

ABSTRACT

Crystal violet (CV) is a cationic dye with mutagenic and carcinogenic properties that poses a potential threat to aquatic environments. Although adsorption is an effective method for dye removal, it merely transfers pollutants from the solution to the adsorbent surface without degrading them. Therefore, this study aimed to synthesize a chitosan-polyvinyl alcohol (PVA)-ZnO:Ag composite membrane that combines adsorption and photocatalysis for the removal of crystal violet. ZnO:Ag was synthesized using the coprecipitation method and subsequently characterized by FTIR, UV-Vis DRS, and XRD. The synthesized ZnO:Ag was then immobilized into a chitosan-PVA membrane with ZnO:Ag loadings of 0.05, 0.10, and 0.15 g. The resulting membranes were characterized using FTIR and Scanning Electron Microscopy coupled with Energy Dispersive X-ray Spectroscopy (SEM-EDX) and evaluated for their physicochemical properties, including weight, thickness, porosity, swelling, water uptake, and hydrophilicity. The results confirmed the successful synthesis of ZnO:Ag, as indicated by the presence of Zn–O and Ag–O bonds in the FTIR spectra, a band gap energy of 2.98 eV, a crystallinity of 97.98%, and an average crystallite size of 24.68 nm. The incorporation of PVA enhanced the membrane porosity, swelling, water uptake, and hydrophilicity, whereas the addition of ZnO:Ag increased the membrane weight and thickness while tending to reduce porosity, swelling, water uptake, and hydrophilicity due to pore filling. The presence of ZnO:Ag in the membrane was confirmed by the Ag–O absorption band in the FTIR spectra, while SEM-EDX analysis revealed the distribution of ZnO:Ag particles on the membrane surface and a denser membrane morphology after application. Among the prepared membranes, Cs-PVA-ZnO:Ag 3 exhibited the highest adsorption-photocatalytic performance, achieving a crystal violet removal efficiency of 86.69%. These findings demonstrate that the chitosan/PVA/ZnO:Ag composite membrane is a promising material for the simultaneous removal and degradation of crystal violet in wastewater treatment.

Keywords: *membrane, chitosan, ZnO:Ag, crystal violet, adsorption-photocatalysis.*