**Improved permeability and selectivity in the cellulose acetate membranes by tosylated cellulose nanowhiskers**

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Abstract

The first material utilized for industrial fabrication of membranes is Cellulose acetate (CA). This polymer is a cheap material used in the membrane field, and has a good selectivity for the separation of CO2 from N2; but its low permeability is a weakness. On the other hand, cellulose nanowhisker (CNW) has characteristics such as high crystalinity and polar functional groups on its surface that can improve the useful features of the polymeric membranes. The precursor of CNW is cellulose, a cheap material widely found in nature. We used cotton (a cellulosic material) as the precursor of CNW in the research. Permeability and selectivity of CA nanocomposite membranes were investigated at a pressure of 2 bar and three different concentrations of the Tosylated-CNW (To-CNW) which were 0.25, 0.5 and 1 wt% of nanocomposite. Solution-casting method was used to prepare the membranes and the concentration of the solid material (CA together with To-CNW) in the solvent (THF) was 11.2 wt%. The cast films were allowed to be dried at ambient conditions then in a vacuum oven for two days. Afterward the dense nanocomposite membranes were cut in the circle shapes and placed in the cell of the “pure gas set-up”. The results indicated useful features of the nanocomposite membranes have been improved using To-CNW derived from acidic hydrolysis and tosylation process. The effect of To-CNW content on permeability and selectivity of the prepared membranes is interpreted based on the influence of To-CNW on the CA chain packing because of good interaction between To-CNW and CA polymer matrix. The good interaction is related to existence of polar groups such as hydroxyls and tosyle esters on the surface of To-CNW and, hydroxyl and acetate groups on the CA polymer chains. Disrupting CA polymer chains leads to facilitate the diffusion of penetrants and consequently, increase in permeability. The most permeability and selectivity of penetrants were observed at 1 wt% and 0.5 wt% To-CNW. The polar groups on the surface of To-CNW, tosyle esters and hydroxyls, interact with the polar gas, CO2, and as a result, CO2 has more improved permeability than N2, especially at 0.5 wt%. Therefore incorporation of To-CNW into the CA matrix leads to enhancement in CO2/N2 selectivity which is maximum at the 1% of nanocomposite without a clear drop in selectivity. It should be mentioned that the plasticization effect of CO2 on the membrane shouldn’t be ignored, a phenomenon which is observed due to CO2 permeability increment versus increased pressure in all prepared membranes.