Formation of asymmetric polysulfone flat sheet membrane for gas separation: Rheological assessment

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Abstract

This study was focused to the effect of shear rate on asymmetric polysulfone membrane structure and gas separation performance. Flat sheet asymmetric membranes were formed using an optimized ternary casting solution. The asymmetric membranes with the molecular-oriented skin layer were prepared by a simple dry/wet phase inversion technique with forced convection using a newly developed pneumatically-controlled casting system. Experimental investigation was conducted focus on different casting speed, thus representing different rheological conditions. Casting speed was varied from 5s to 60s, as known that varying casting speed would vary shear rate. Rheologically induced molecular orientation on the skin layer of membrane was measured using fourier transform attenuated total reflection spectroscopy (ATR-FTIR) to examine if higher shear rate may induce anisotropy at the molecular level of the membrane. These rheological results were then correlated to the gas separation performance in 4 different pure gases. The results indicated that the highly sheared asymmetric membranes tend to exhibit greater molecular orientation in the skin layer. As the casting speed increased, the level of shear experienced on the membrane surface layer also increased, thus leading to greater molecular orientation in the skin layer. Hence, the gas selectivities of O_2/N_2 and CO_2/CH_4 significantly increased with an increased in the shear rate and were greater than that of the recognized intrinsic value.

1. Introduction

Recently, gas separation membrane systems have received a lot of attention from both industry and academia. This is due to the fact that there is a belief that membrane separation processes may offer high separation efficiency, simple operation, more capital and energy efficiency when compared to the conventional separation processes in some applications.

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