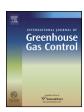


Contents lists available at ScienceDirect

International Journal of Greenhouse Gas Control

journal homepage: www.elsevier.com/locate/ijggc



Review

Current challenges in membrane separation of CO₂ from natural gas: A review



J.K. Adewole^{a,b}, A.L. Ahmad^{a,*}, S. Ismail^a, C.P. Leo^a

- a School of Chemical Engineering, Engineering Campus, Universiti Sains Malaysia, 14300 Nibong Tebal, Seberang Prai Selatan, Pulau Pinang, Malaysia
- ^b Center for Petroleum & Minerals, King Fahd University of Petroleum & Minerals, Dhahran 31261, Saudi Arabia

ARTICLE INFO

Article history: Received 28 August 2012 Received in revised form 9 April 2013 Accepted 20 April 2013 Available online 21 May 2013

Keywords:
Membrane gas separation
CO₂ removal
Penetrant-induced plasticization
Conditioning
Physical aging
Natural gas
Polymeric membrane

ABSTRACT

In recent year, the need for more energy efficient and environmental friendly gas purification techniques has lead to massive research efforts into membrane based gas separation technology. Today, this technology is widely used in removal of CO_2 from raw natural gas components. Penetrant-induced plasticization, physical aging, conditioning and poor balance between permeability and selectivity are some of the major challenges facing the expansion of membrane market in industrial application. A comprehensive review of research efforts in alleviating these problems is required to capture details of the progresses that have already been achieved in developing membrane materials with better CO_2 separation performance.

This paper presents details of recent research progresses that have been recorded in the context of breakthrough and challenges in development of membrane materials. Descriptions of membrane preparation methods that have been investigated to develop membranes with better gas separation performance are discussed.

© 2013 Elsevier Ltd. All rights reserved.

Contents

1.	Introduction		47
	1.1.	Natural gas	47
	1.2.	Polymeric membrane gas separation	47
	1.3.	Fundamental of gas separation in polymer membranes	49
2.	Achie	eving better balance of gas selectivity and permeability	50
3.	Plasti	icization, conditioning and physical aging	50
4.	Techniques for improving separation performance of polymeric membranes		53
	4.1.	Cross-linking and thermal treatment techniques	53
	4.2.	Grafting of polymer backbone	57
	4.3.	Template polymerization and use of porogens	57
	4.4.	Spinning processes and dual-layer hollow fiber spinning	58
	4.5.	Thermal rearrangement	
	4.6.	Phase inversion	60
	4.7.	Sulfonation of polymers	60
	4.8.	Copolymerization and blending	60
	4.9.	Polymers of intrinsic microporosity (PIM)	60
5.	Concl	lusion and recommendations	
	Ackn	owledgements	61
	Refer	rences	61

^{*} Corresponding author. Tel.: +60 45941012; fax: +60 45941013. E-mail address: chlatif@eng.usm.my (A.L. Ahmad).