ENHANCEMENT OF CH4 SELECTIVITY BY MIXED MATRIX MEMBRANE INCORPORATED WITH SURFACE-ETCHED AND 3-AMINOPROPYLTRIETHOXYSILANE GRAFTED HALLOYSITE NANOTUBES

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ABSTRACT

In this study, mixed matrix membranes (MMMs) were fabricated from polysulfone (PSf) and inorganic filler which is halloysite nanotubes (HNTs). The embedding of the HNTs gave CH_4 a more difficult gas path thus improving the gas separation. The modified HNTs were tested whether they are effective in reducing the interfacial defects and able to help in improving the overall membrane properties. Prior to the incorporation, the HNTs underwent two types of modifications which are surface-etched which involved alkali etching and silanation with 3-APTES and comparative studies are carried out between these two methods. 1 wt% to 5 wt% of each type of HNTs were embedded in the membranes. Through FTIR it can be seen that the modifications of HNTs have successfully took place which can be confirmed by the presence of peak 1347 cm^{-1} for surface-etched HNTs. This peak caused by hydroxyl vibration which shows the presence of adsorbed water molecules. Besides, the intensity of the bending vibration of the Al-OH is reduced on surface-etched HNTs which is due to the breakage of Si-O bond on the etching site. For the membrane performance after embedded with the modified HNTs, the tensile strength of mixed matrix membrane with modified HNTs shows an increment compared to membranes with raw HNTs. The cross-section images of the membranes were taken by using SEM and it can be seen that lower weight percent of HNTs embedded shows less agglomeration in the membranes compared to the higher percentage of HNTs. Membranes with surface-etched HNTs shows better performance than the other types of HNTs since they have better selectivity compared to the others. It can be concluded that incorporation of lower weight percentage which is 1 wt% of the inorganic filler resulted in a better performance of the membrane since it can easily disperse in the membrane and reduce agglomeration.

ABSTRAK

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Dalam kajian ini, membran matriks campuran (MMM) dibuat daripada polysulfone (PSf) dan pengisi bukan organik iaitu nanotube halloysite (HNTs). Pembenaman HNTs memberikan CH_4 laluan gas yang lebih sukar sekali gus meningkatkan pemisahan gas. HNTs yang diubah suai telah diuji sama ada ia berkesan dalam mengurangkan kecacatan interfacial dan dapat membantu dalam meningkatkan sifat membran keseluruhan. Sebelum pembenamannya, HNTs telah menjalani dua jenis pengubahsuaian iaitu goresan permukaan yang melibatkan goresan alkali dan silanasi dengan 3-APTES dan kajian perbandingan dijalankan di antara kedua-dua kaedah ini. 1 wt% hingga 5 wt% daripada setiap jenis HNTs tertanam dalam membran. Melalui FTIR dapat dilihat bahawa pengubahsuaian HNTs telah berjaya berlaku yang dapat disahkan dengan kehadiran puncak 1347 cm^{-1} untuk HNTs permukaan. Bacaan ini disebabkan oleh getaran hidroksil yang menunjukkan kehadiran molekul air terserap. Selain itu, keamatan getaran lenturan Al-OH dikurangkan pada HNTs yang mengalamai goresan permukaan yang disebabkan oleh kerosakan ikatan Si-O di tapak goresan. Untuk prestasi membran selepas tertanam dengan HNTs yang diubah suai, kekuatan tegangan membran matriks campuran dengan HNTs yang diubah suai menunjukkan peningkatan berbanding membran dengan HNT mentah. Imej keratan rentas membran diambil dengan menggunakan SEM dan dapat dilihat bahawa peratus berat badan HNTs yang lebih rendah yang tertanam menunjukkan kurang aglomerasi dalam membran berbanding dengan peratusan HNTs yang lebih tinggi. Membran dengan HNTs permukaan yang terukir menunjukkan prestasi yang lebih baik daripada jenis HNTs yang lain kerana mereka mempunyai pemilihan yang lebih baik berbanding yang lain. Dapat disimpulkan bahawa pembenaman peratusan yang lebih rendah iaitu 1 wt% pengisi bukan organik menghasilkan prestasi membran yang lebih baik kerana ia mudah tersebar di dalam membran dan dapat mengurangkan aglomerasi.