Title: Impact of titanium dioxide/graphene in polyvinylidene fluoride nanocomposite membrane to intensify methylene blue dye removal, antifouling performance, and reusability

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Abstract: The development of efficient water purification technologies is a critical research focus driven by the crucial role of clean water sources for ecological sustainability. This study explores the strategic incorporation of nanoparticles within polyvinylidene fluoride (PVDF) membranes as a promising approach to enhance membrane performance for wastewater remediation. PVDF membranes containing varying ratios of graphene (GR) and titanium dioxide (TiO2) nanocomposites were fabricated via phase inversion method. Characterization techniques including XRD, FTIR, and FESEM-EDX revealed that the 80% GR nanocomposite membrane exhibited desirable structural and functional properties with pronounced sponge-like morphology and homogenous nanoparticle distribution. Fourier-transform infrared spectroscopy and x-ray diffraction analysis confirmed the 80% GR membrane retained PVDF crystallinity while uniquely eliminating TiO2 crystallinity. Subsequently, performance testing demonstrated the 80% GR nanocomposite membrane had the highest water flux and methylene blue dye rejection rates compared to other ratios and the pristine PVDF membrane. Both fabricated membranes exhibited sufficient reusability and antifouling properties. However, 80% GR ratio exhibited superior antifouling properties, indicating its potential as an optimal material for improving membrane hydrophilicity and overall water purification technologies. These findings underscore the strategic utility of GR-TiO2 nanocomposites for enhancing PVDF membrane performance in sustainable wastewater treatment applications.

Keywords: Water purification, Nanoparticles, Polyvinylidene fluoride (PVDF) membranes, Graphene (GR), Titanium dioxide (TiO2), Nanocomposites

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