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HEADLINE: Tri-Layer Structure Treats Oil-in-Water Emulsions

BODY:

Chemical engineers at China's Sichuan University have fabricated fouling-resistant ceramic-supported polymer composite membranes for the removal of oil-in-water microemulsions. At an operating pressure of 0.4MPa, the membrane permeability remained steady at about 190L/m-2h-1, the oil concentration in the permeate was less than 1.6mg/L-1, and the oil rejection coefficient was always higher than 98.5%. In the Chinese Journal of Chemical Engineering, researchers Wang Shu, **Chu** Liangyin and Chen Wenmei write that the membrane's asymmetric three-layer structure is key to its performance. The composite features a porous ceramic membrane substrate, a PVDF ultrafiltration sub-layer, and a PVA/polyamide composite thin top-layer. The PVDF polymer is cast onto the tubular porous ceramic membranes with an immersion precipitation method, and the PVA/polyamide composite thin top-layer is fabricated using interfacial polymerization.

Irreversible Fouling. Membrane fouling is frequently encountered in the treatment of oil-in-water emulsions found in the food processing, metal fabricating and plating, mining and textile industries. Such oily wastewaters result in fouling that causes a substantial decline in permeability, which may be irreversible. Irreversible fouling is often due to strong physi-sorption and/or chemi-sorption of particles or solutes onto the membrane surface and in its pores Irreversible fouling can become more serious with each treatment and cleaning cycle, due to further adsorption of particles or solutes onto the membrane surface. Cleaning of irreversibly fouled membranes requires harsh chemical and/or high temperature thermal treatments. However, the initial permeability of irreversibly fouled membranes cannot be recovered even with these methods.

Various chemical and physical techniques are employed to modify existing membranes with the goal of improving performance. For oil-removing membranes, surface modification typically is based on the principle that increased hydrophilicity of the membrane surface reduces the adsorption of particles or solutes by inhibiting non-specific binding. Polyvinyl alcohol (PVA) polymer appears attractive for fabricating improved membranes because of its high water permeability, hydrophilicity, good film-forming properties, and its resistance to grease, hydrocarbons, and animal or vegetable oils. PVA also possesses physical and chemical stability against organic solvents. However, PVA because dissolves or/and swells in water (because its solubility parameter is similar to that of water) PVA must be modified when preparing membranes

In their preparation process, the Sichuan scientists introduced a new interfacial polymerization method for making the topmost PVA/polyamide layer, in which the porous membrane substrate was immersed into an organic solution (containing terephthaloyl chloride) first and an aqueous solution (containing piperazine) secondly. By increasing the concentration of either piperazine or terephthaloyl chloride, the flux of the composite increased at first, reached a maximum value, and then dropped; while the oil rejection coefficient increased simply. When both PVA and piperazine were included in the aqueous phase, membrane flux dropped with increasing PVA concentration, but the oil rejection coefficient increased. In their study, the Sichuan researchers found the optimal concentration of piperazine was 15g/L-1 and the optimal concentration of terephthaloyl chloride was 4Og/L-1. Sub-Layer Pore Size. Average pore size and roughness of the sub-layer also are crucial for preparing the composites with satisfactory flux and oil rejection, and the PVDF concentration in sub-layer were found to affect the average pore size and roughness of the film directly. With increasing PVDF concentration, the average pore size of the PVDF film decreased, reducing flux, while increasing the oil rejection coefficient. On the other hand, film surface roughness and average thickness decreased with increasing PVDF concentrations, resulting in increased flux. The engineers report a PVDF concentration of 10% was optimal for obtaining both high flux and high oil rejection.

Contact: Chu Liangyin, School of Chemical Engineering, Sichuan University, Chengdu 610065, China: Tel: +86-28-85460682, Fax: +86-28-85404976, email: chuly @scu.edu.cn

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