A Study on Biodegradation Capability and Microbial Community Dynamics using Permeable Reactive Barriers

陳立軒、林啟文

E-mail: 9601240@mail.dyu.edu.tw

ABSTRACT

The purposes of this study are to evaluate the bioremediation capabilities using two laboratory-scale permeable reactive barriers (PRB) in a BTEX-contaminated groundwater, and to explore the changes in microbial community in the reactor by using PCR-SSCP. The bioremediation capabilities were evaluated by introducing biostimulation (addition of oxygen-releasing materials and nitrogen) and bioaugmentation (addition of BTEX-degrading cultures). A relationship among biodegradation capability, changes in microbial community and total plate count of microorganisms was determined. Results of oxygen-releasing materials in laboratory column tests indicates that the oxygen release rates increase with the addition of CaO2 and achieve a constant value of 0.22 mg O2-day-1 g-1-ORC while increasing CaO2 to 30 % – 60 %, thereby revealing that the linear relationship between oxygen release rates and addition of CaO2 is not consistently observed while keeping increasing CaO2. Moreover, it is found that the total packing amounts of ORC and inlet flowrate had no significant effects on oxygen release rate and the ORC releasing system could consistently release oxygen for at least thirty five days. Results of the permeable reactive barriers show that (1)the removal capability for BTEX decreases in the order of ethylbeneze, p-xylene, toluene, benzene for both nitrogen addition and no nitrogen addition under BTEX concentrations at 30 mg l-1; (2)the removal efficiency of PRB is higher in the nitrogen addition condition for biostimulation comparing with no nitrogen addition condition, and an increased pattern for removal was observed during the bioaugmentation process; (3) the BTEX removals for nitrogen addition and no nitrogen addition are 52.4 % and 38.9 % for benzene, 72.3 % and 51.6 % for toluene, 80.2 % and 71.4 % for ethylbenzene, and 72 % and 71 % for p-xylene; (4)the amount of dissolved oxygen is found to be inversely proportional to the distance from PRB, as evidenced by the average bacteria densities are two orders higher in a location at 15cm than at 30 cm from the PRB), thereby revealing that the primary aerobic biodegradation zone is in the ranges from 5 to 30 cm downstream of the PRB; (5)the microbial community structure is similar in both the nitrogen addition and in no nitrogen addition conditions, though the removal efficiency of BTEX and the bacteria densities increase, indicating the nitrogen addition stimulates the activity of microorganisms; and (6)determination the relationship among the BTEX removal efficiency, COD, DO, bacteria densities and the microbial community structure provides assistance in evaluating the feasibility of bioremediation using PRB in a BTEX-contaminated groundwater.

Keywords : Bioremediation, Biostimulation, Bioaugmentation, Microbial community structure, Oxygen releasing compound, Oxygen releasing reactive barrier

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