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ORIGINAL PAPER

Effect of stretching on continuous oil/water separation performance of polypropylene hollow fiber membrane

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Abstract In this work, polypropylene (PP) hollow fiber membranes were fabricated by thermal-induced phase separation method. The influence of cold-stretched and hot-stretched treatment on the morphology and permeability of the PP hollow fiber membranes was investigated. The results showed that there were cracks and crystalline particulate structures on the outer and inner surfaces of the stretched PP hollow fiber membranes, which were not isolated but linked together through fiber-like connections. Compared to the original PP hollow fiber membrane, the mean pore sizes, the porosities, the hydrophobicity and water entry pressure of the stretched PP hollow fiber membranes improved significantly. When applied in conjunction with a vacuum system, the PP hollow fiber membranes could continuously remove oils from water surface, and separate surfactant-free and surfactant-stabilized water-in-oil emulsions, as well. The initial kerosene fluxes of the hot-stretched PP hollow fiber membrane were higher than that of the membranes prepared from original PP hollow fibers or cold-stretched PP hollow fibers. The permeate fluxes of the hot-stretched PP hollow fiber membrane for all different emulsion separations were higher than those of the original PP hollow fiber membrane. There could be seen no emulsion droplet in the optical micrographs after separation, indicating that the water-in-oil emulsions were effectively separated in one-step method.

Keywords Polypropylene · Hollow fiber membrane · Continuous oil/water separation · Emulsion

Introduction

Oily wastewater is one of the environmental concerns nowadays. Oily wastewater that contains emulsified oil/water mixtures is generated in many industrial processes, such as petrochemical, food, textile, leather, steel and metal finishing [1–3]. The direct discharge of oily wastewater will bring harm to the environment and people's health [4–7]. Separation of emulsified oil/water mixtures is a worldwide challenge. The desirable functional materials that can effectively separate oil/water mixtures were demanded urgently to environmental development and environmental protection.

Based on this, many useful oil absorbents, including inorganic nanowire membrane [8, 9], polymethacrylate oil absorbents [10–12], carbon nanotube [13–15], sponges [16], etc., have been developed extensively. Nguyen et al. [17] reported a facile, inexpensive approach to fabricate graphene-based sponges with superhydrophobicity and superoleophilicity, which could absorb and remove various kinds of oils and organic solvents from water surfaces. Zhao et al. [18] fabricated graphene sponge by hydrothermal treatment of GO suspensions with the assistance of thiourea, where the adsorption capacity of diesel oil could be reached 129 g/g. Fard et al. [19] prepared a novel iron-oxide/CNTs nanocomposite using a wet impregnation technique where the adsorption capacity of doped CNTs was found to be greater than 7 g/g for gasoline oil. Because the oil/water separation process of these

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