Pervaporation performance of silico-manganese nanohybrid/PU mixed matrix membranes for separation of phenol from water

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ABSTRACT

Preparing a mixed matrix membrane (MMM) is an effective method for modifying pervaporation membranes. In our study, a variety of silico-manganese nanohybrids (SMNH) were prepared and applied for the first time in the modification of a polyurethane (PU) pervaporation membrane. The structure and morphology of SMNH and its MMMs were characterized using Fourier-transform infrared spectroscopy, X-ray diffraction, scanning electron microscope, transmission electron microscopy, contact angles, and Brunauer–Emmett–Teller. Moreover, the separation performances of MMMs were tested for separating phenol from water. Also, the effects of silica content, particle loading, feed temperature, and concentration were investigated. It was found that the mesoporous structures of SMNH particles have good affinity for phenol. SMNH with 30 wt% silica that is prepared via a two-step method (T-Mn-Si(30)) can simultaneously increase permeability and selectivity. In detail, a PU membrane with thickness of 110 μm containing 1 wt% T-Mn-Si(30) and with size of 200 nm can increase flux from 18.6 to 24.7 kg·μm·m⁻²·h⁻¹ with an increase in the separation factor from 9.3 to 15.5 for 0.3 wt% phenol solution at 80°C. Loading more than 1 wt% reduces flux and the separation factor for the special structure of T-Mn-Si(30) that has a tiny fringe. Increasing feed temperature and concentration increases both flux and the separation factor. Therefore, SMNH is an effective modifier for the PU membrane used to separate phenol from water.

Keywords: Pervaporation; Silico-manganese nanohybrid; Polyurethane; Mixed matrix membrane

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