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SUPERCRITICAL EXTRACTION OF POLYCHLORINATED BIPHENYLS FROM SOILS AND SEDIMENTS: REMEDIATION AND POSSIBLE RISKS

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INTRODUCTION

It is estimated that there exists about 350 million pounds of polychlorinated biphenyls (PCBs) in landfill and other storage, and another 24 million pounds in sediments, soil, vegetation and animals (1). The potential environmental threat of the large amount of PCBs has called for the development of effective PCB cleanup techniques. Although some PCB remediation technologies such as incineration and in-situ vitrification have been commercial available, many efforts are still being conducted in order to develop more economic and social acceptable methods (1-3). Among these efforts, the application of supercritical fluid extraction (SFE) in the removal of toxic organics from environmental samples is receiving much attention due to the unique properties of supercritical fluids (SCFs) such as low viscosity, high diffusivity, and easily tunable solvent power (2-5). A process concept advanced at Syracuse University will be presented here.

The process to treat PCB contaminated soils with supercritical technique may involve some risks. These risks could include additional contamination of underground waters due to fracture and permeation through underground structure when contaminated soils are excavated; removal of organic matter from soil and rendering it inert; hazardous operation of large scale high pressure mobile apparatus; and hazards in surface transportation of PCB soil extracts to a central site for supercritical water oxidation (SCWO) destruction. These issues will be discussed.

METHODOLOGY

We are developing a new generation of soil remediation technology at Syracuse University to clean soils and sediments contaminated with chlorinated hydrocarbons such as PCBs as well as polycyclic aromatic hydrocarbons (PAHs). The two-stage concept advanced is shown in Figure 1. First (Figure 1a), the toxic PCBs or PAHs are extracted from the sediments or soils using SFE with high-pressure carbon dioxide fluids. The clean soils/sediments are returned to the site, the concentrated toxic organics are separated from the supercritical fluids for further processing, and the supercritical fluids are recycled. In the second process step (Figure 1b), SCWO, the concentrated toxic organics are destroyed by wet oxidation to form harmless carbon dioxide, water and hydrochloric acid.

A laboratory scale extraction unit is employed to obtain desorption data for PCB removal from laboratory-spiked and native contaminated soils with supercritical carbon dioxide and cosolvents. Various conditions of extraction for a variety of soils/sediments have been studied. A flowsheet of the unit is shown in Figure 2. The fixed-bed unit can be operated at pressures and temperatures as high as 680 atm and 100 °C.