Chapter I

INTRODUCTION

Polychlorinated biphenyls (PCBs) are ubiquitous environmental contaminants that have attracted great concern because of their worldwide distribution, persistence in the environment, and possible deleterious effects. PCBs were manufactured in the United States between 1929 and 1978 by Monsanto Corporation, and were marketed under the trade name Aroclor. Their electrical insulating properties and inflammability, combined with unique thermal and chemical stability, led to a wide variety of industrial uses as heat transfer fluids, hydraulic fluids, plasticizers, dielectric fluids, flame retardants, solvent extenders, and organic dieluents (Abramowicz, 1990; Abramowicz and Olson, 1995; Boyle et al., 1992; Yadav et al., 1995). The widespread use of PCBs coupled with improper disposal practices resulted in the discharge of large quantities of these environmental pollutants into non-target sites, such as soils, river and lake sediments and landfills. Because their hazardous nature has only recently been understood, PCBs have been routinely disposed of over years, without any precautions being taken. Serious environmental contamination with PCBs has been documented for industrial areas such as the Great Lakes, the Baltic Sea and Tokyo Bay. It is estimated that approximately 1.4 billion pounds of PCBs have been manufactured and several million pounds have been released into the environment (Abramowicz and Olson, 1995; Mousa et al., 1996). PCBs are truly pervasive in the environment and will remain so for a long period of time.

PCBs are reported as contaminants in almost every component of the global ecosystem including air, water, soil, fish, wildlife, plants, domestic animals, human blood, adipose tissue and milk (Crine, 1988; Tanabe, 1988; WHO, 1993). They can bioaccumulate in biological tissues, and their lipophilic behavior poses a serious threat to mammalian systems (Borlakoglu and Haegele, 1991; Brunner et al., 1985). PCBs are known to elicit a spectrum of toxic responses in humans, laboratory animals and wildlife including lethality, reproductive and developmental toxicity, body weight loss, dermal toxicity, liver damage, neurotoxicity, immunosuppressive effects, porphyria, teratogenic effects and carcinogenic effects (Borlakoglu and Haegele, 1991; Mousa et al., 1996).

PCBs can be biodegraded under both aerobic and anaerobic conditions. Degradation studies involving PCBs have been largely conducted in estuarine and marine sediments. In general, much less effort has been given to the degradation of these contaminants in the soil environment. Also, toxic effects of PCBs have been focused primarily on higher organisms and very little is known about the toxicity of PCBs to bacteria and other microorganisms.

This feasibility study was performed in collaboration with BioSystems Technology, Inc. (Blacksburg, VA). The objectives of this research were to:

(1) evaluate the toxicity of an aged surface soil, contaminated with Aroclor 1242, on an aceticlastic methanogenic consortium, enriched from a municipal anaerobic digester and to;

(2) analyze the rate and extent of PCB degradation in an aged surface PCB contaminated soil, using an aceticlastic methanogenic consortium enriched from a municipal anaerobic digester.

1.1 REFERENCES

Abramowicz, D. A. 1990. Aerobic and anaerobic biodegradation of PCBs: a review. Crit. Rev. Biotechnol. 10:241-251.

Abramowicz, D. A., and D. R. Olson. 1995. Accelerated biodegradation of PCBs. Chemtech. 25:36-41.

Borlakoglu, J. T., and K. D. Haegele. 1991. Comparative aspects on the bioaccumulation, metabolism and toxicity with PCBs. Comp. Biochem. Physiol. 100C(3):327-338.

Boyle, A. W., C. J. Silvin, J. P. Hassett, J. P. Nakas, and S. W. Tanenbaum. 1992. Bacterial PCB degradation. Biodegradation. 3:285-298.

Brunner, W., F. H. Sutherland, and D. D. Focht. 1985. Enhanced biodegradation of polychlorinated biphenyls in soil by analog enrichment and bacterial inoculation. J. Environ. Qual. 14(3):324-328.

Crine, Jean-Pierre, 1988. Hazards, decontamination, and replacement of PCB. A comprehensive guide. Environmental Science Research. Vol. 37. Plenum Press, New York.

Mousa, M. A., J. F. Quensen III, K. Chou, and S. A. Boyd. 1996. Microbial dechlorination alleviates inhibitory effects of PCBs on mouse gamete fertilization in vitro. Environ. Sci. Technol. 30(6):2087-2092.

Tanabe, S. 1988. PCB problems in future: Foresight from current knowledge. Environ. Pollut. 50:5-28.

Yadav, J. S., J. F. Quensen III, J. M. Tiedje, and C. A. Reddy. 1995. Degradation of biphenyl mixtures (Aroclors 1242, 1254, and 1260) by the white rot fungus Phanerochaete chrysosporium as evidenced by congener-specific analysis. Appl. Environ Microbiol. 61(7):2560-2565.

WHO. 1993. Environmental Health Criteria 140:Polychlorinated biphenyls and terphenyls. Second Edition. WHO, Geneva.