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Prospect of Mixed Matrix Membrane towards CO_2 Separation

A. L. Ahmad[1]*, Z. A. Jawad[1,2], S. C. Low[1] and S. H. S. Zein[1]

[1]School of Chemical Engineering, Engineering Campus, Universiti Sains Malaysia, 14300 Nibong Tebal, Penang, Malaysia
[2]Nanotechnology and Advanced Materials Research Center, University of Technology, Baghdad, Iraq

One of the major issues haunting environmentalist in both developed and developing countries was the control of anthropogenic carbon dioxide (CO_2) emissions [1]. The development of low-emission fossil fuel technologies combined with the carbon capture and storage (CCS) system has been proposed to reduce the adversities of climate change caused by the emission of greenhouse gases particularly CO_2. Gas separation in this process could be accomplished by either chemical solvent technology or membrane technology. In spite of its popularity, the chemical solvent technology has certain limitations such as expensive operational cost, high heat reaction with CO_2, and corrosive nature of some solvents [2]. In contrast, gas separation using membrane technology provides good benefits such as energy efficiency, utilization of non-toxic chemical, and simple operating procedure that makes it extremely attractive for CO_2 capture [3]. In terms of energy requirements, membrane technology was comparable for the adsorption of flue gases containing 20% or more of CO_2 [4]. Numerous studies have shown the economical benefits of membrane based separation system for a high concentration of CO_2 [5].

In fact, the polymeric membranes have several limitations for gas separation such as low selectivity, high temperature instability, swelling and decomposition in organic solvents [6]. These limitations have led to the development of alternative membrane materials (inorganic membrane) that are synthesized from metal, ceramics or pyrolyzed carbon. Although the properties of some inorganic materials are well above the trade-off curve for polymers, it is challenging to duplicate the enlarge-scale modules containing thousands of square meters of membrane areas due to the expensive of the capital cost. In addition, the brittleness and low surface-to-ratio volume of inorganic membrane are also the challenges to fully optimize its applications for gas separation industries [7].

The improvement of membrane separation properties can be achieved by the development of mixed matrix membrane (MMM). The MMMs are recently getting much attention as an attractive candidate for membrane-based separation [8], where it has a bright future as an alternative to conventional polymeric and inorganic membranes. The incorporation of inorganic components such as zeolite, carbon molecular sieves, and carbon nanotubes (CNTs) into the polymer matrix enable MMM to have the potential to achieve higher selectivity and/or permeability relative to existing polymeric membranes [8-11], as illustrated in Figure 1. MMM is expected to have a good adhesion properties between organic-inorganic composite [12], improved gas separation performance with the thin selective layer [13] and enhanced the mechanical properties of conventional polymeric matrix [7,14]. In the other words, the MMMs possess promising properties compared to the polymeric and inorganic membranes, as some of the properties are briefly summarized in Table 1 [8].

The MMM have the potential to improve the gas separation properties at elevated temperatures and pressures, which attributed by its high separation capabilities (inorganic fillers) and economical processing materials (polymeric membrane). However, the existing polymeric membrane materials are not been fully exploit to inadequate comprehensive research in material science and engineering. The

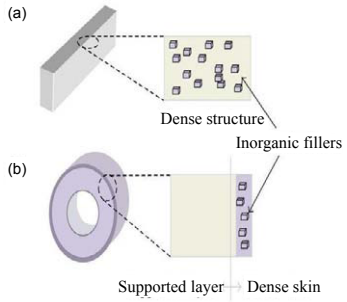

Figure 1: MMMs in configuration: (a) symmetric flat dense, and (b) Asymmetric hollow fiber [7].

Properties		Polymeric Membrane	Inorganic Membrane	MMM
i.	Cost	Economical to fabricate	High Fabrication cost	Moderate
ii.	Chemical and thermal stability	Moderate	High	High
iii.	Mechanical strength	Good	Poor	Excellent
iv.	Compatibility to solvent	Limited	Wide range	Limited
v.	Swelling	Frequently occurs	Free of swelling	Free of swelling
vi.	Separation performance	Moderate	Moderate	Exceed Robeson upper boundary
vii.	Handling	Robust	Brittle	Robust

Table 1: Comparison of the properties for polymeric, inorganic and MMM [8].

enhancement in permeability is at the expense of selectivity, and vice versa. In this regards, future prospects should be focused on the combination of the both polymeric and inorganic materials in order to tailor the high separation permeability and selectivity needed for many high-energy industrial. New MMM developed from cellulose acetate (CA) polymer with good toughness, high biocompatibility as well as high hydrophilic properties posses a great potential to perform

***Corresponding author:** A. L. Ahmad, School of Chemical Engineering, Engineering Campus, Universiti Sains Malaysia, 14300 Nibong Tebal, Penang, Malaysia, Tel: +(604) 5996499; Fax: +(604) 5941013; E-mail: chlatif@eng.usm.my

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high permeability gas separation. At the same time, its selectivity can be improved by the incorporation of the functionalized multi walled CNTs. It is believed this hybrid mixed matrix membrane (CA-CNTs) is able to combine the advantages of both low cost and energy saving in gas separation application.

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References

1. Aaron D, Tsouris C (2005) Separation of CO2 from flue gas: A review. Sep Sci Technol 40: 321-348.
2. Diwekar U, Shastri Y (2011) Design for environment: a state-of-the-art review. Clean Technologies and Environmental Policy 13: 227-240.
3. Bernardo P, Clarizia G (2012) Integrated membrane operations in the ethylene oxide production. Clean Technologies and Environmental Policy 14: 475-485.
4. Favre E (2007) Carbon dioxide recovery from post-combustion processes: Can gas permeation membranes compete with absorption?. J Memb Sci 294: 50-59.
5. Baker RW, Lokhandwala K (2008) Natural Gas Processing with Membranes: An Overview. Ind Eng Chem Res 47: 2109-2121.
6. Shelekhin AB, Grosgogeat EJ, Hwang ST (1992) Gas separation properties of a new polymer/inorganic composite membrane. J Memb Sci 66: 129-141.
7. Goh PS, Ismail AF, Sanip SM, Ng BC, Aziz M (2011) Recent advances of inorganic fillers in mixed matrix membrane for gas separation. Separation and Purification Technology 81: 243-264.
8. Ismail AF, Goh PS, Sanip SM, Aziz M (2009) Transport and separation properties of carbon nanotube-mixed matrix membrane. Separation and Purification Technology 70: 12-26.
9. Jain AK, Acharya NK, Kulshreshta V, Awasthi K, Singh M, et al. (2008) Study of hydrogen transport through porous aluminum and composite membranes. Int J Hydrogen Energy 33: 346-349.
10. Moore TT, Mahajan R, Vu DQ, Koros WJ (2004) Hybrid membrane materials comprising organic polymers with rigid dispersed phases. AIChE Journal 50: 311-321.
11. Itta AK, Tseng HH, Wey MY (2010) Effect of dry/wet-phase inversion method on fabricating polyetherimide-derived CMS membrane for H2/N2 separation. Int J Hydrogen Energy 35: 1650-1658.
12. Mahajan R, Koros WJ (2002) Mixed matrix membrane materials with glassy polymers. Part 1. Polymer Engineering & Science. 42: 1420-1431.
13. Bernardo P, Drioli E, Golemme G (2009) Membrane Gas Separation: A Review/ State of the Art. Ind Eng Chem Res 48: 4638-4663.
14. Cong H, Zhang J, Radosz M, Shen Y (2007) Carbon nanotube composite membranes of brominated poly(2,6-diphenyl-1,4-phenylene oxide) for gas separation. J Memb Sci 294: 178-185.