destruction of dioxin.

Additional testing was conducted using Fenton's reagent chemistry as an alternate method of degrading PCBs to more easily biodegraded compounds. Experiments on soil contaminated with 5000-10,000 ppm PCBs (arochlor 1248) were performed. PCB destruction ranged from <15 to 55%.

The ability of selected organisms to biotransform PCB congeners in surfactant/UV treated and untreated soils was evaluated during two bioslurry treatment experiments. The first bioslurry treatment experiment evaluated the biological reduction of PCB congeners

Table 1. *Summary of UV Photolysis Results on PCB Contaminated Soil*

Test	*Condition*	*Time (Hours)*	*Initial PCB Conc. (ppm)*	*Final PCB % Reduction*
1	*Surface soil, pulsed lamp, 0.25 inch soil depth, 2% surfactant, 25°C*	*12*	*7240*	*<15*
2	*Surface soil, medium pressure Hg lamp, 0.25 inch soil depth, 2% surfactant, 28°C*	*7*	*7430*	*<15*
3	*Surface soil, medium pressure Hg lamp, 0.25 inch soil depth, 2% surfactant, 40°C*	*7*	*8440*	*33*
4	*Pit soil, medium pressure Hg lamp, 0.5 inch soil depth, 2% surfactant, 30°C*	*16*	*140*	*30*
5	*Pit soil, pulsed lamp, 0.5 inch soil depth, 2% surfactant, 28°C*	*16*	*157*	*13*
6	*Pit soil, pulsed lamp, 0.5 inch soil depth, 2% surfactant, 28°C*	*12*	*170*	*23*
7	*Pit soil, solar irradiation, 1.0 inch soil depth, 4.5% surfactant, 30-40°C*	*25 days*	*132*	*<15*
8	*Pit soil, solar irradiation, 1.0 inch soil depth, 2% surfactant, 30-40°C*	*25 days*	*159*	*<15*
9	*Pit soil, solar irradiation, 1.0 inch soil depth, 0% surfactant, 30-40°C*	*25 days*	*171*	*<15*
10	*Fine ground surface soil, med. Hg lamp, 0.25 inch soil depth, 2.5% surfactant*	*20*	*10000*	*52**
11	*Fine ground surface soil, med. Hg lamp, 0.25 inch soil depth, 2.5% surfactant*	*20*	*10000*	*32*

**Increase in concentration noted for di-PCBs, decrease in concentration for tetra through hepta-PCBs.*

In surfactant/UV-treated and untreated soils. A subsequent enhanced bioslurry treatment evaluated the impact of PCB-biodegradation inducers on congener removal. Bioslurry experiments were conducted under aerobic conditions at 25°C. PCB reductions lessened with increasing level of chlorination with no significant reduction of penta, hexa, and hepta-PCBs. Similar reductions were obtained with inducer additions to the soil.

Although the percent of PCB degradation was low, meaningful destruction may have been masked by the high concentration of PCBs in the surface soil that was used in many of these tests.

Also, high amounts of surfactant were carried through the treatment process and may have been inhibitory to bacterial activity as evidenced by the high total organic carbon and low pH of the soil.

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