THESIS SUMMARY

Abstract

In this proposed study, various modifications in polymer membrane are performed to analyse improvement in the gas transport parameters. Researchers attempted range of samples by various modifications in membrane structure such as blending, filling of micro/nano particles in the polymer matrix, synthesizing mixed matrix membranes etc. The change in free volume due to modification in polymer chains alters directly the transport mechanism. The host polymer used in this work is bisphenol-A polycarbonate. The presented study focusses on the transport behaviour of different gases across the metal coated membrane and compared with that of standard polycarbonate membrane. Deposition of nanolayer affects the transport properties due to the modification in sorption-diffusion process. A Pt-Pd alloy thin film of around 8-10 nm was coated on thick polycarbonate substrate using sputtering technique to make layered polymer nanocomposite membrane. Gases used for the present study were He, H_2, CO_2, O_2, N_2 and CH_4 and the selectivity was calculated for particular gas pairs. Moreover, the effect of CO_2 plasticization under the range of 30 psi to 230 psi upstream pressure has also been analyzed. The modification in the polymeric membrane with the dispersion of inorganic nanofiller can be used for separation of various gases, in particular with hydrogen gas as it is widely used as fuel material. The study also focusses on the transport behaviour of H_2 across the different metal coated and nanocomposite membrane. A Pt-Pd alloy thin film and iridium thin film of around 8-10 nm was coated on polycarbonate substrate using the same sputtering technique to make layered polymer nanocomposite membrane. Moreover, SiO_2 nanocomposites with 10 wt% and 15 wt % were prepared by solution casting method and the uniform dispersion of silica nanoparticles was obtained by sonication before casting the membrane. Pure gas permeability tests were carried at constant upstream pressure 30 psi and at constant temperature 35 °C using constant volume/variable pressure method.

The proposed study is also explored for gas transport through blend polymer membrane with doping of nanofillers within the polymer matrix. The hybridization made using nanofillers in the blend polymer matrix forms no more change in the gas permeation as compared to the polymer blend membranes relative to same blending ratio. But they play vital role in improving gas permeation if composite with single polymer matrix. The same silica nanoparticles are used as filler compositions and polycarbonate as well polysulfone is used as blend polymer matrix. The gas permeability test for H_2 and CO_2 was carried at 30 psi constant upstream pressure and at room temperature by constant pressure/variable volume system established in our laboratory. Oxygen permeability was determined from oxygen transmission rate (OTR) by differential pressure method for gas transmission rate (i-Gastra 7100 Gas Permeability Tester) at Lab Think (Jinan, China) at constant 30 psi upstream pressure and at constant temperature 35 ˚C. Complementary characterizations were applied to study morphological and thermal properties of the composite membranes.

Keywords: Gas permeation and separation, thin film coating, composite membrane, blend membrane, inorganic nanofillers, polycarbonate, Plasticization.

Organization of the Thesis

Chapter 1: Introduction

The study presented includes the effect of membrane modification on transport parameters and provides depth of analytic study by respective characterization techniques. Chapter 1 describes thesis background including research objectives, fundamental theories and literature survey.

Chapter 2: Experimental Techniques

The whole experimental work including membrane fabrication, gas permeation experiments and other analytic characterization are described in this chapter. Various modifications applied during membrane synthesis process are described in this chapter. Moreover, gas permeation tests with different systems such as constant pressure/variable volume and constant volume/variable pressure are also included. The accuracy of constant pressure/variable volume system established in our laboratory during this research work is also explained with detailed analysis in this chapter. The other characterization techniques are explained with the respected instruments used to analyse properties of the developed membranes.

Chapter 3: Gas Transport through Layered Polymer Nanocomposite Membrane

This chapter describes transport behaviour of various gases across the platinum-palladium alloy coated polycarbonate membrane and compared with that of standard polycarbonate membrane. Effect of alloy coating on carbon dioxide plasticization has also been covered in this chapter.

Chapter 4: Hydrogen Transport through Metal Coated and Nanofiller Polycarbonate

The transport behaviour of H_2 across the different metal coated and nanocomposite membrane has been studied with some applied characterization techniques in this chapter. The comparison of metal coating and nanofiller mixed matrix membranes (MMMs) is given by determination of gas flux and

permeability values. The mechanism and hypothesis applied are described with required references. Moreover, the effect of pressure on H_2 transport is studied in this chapter including selectivity. The effect of filler content on hydrogen permeability has also been analyzed in this chapter.

Chapter 5: Gas Permeation through Polymer Blends and Blend Composite Membrane

The effect of blending and blend composite membrane is describe in the Chapter 5. It also includes selectivity of performed gas pairs and comparison of resultant outcomes by various membrane samples. Oxygen transmission rate was also studied in this chapter applicable in the packaging industry.

Chapter 6: Conclusion and Future scopes

Conclusion and the future scope of the proposed research work have been explained in this chapter**.** It also includes the whole resultant summery of the thesis concluding necessary comments.