Development of Carboxymethylated Nanocellulose-Ionic Liquid Membranes for CO_2 Capture Under Tunable Humidity Conditions

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The exploration of bio-based polymers for polymeric membranes in carbon capture applications has gained significant attention in recent years. This study investigates the development of a membrane based on carboxymethylated NFC (C-NFC) and 1-ethyl-3-methylimidazolium acetate ([EMIM][Ac]), chosen for its high CO_2 solubility. The highly charged surface of C-NFC ensures homogeneous dispersion of [EMIM][Ac], resulting in a stable water-based system. This work highlights the potential of C-NFC+[EMIM][Ac] membranes for humidity-tunable CO_2 capture, offering a sustainable and efficient solution for post-combustion gas separation.

Single-gas permeation tests (CO_2 and N_2) were performed under humid conditions at 35 °C and 50 °C to assess the effects of relative humidity (RH) and temperature on gas transport properties. Preliminary results show substantial improvements in both CO_2 permeability and CO_2/N_2 selectivity with increasing IL content. At elevated temperatures, a further increase in CO_2 permeability was observed with higher IL loading, suggesting the possible formation of a transient CO_2–IL complex. Notably, N_2 permeability remained consistently low across varying humidity and temperature conditions, indicating a strong affinity of the membrane system for CO_2. With 50 wt% IL loading at 50°C, an optimal selectivity (~300) was achieved at 50% RH—under which NFC-based membranes typically function as gas barriers, highlighting the impact of [EMIM][AC] incorporation.

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