A Novel All-In-One Membrane for Microplastics Removal, Oil-Water Separation, and Organic Dyes Photodegradation in Wastewater

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Rapid industrial development has led to severe environmental damage and negative impact on human health due to the release of unwanted massive microplastics (diameter < 5 mm), water-soluble organic pollutants, and oils into fresh and marine waters. Despite great efforts are done on wastewater remediation, there is no available technology that is economical, and effective for complex wastewater remediation in a single unit operation. In this study, a novel all-in-one, low-cost photocatalytic TiO2 coated microporous membrane was developed and sandwiched between two vertical glass tubes. The tested membrane integrates (i) gravity-driven oil-water separation resulting in water-rich permeate at the bottom and microplastics-in-oil phase above the membrane as oil-rich retentate, (ii) photodegradation of water-soluble organic pollutants present in the water-rich permeate under UV light irradiation from the permeate side, and (iii) gravity-driven microplastics removal from the oil-rich retentate. This membrane was successfully used to treat feed samples each containing a mixture of microplastics-in-oil and methylene blue dye-contaminated water. Its efficiency of oil-water separation, methylene blue dye photodegradation, and microplastics removal was estimated using thermogravimetric analysis, spectrophotometer, and optical microscope. The results of treating twenty samples showed an average remediation efficiency of ~ 99 % for the three pollutants in a single unit operation including gravity-driven oil-water separation, methylene blue dye photodegradation, and microplastics removal from the oil-rich retentate. This study demonstrates an efficient strategy that may deliver great benefits ranging from small household remediation units to large-scale wastewater treatment plants.

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