Fenton-like treatment of marine sediment contaminated by PCBs

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Introduction: Contaminated marine sediment with PCBs entered from various sources is a potential contamination source because those pollutants adsorbed on sediments can be taken up and bio-accumulated by sediment-dwelling organisms, transferred to high trophic levels and then cause toxic effect on terrestrial organism as well as marine organisms. Therefore it is necessary to remediate the marine sediment contaminated with PCBs either *in situ* and *ex situ*. Chemical oxidation processes have the potential to provide effects of quick destructing contaminated sediment with efficient process control.

Methods: In this study, some simultaneous effects on PCBs in the fine sediments, caused by Fenton – like oxidation with surfactant in contaminated marine sediments, were tested. Hydrogen peroxide was used as chemical oxidation regent for Fenton like reaction. $KMnO_4$ was used to compare efficiency of Fenton-like reagent. Surfactants including Triton X-100, and Tween 80 were used to enhance the solubility of PCBs as washing reagent. A combination of using various concentrations of hydrogen peroxide and surfactants was evaluated to degrade PCBs in contaminated marine sediments. And time-dependent removal efficiencies of various concentrations of hydrogen peroxide were also tested.
The PCBs from sediment were analyzed using a gas chromatograph with a ^{63}Ni electron capture detector (GC- ECD, SHIMADZU). Total PCBs Σ(PCBs), total DDTΣD(DT) and total HCH (ΣHCH) concentrations were reported as the sum of 18 congeners (PCB8, -18, -28, -29, -44, -52, -66, -87, -101, -105, -110, -118, -128, -138, -153, -170, -180, -187), respectively.

Results: A washing treatment of using various concentrations of hydrogen peroxide and surfactants was evaluated to degrade PCBs in contaminated marine sediments and the mean removal efficiency of total PCBs were from 0 to 47 % in the sediment for 1 hour duration of the treatment. The highest removal efficiency was shown in the fine sediment (<32 μm) treated 15% hydrogen peroxide and 0.05% Tween 80 among various concentrations of hydrogen peroxide and surfactants. In case of 63-125 μm of the sediment size fraction, 1% hydrogen peroxide and 0.05% Tween 80 also showed the highest removal efficiency of total PCBs. Most of treatment conditions were tested for from 10 minutes to 24 hour and the sediments treated for 24 hour yielded the highest degradation rate of total PCBs in tested contaminated sediment. The level of tPCBs in treated marine sediment by the combination of hydrogen peroxide and Tween 80 satisfy the government regulatory limit of tPCBs for remediation of contaminated harbor marine sediments in South Korea. From these findings, we are currently designing bench scale pilot system to develop a commercial system to be used in harbors around the nation.

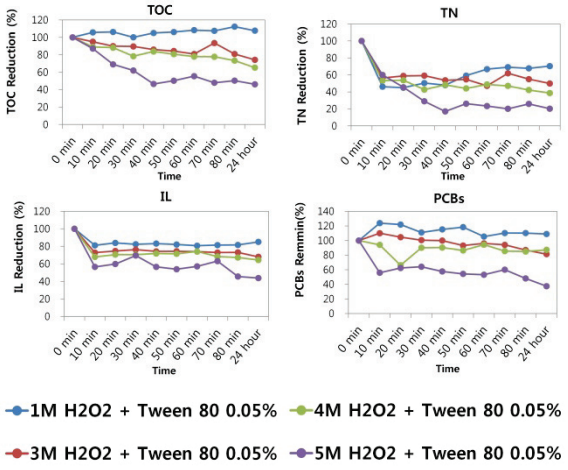

Fig. 1: OMs and PCBs Removal efficiency of 1, 3, 4, 5M H_2O_2 + 0.05% Tween 80

Discussion: Based of this research, the efficiency of the chemical oxidation enhanced by surfactant of PCBs in marine sediment, including the properties of the specific PCBs. PCBs removal efficiency in contaminated marine sediment with Fenton oxidation (H_2O_2) was comparable with $KMnO_4$ which is effective oxidizer for remove organic contaminants in soil. The most efficient treatment solution for destruction of PCBs in marine sediments was 5 M H_2O_2 + 0.05% Tween 80 solutions during the treatment time. The more the sediments are treated by Fenton's regent for longer time, the more PCBs can be destructed till 24 hours.

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