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Two-dimensional MXene incorporated chitosan mixed-matrix membranes for efficient solvent dehydration

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Abstract

Pervaporation dehydration is an energy efficient process for purifying organic solvents, whose application depends on the development of highly permeable and selective membranes. In this work, synthesized two-dimensional $Ti_3C_2T_x$ MXene nanosheets were incorporated into chitosan (CS) to fabricate a new MXene/CS mixed-matrix membrane used for solvent dehydration via pervaporation process. The morphology, chemical structure and surface hydrophilicity of the membranes were studied by SEM, AFM, IR, XPS and water contact angle measurement. Three kinds of organic solvents, ethanol, ethyl acetate and dimethyl carbonate were used for evaluating the membrane dehydration performance. The results indicated that incorporation of MXene nanosheets did not increase the surface sorption, whereas the assembled MXene laminates with interlayer channels greatly enhanced the permeation of water molecular through the membrane. Thus, flux and separation factor of CS membrane were simultaneously improved by introducing the MXene nanosheets. Specifically, the optimized 3 wt% MXene/CS MMM exhibited total flux of ~1.4-1.5 kg/(m^2 h) and separation factor of 1421, 4898 and 906 for dehydration of ethanol, ethyl acetate and dimethyl carbonate at 50 ºC, respectively.

Keywords: MXene, mixed matrix membrane, solvent dehydration, pervaporation, chitosan

1. Introduction

Dehydration of organic solvents such as alcohols and esters, is a key process in chemical industry, but energy intensive by using conventional separation methods. Alternatively, pervaporation technology