FLOW DYNAMICS ASSESSMENT WITH INTEGRATED 3D PRINTED TURBULENCE PROMOTERS TO MITIGATE MEMBRANE FOULING IN ULTRAFILTRATION MODULE

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ABSTRACT

Rapid population growth increased the consumption of water resources and augmented the amount of wastewater generated. Membrane fouling, a challenge in membrane technology of wastewater treatment, requires innovative solutions for improved efficiency. Addressing this issue is crucial for maintaining filtration efficiency, prolonging membrane lifespan, and reducing operational costs. The study assessed the integration of 3D printed turbulence promoters to improve the efficiency of the ultrafiltration module in treating dairy wastewater. It investigated transmembrane pressure (0.2 - 0.4 MPa), stirring speed (0, 200 & 400 rpm), and membrane cut-off values (10, 20 & 50 kDa), to optimize the ultrafiltration process. Through experiments conducted on lab-scale ultrafiltration equipment using dairy model effluent, the research identifies optimal conditions, including a 20 kDa membrane, 0.3 MPa pressure, and 400 rpm stirring speed. Four different designs of 3D printed turbulence promoters, made from various filament materials (PLA, TPU, Stainless steel, Resin), are tested to assess their impact on permeate fluxes, membrane retention, and total resistance. Results indicate that certain turbulence promoter designs, particularly 'PLA initial' and 'PLA mini', significantly enhance permeate flux and organic retention. Subsequent tests with different printing filaments reveal resin as the most effective material, notably improving both flux and total resistance.

Keywords: Dairy Wastewater, Turbulence Promoters, Ultrafiltration, Membrane Fouling Mitigation, 3D Printed Materials.

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