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Influence of biosurfactant on combined chemical–biological treatment of PCB-contaminated soil

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HIGHLIGHTS

- EDTA and biosurfactant both improved the removal efficacy of the combined treatment.
- Biosurfactant addition increased microbial respiration and dehydrogenase activity.
- Similar removal of PCBs was achieved after a 42-d combined treatment with either H_2O_2 or CaO_2.

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ABSTRACT

The contamination of soil with polychlorinated biphenyl-containing industrial fluids is a worldwide environmental problem due to their high persistence. The present study aimed to elaborate a new strategy of process integration by the joint application of biosurfactant and combined chemical–biological treatment for soil decontamination. The addition of a microbial surfactant from *Pseudomonas* sp. PS-17 to the combined chemical–biological treatment, utilizing liquid hydrogen peroxide or calcium peroxide and a natural consortium of microorganisms-destructors, resulted in process modification that increased the treatment efficacy of soil contaminated with polychlorinated biphenyl-containing electrical insulating oil. A 42-d combined chemical–biological treatment supplemented by biosurfactant addition resulted in an average 47–50% of polychlorinated biphenyls removal – independent of the hydrogen peroxide carrier used. Changes in the soil pH during the combined treatment application with oxidizing chemicals in moderate dosages were unsubstantial. Joint application of the biosurfactant, microorganisms and oxidizing chemicals in moderate dosages increased soil respiration and dehydrogenase activity compared to that obtained by application of the microbial consortium alone, indicating stimulation of microflora by the process integration. The application of the higher calcium peroxide doses (soil/CaO_2 = 1/0.005, g/g) substantially increased the soil pH and diminished soil microbial respiration compared to that for untreated incubated soil. Ethylenediaminetetraacetic acid addition in the experiments with the solid hydrogen peroxide did not affect the treatment efficacy even after the prolongation of the treatment time from 1 to 42 d. Joint addition of both the biosurfactant and the chelating agent to the combined chemical–biological treatment was not effective.

1. Introduction

The contamination of soil by some organic compounds is a great threat to the environment and human health due to disruption of soil structure and inhibition of flora, fauna and microflora. Polychlorinated biphenyls (PCBs) are one of the most dangerous persistent contaminants due to its high bioaccumulation potential [1], high toxicity and carcinogenicity [2] as well as possible endocrine disruptiveness [3]. PCBs were the main component of insulating oil used in electric equipment from the start of their commercial production in 1929 until their banning in many of countries including the USA, the UK and Japan in the 1970s. The widespread use of these compounds led to their substantial release into environments, and effective treatment methods are required.

Various types of remediation procedures including bioremediation [4], chemical oxidation [5], phytoremediation [6] and incineration [7] have been utilized on PCB-contaminated soils with differing degrees of success. There is some evidence that bioremediation can be helpful for decontamination of PCB-contaminated soil. For instance, bioremediation with commercial mixtures of microorganisms [8], separate strains of microorganisms-destructors of hydrocarbons [9] and a lignin-degrading white rot fungus [10] was successfully used to degrade some PCB congeners in soil

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