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PVA–PSSS membranes for alkali recovery through diffusion dialysis: effect of alkoxysilanes

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ABSTRACT

Poly(sodium-p-styrene-sulfonate) (PSSS) is synthesized by the method of ARGET ATRP, then mixed with polyvinyl alcohol (PVA), and cross-linked with different alkoxysilanes, that is, tetraethoxysilane (TEOS), 3-aminopropyltriethoxysilane (APTS), or γ-glycidoxypropyltrimethoxysilane (GPTS). The obtained flexible cation-exchange membranes have water uptakes (W_R) of 46.8–120.7% and ion-exchange capacities (IEC) of 1.03–1.64 mmol/g. The category of the alkoxysilanes strongly influences the membrane properties. The membrane from GPTS has the highest thermal stability with T_d (temperature at 5% weight loss) of 267.4°C, the highest IEC, and the lowest swelling degree in 65°C water, which is due to the dual cross-linking of Si–O–Si and C–O–C between GPTS and PVA. When applied for diffusion dialysis (DD) process of $NaOH/Na_2WO_4$ mixture, the membranes exhibit excellent alkali flux. The OH^- dialysis coefficients (U_{OH}) are in the range of 0.0072–0.0208 m/h, higher than PVA blank membrane (0.0077 m/h) or commercial poly(2,6-dimethyl-1,4-phenylene oxide)-based membrane (0.004 m/h) (Tianwei Membrane Co., Ltd., Shandong of China). The separation factors (S) are in the range of 16.8–25.7, higher than PVA–PSSS membrane cross-linked with formaldehyde ($S = 8.0$). Hence, the membranes can be potentially applied in DD process for alkali recovery.

Keywords: Polyvinyl alcohol (PVA); ARGET ATRP; Cation-exchange membrane; Diffusion dialysis (DD); Alkali recovery

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