ABSTRACT

Increased activity in the textile industry generates wastewater with high concentrations of dyes and salts, which are difficult to treat using conventional methods due to low efficiency and the potential formation of secondary waste. Loose nanofiltration (LNF) technology offers a promising alternative, as it enables the separation of dyes and salt ions at low operating pressure with high energy efficiency. This study aims to develop an LNF membrane based on polyvinyl alcohol (PVA) and polyacrylic acid (PAA) modified with an Interlayer of oxygen-doped and protonated graphitic carbon nitride (AO-g-C_3N_4) to enhance hydrophilicity, interfacial interactions, and photocatalytic functionality. The membrane was fabricated via a layer-by-layer method on a nylon substrate and crosslinked with glutaraldehyde, with varying Interlayer loadings (1–4 mg). The photocatalytic properties of the material were also comparatively evaluated using an S-g-C_3N_4/rGO model system to elucidate the effect of structural engineering on catalytic activity. Characterization results (XRD, FTIR, SEM, AFM, and UV–DRS) confirmed successful material modification and the formation of a compact and stable selective layer. Electrostatic interactions between positively charged AO-g-C_3N_4 (+20.38 mV) and negatively charged PVA/PAA matrix resulted in effective interfacial densification and improved membrane structural integrity. Under optimal conditions (AOG3), the membrane exhibited excellent separation performance, achieving approximately 99% rejection of Remazol Black B (RBB), maintaining low NaCl rejection (<10%), and a water flux of ~20 L m^{-2} h^{-1} bar^{-1}. Cyclic filtration tests demonstrated high operational stability, where the membrane maintained fouling resistance and self-cleaning capability through in-situ photocatalytic degradation of organic foulants under UV irradiation over five consecutive cycles. The novelty of this work lies in the multifunctional interfacial engineering that integrates dye–salt selective separation, enhanced Interlayer adhesion, and active photocatalytic Self-cleaning capability, validated through a comparative study of two g-C_3N_4 modification systems.

Keywords: *loose nanofiltration, g-C_3N_4, interfacial engineering, dye-salt separation, self-cleaning membrane*

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