Studies on Biodegradation Capacity and Inhibitory Effects of Heavy Metals for Methyl Tertiary Butyl Ether-Degrading Cult

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ABSTRACT

The thesis was focused on obtaining MTBE-degrading cultures through acclimation by a laboratory-scale biotrickling filter. Removal of MTBE vapors from air streams in a biotrickling filter was studied under various operating conditions including inlet MTBE concentration, air residence time, liquid recirculation rate, liquid temperature, and flow direction of air-to-liquid. Additionally, the MTBE-degrading pure culture isolated from a biotrickling filter was employed to study the inhibitory effects of heavy metals on the biodegradation of MTBE, and the kinetic characteristics for the pure culture were examined by a batch experiment. With the several months ’ acclimation period, the mixed culture was capable of degrading MTBE with the removal rate of 1—3 mg-MTBE/g-cell ‧ h under suspended growth or attached growth conditions. It was also found that the removal efficiency was up to 77.7%, and the volume elimination capacity was 14.1 g-MTBE/m3 ‧ h in the biotrickling filter. Therefore, it is believed the developed biotrickling filter can be used as a pollution control device for treating MTBE-contaminated air. For the operating conditions investigation, MTBE vapor was found to volatilize to air from liquid phase when the liquid recirculation rate was high. However, MTBE removal increases to 90% when temporarily stop the recirculation liquid feeding. Results of the experiment also indicate that to increase the air residence time will increase the MTBE removal rate, under both co-flow and counter-flow conditions for the air-liquid contact. Of these, operating in co-flow condition was found to give a better MTBE removal. Because the temperature effect on MTBE removal was significant in high temperature operation condition compared to low temperature operation condition, it should be operated in an appropriate temperature environment for the field application. For the aerobic condition of the batch experiment, it was found that MTBE can be degraded completely in ten hours by the pure culture (i.e., 74.5 mg-MTBE/g-cell ‧ h). The kinetic parameters for maximum specific growth rate, the half saturation constant, and inhibitory coefficient were 0.0613 hr-1, 4.95 mg/L, and 158-816 mg/L, respectively. The inhibitory effect of several selected metals on the rate of MTBE degradation under aerobic conditions was tested. The metals considered were Cr3+, Cu2+, Mn2+, Pb2+, and Zn2+. The MTBE degradation was carried out in batch liquid culture with MTBE being introduced in combination with each of the metals. Results showed: (1)inhibitory effect of Cu2+ on MTBE degradation was occurred at low concentration, and MTBE was unable to be degraded at Cu2+ concentration greater than 10 mg/L; (2)the presence of Cr3+, Mn2+, Pb2+, and Zn2+ had no effect on MTBE degradation at their concentrations of 1 mg/L; however, the presence of Cr3+, Pb2+, and Zn2+ had inhibitory effect on MTBE degradation at their concentrations of 10 mg/L; (3)the presence of Mn2+ had no effect on MTBE degradation until concentration as high as 50 mg/L; (4) the magnitude of inhibitory effect follows the pattern of Cu2+ > Cr2+ > Zn2+ > Pb2+ > Mn2+.

Keywords : MTBE ; biotrickling filter ; heavy metals ; kinetic parameter

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