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Coupling ozone and hollow fibers membrane bioreactor for enhanced treatment of gaseous xylene mixture

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HIGHLIGHTS

- This paper reports coupling ozone and hollow fibers membrane bioreactor (HFMBR) to treat VOCs.
- Ozone helps to enhance the max elimination capacity of HFMBR.
- The presence of ozone can avoid the formation of EPS and help stable long-term operation.

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ABSTRACT

Two hollow fiber membrane bioreactors (HFMBRs) inoculated with activated sludge were used in series to biodegrade continuously mixed xylene. The influence of gas residence time (τ) and mass loading rate (LR) on elimination capacity (EC) of the mixed xylene was investigated. A maximum elimination capacity ($EC_{max,v}$) of 466 g m^{-3} h^{-1} was achieved at τ = 10 s and LR_v = 728 g m^{-3} h^{-1}. Thereafter, ozone was introduced into inlet gas and the influence of ozone was investigated. Results showed that the maximum xylene elimination capacity increased from 524 g m^{-3} h^{-1} to 568 g m^{-3} h^{-1} and 616 g m^{-3} h^{-1} at τ = 10 s, respectively when the inlet ozone concentration rose from 200 mg m^{-3} to 400 mg m^{-3} and 600 mg m^{-3}, respectively. HFMBR coupled with O_3 has higher performance and stability for the long-term operation at the same condition.

1. Introduction

Volatile organic compounds (VOCs) are of great concern due to their toxicity, odor pollution and contribution to photochemical oxidants. Some of VOCs such as aromatic hydrocarbon and reactive alkenes have been identified to form ozone through combining with NO_x in the condition of exposure to UV light. Some of VOCs are air toxics and could bring about acute and chronic toxicity to human health and other biological impact through cumulative emission and accidental leakage, particularly in the local area. VOCs have been listed as one of the priority gaseous organic pollutants of chemical, petrochemical and allied industries (Khan and Ghoshal, 2000). Aromatic hydrocarbons, such as benzene, xylene, toluene and ethylbenzene, were the most crucial composition of VOCs because of their higher reactivity and ozone production potential. For instance, in the process of vent and storage tank of paint manufacturer, miscellaneous coating manufacturing, miscellaneous organic chemical production together with processes as well as toluene and xylene have been frequently detected.

The feature of waste gas stream including higher volume, miscellaneous pollutants and low concentration brings more difficulties for cost-effective purification technology. Consequently, biological treatment technique for VOC and odor control has gained tremendous popularity in view of its several advantages in comparison to the traditional physical and chemical methodology, such as incineration and adsorption (Khan and Ghoshal, 2000; Mudliar et al., 2010). The bioreactors applied commonly in industries for odor and VOC removal have three main types including biofilters, biotrickling filters and bioscrubbers (Shareefdeen and Singh, 2005). Although the three types of bioreactors have been extensively investigated and applied in the real waste gas treatment, the conventional biofiltration was also found limitations for VOCs removal. This is because that its operation condition is not stable and the phenomenon of clogging of the medium occurs frequently. Moreover, a large land area is needed for its setup, and so this is often a restriction where a land is costly or not available (Mudliar et al., 2010). Compared to the conventional

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