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Control of Airborne Aromatic Hydrocarbons over TiO2-Carbon Nanotube Composites

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Abstract : Poly vinyl acetate (PVA)-based titania (TiO2)–carbon nanotube composite nanofibers (PVA-TCCNs) with various PVA-to-solvent ratios and PVA-based TiO2 composite nanofibers (PVA-TN) were synthesized using an electrospinning process, followed by thermal treatment. The photocatalytic activities of these nanofibers in the degradation of airborne monocyclic aromatics under visible-light irradiation were examined. This study focuses on the application of these photocatalysts to the degradation of the target compounds at sub-part-per-million indoor air concentrations. The characteristics of the photocatalysts were examined using scanning electron microscopy, X-ray diffraction, ultraviolet-visible spectroscopy, and Fourier-transform infrared spectroscopy. For all the target compounds, the PVA-TCCNs showed photocatalytic degradation efficiencies superior to those of the reference PVA-TN. Specifically, the average photocatalytic degradation efficiencies for benzene, toluene, ethyl benzene, and o-xylene (BTEX) obtained using the PVA-TCCNs with a PVA-to-solvent ratio of 0.3 (PVA-TCCN-0.3) were 11%, 59%, 89%, and 92%, respectively, whereas those observed using PVA-TNs were 5%, 9%, 28%, and 32%, respectively. PVA-TCCN-0.3 displayed the highest photocatalytic degradation efficiency for BTEX, suggesting the presence of an optimal PVA-to-solvent ratio for the synthesis of PVA-TCCNs. The average photocatalytic efficiencies for BTEX decreased from 11% to 4%, 59% to 18%, 89% to 37%, and 92% to 53%, respectively, when the flow rate was increased from 1.0 to 4.0 L min□1. In addition, the average photocatalytic efficiencies for BTEX increased 11% to ~0%, 59% to 3%, 89% to 7%, and 92% to 13% , respectively, when the input concentration increased from 0.1 to 1.0 ppm. The prepared PVA-TCCNs were effective for the purification of airborne aromatics at indoor concentration levels, particularly when the operating conditions were optimized.

Keywords : mixing ratio, nanofiber, polymer, reference photocatalyst
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