Ⅶ－274 Simultaneous removal of BTX and Nitrate by a bio-electro reactor system

Gunma University Aguirre Carmen,
Gunma University Numata Tomoyuki
Gunma University Watanabe Tomohide
Gunma University Kuroda Masao

INTRODUCTION

The contamination of soil and groundwater by petroleum components such as benzene, toluene and xylene (BTX) is one of particular environmental problems. Biological process is one of the promising techniques for remediation of BTX compounds contaminated soil and water. Some previous researches have reported that BTX compounds are biodegradable under different conditions including denitrifying conditions. However, several factors such as pollutant concentration, active biomass concentration, temperature, availability of inorganic nutrients and electron acceptors, influence the rate and extent of biodegradation of BTX compounds. Considering that BTX compounds can be transformed under denitrifying conditions, simultaneous removal of BTX compounds and nitrate may proceed. In this study, the simultaneous removal of BTX compounds and nitrate by a bio-electro reactor system in which mixed curlture containing denitrifiers were immobilized on the surface of the electrodes was demonstrated. The effect of the electric current on removal of BTX compounds and nitrate was also investigated.

MATERIALS AND METHODS

Procedure

Tranformation of BTX in 32 ml reactors: The transformation of BTX compounds was investigated using 22 ml suspensions culture in 32-ml serum vials sealed with teflon-lined septa , incubated with shaking in the dark at 35°C in an inverted position. A mixed culture of denitrifiers cultivated in our laboratory and activated sludge obtained from wastewater facilities was used as inoculum source. The headspace gas was analyzed by gas chromatography equipped with ECD and FID detector to measured BTX compounds. Because m-xylene and p-xylene have the same retention time, the transformation of p-xylene was not investigated.

Removal of BTX compounds and nitrate in a bio-electro reactor: The schematic diagram is shown in Figure 1. The bio-electro reactor consists of 2 rectangular electrodes used as anodic and cathodic electrodes. The mixed culture mentioned above was immobilized on the surface of the cathodic and anodic electrodes. The removal of BTX compounds and nitrate were investigated by applying an electric current of 0 mA and 10 mA. The microorganisms were immobilized under the following procedure: The above mentioned inoculum source and an aqueous solution containing glucose, acetate, formate, nitrate (C/N=1), BTX compounds (benzene, toluene, o-xylene and m-xylene at 10 mg/l nominal initial concentration) and mineral solution containing K_2HPO_4, KH_2PO_4, NaCl, $MgSO_4.7H_20$, $CaCl_2$, $FeCl_3.6H_20$, $(NH_4)_2C0_3$ were fed into the bio-electro reactor. An electric current of 10 mA was also applied in order to acclimatize the immobilized microorganisms to electrical condition After nitrate was completely removed, part of

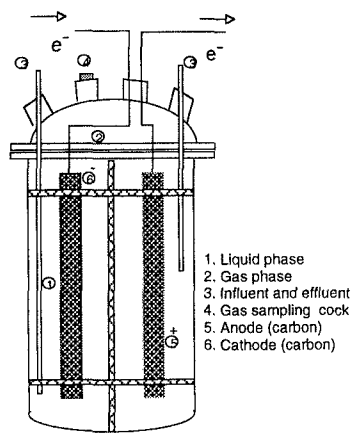

Fig. 1. Schematic diagram of a bio-electro reactor.

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Dept. of Civil Eng. Gunma Univ., 1-5-1 Tenjincho Kiryu 376, 0277-30-1630 (Tel) 1601 (Fax)

the solution was drained and aqueous solution as that described previously was fed. The reactor was operated under semi-batch conditions for 2 months. After corroborate the formation of the biofilm on the surface of the electrodes, the suspend solution contained in the bio-electro reactor was completely drained and a new solution containing BTX compounds (10 mg/l each), nitrate, mineral constituents but not organic substrates (glucose, acetate, formate) was fed. Previous to evaluation of the ability of the microorganisms immobilized on the surface of the cathodic and anodic electrodes, the bio-electro reactor was operated under semi-batch conditions for 1 month.

RESULTS:

Transformation of BTX compounds by the cultivated mixed culture .

The BTX concentrations in the 32 ml reactor are shown in Figure 2. As can be seen, all the BTX compounds tested could be transformed completely by the cultivated microorganisms. Benzene, toluene and o-xylene were transformed within 3 days and m-xylene was in a period of 6 days.

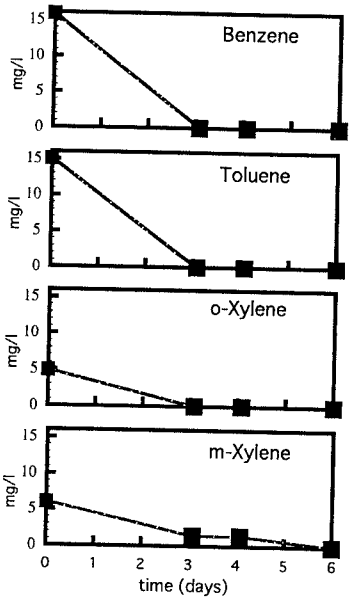

Fig. 2 BTX concentration in a 32 ml reactor.

Removal of BTX compounds and nitrate in a bio-electro reactor.

The removal of BTX compounds and nitrate as well as PH, ORP and DO in the bio-electro reactor at I=0 mA and 10 mA are shown in Figure 3. The transformation of BTX compounds at I= 0 mA was similar to that at I=10 mA. It seems that the electric current at the tested conditions doesn't have any effect on the transformation of BTX compounds. However, in the case of nitrate, the electric current applied has an important influence on nitrate removal. When an electric current of 0 mA was applied, only the 40% of the nitrate initial dose was removed within 3 days. However, when an electric current of 10 mA was applied; nitrate was completely removed in a period of 2 days. ORP, pH and DO don't have any considerable effect. The fact that the peformace of transformation of BTX compounds was similar at the two diferent tested conditions even nitrate removal rate was higher at I=10 mA seems that removal of BTX and nitrate might be independent process under the tested conditions.

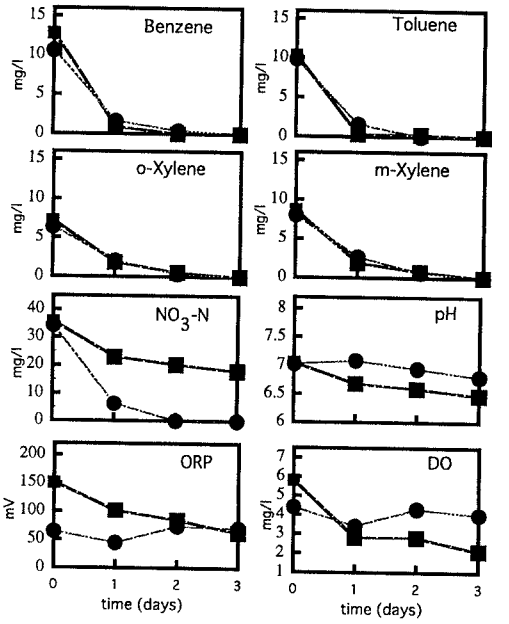

Fig. 3 BTX, NO_3-N, pH, ORP and DO concentration in the bio-electro reactor at ■ I=0 mA and ● I=10 mA.