Simultaneous Decomposition of Three Inhibitory Substances as Phenol, m-cresol and Formaldehyde in Biological Fluidized Bed

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Introduction

The wastewater from various chemical plants usually involve more than two components which are toxic and show inhibitory behavior against biological decomposition(Klecka and Maier, 1988; Cooper and Atkinson, 1981). The mixture of phenolic compounds and formaldehyde is a typical example of such wastewater and frequently present in the effluent from chemical plants, ironworks and hospitals. It is necessary to have a through knowledge of mutual interaction between each components for biodegradation before designing the treatment units of such waste waters, since these compounds exhibit the substrate inbition in biodegradation (Sokol, 1988).

The purpose of the present study is to perform the simultaneous decomposition of three inhibitory substances such as phenol, m-cresol and formaldehyde with a three phase fluidized bed and to analyze the treatment characteristics based on uptake kinetics obtained in suspended systems.

Experimental

The fluidized bed reactor used during these studies consisted of a cylindrical acryl column with 4.1cm in inside diameter and 200cm in height. Total volume of unit was 7,500cm^3. Initially, the reactor was filled with about 200g of "granulated slag" particles with the average equivalent

diameter of 0.128cm. Biofilm attachment was carried out by flowing the sludge suspension through the fluidized bed about one week. The most of the effluent from the top of the bed was aerated and recycled to the inlet, and hence the fluidized bed containing suspended particles was applied to the complete mixing tank reactor.

Results and Discussion

The response of a fluidized bed unit against the increase of inlet pollutants concentration was investigated. The experiments were performed by increasing the concentration of one components from 200 to 500g/m^3 at one time abruptly after steady-state operation, while keeping the concentrations of the remaining two components constant. The average residence time of wastewater in the treatment unit was 10h. Before the unsteady-state operation, the influent concentrations of all components were 200g/m^3 and nearly complete removal was accomplished.

From the experimental result, it was found that the mutual interaction between each components was quite different. The formaldehyde decomposition activity was not inhibited by the presence of phenol and m-cresol, but also formaldehyde itself. On the contrary, the decomposition activity of phenolic compounds such as phenol and m-cresol was strongly affected by formaldehyde in addition to the self-inhibition. Further, m-cresol decomposition activity was affected by all three components. The decomposition activity of phenol and m-cresol was dopped by the increase of load at first, but gradually recovered their original activities on the whole. However, the extent of decomposition of m-cresol decreased for a long time and increased gradually after passing the lowest point. The decomposition of phenol was little influenced by m-cresol, while phenol strongly inhibited the decomposition of m-cresol. The effect of formaldehyde on m-cresol decomposition was quite similar to that on phenol. M-cresol is most seriously affected in three components, so it is necessary to avoid excess loading of such material. The recovery behavior of activity against the load increase mentioned above showed that the simultaneous biodegradation of phenolic compounds and formaldehyde could be successfully and stably carried out in a three phase fluidized bed by taking enough residence time.

The experimental result is illustrated in Fig. 1. The steady-state continuous treatment results conducted by changing the inlet concentration

and feed rate of the wastewater are illustrated Fig. 2.

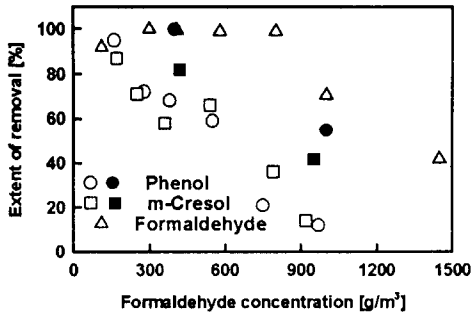

Fig. 1. Effect of feed concentration on removal efficiencies(black keys for phenol and m-cresol mixture).

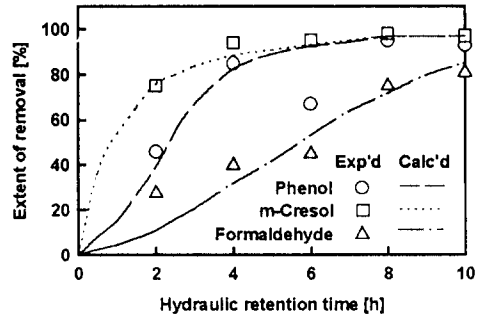

Fig. 2. Effect of hydraulic retention time on the extent of removal at steady state operation.

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