Desalination and Water Treatment
www.deswater.com

doi:10.5004/dwt.2019.23654

145 (2019) 11–25
March

Investigation of phenanthrene degradation in a slurry photocatalytic membrane reactor: Influence of operating variables and data validation

C. Nirmala Rani*, S. Karthikeyan

Centre for Environmental Studies, Anna University, Chennai-600025, India, email: nirmalacrani@gmail.com (C.N. Rani), ksingaram@gmail.com (S. Karthikeyan)

Received 31 May 2018; Accepted 19 December 2018

ABSTRACT

A photocatalytic membrane reactor (PMR) was developed indigenously by integrating a flat sheet ultrafiltration (UF) membrane with a slurry UV-TiO_2 photocatalytic reactor for the removal of phenanthrene (PHE). The effect of operating parameters including initial PHE concentration (1000–1500 µg/L), catalyst dosage (0.1–0.9 g/L) and pH (3.0–9.0) on PHE degradation and TOC removal were investigated. The batch study of the integrated process showed 99.3% PHE degradation and 97.2% TOC removal for optimized values (PHE concentration-1000 µg/L, TiO_2 dosage-0.5 g/L and pH-3) during 3 h reaction while the individual processes; UV-TiO_2 (84% PHE degradation and 60% TOC removal) and membrane separation (53% PHE removal) showed lower removal rates for the same experimental conditions. Lowering the initial PHE concentration was found to increase its percentage removal. The degradation rate of PHE during integrated process (UV-TiO_2 + Membrane) was almost doubled than that during solo photocatalytic process (UV-TiO_2). The PHE degradation followed pseudo-first-order kinetics. The agglomerations of photocatalyst particles were measured by dynamic light scattering (DLS) instrument and the sizes were found to vary between 220–1253 nm for the pH range of 3–9. The obtained experimental results were analysed with response surface methodology (RSM) using Design Expert software. The experimental data showed good agreement with the predicted results obtained from statistical analysis.

Keywords: Phenanthrene; Photocatalysis; Degradation; Mineralization; Kinetics; Modelling

*Corresponding author.