(56) **References Cited**

U.S. PATENT DOCUMENTS

4,781,889	A	11/1988	Fukasawa et al.	
4,799,936	A	1/1989	Riley	
4,895,774	A	1/1990	Ohzu et al.	
5,019,263	A	5/1991	Haag et al.	
5,110,694	A	5/1992	Nagasubramanian et al.	
5,130,211	A	7/1992	Wilkinson et al.	
5,194,158	A	3/1993	Matson	
5,206,095	A	4/1993	Donado et al.	
5,296,318	A	3/1994	Gozdz et al.	
5,510,209	A	4/1996	Abraham et al.	
5,698,339	A	12/1997	Kawakami et al.	
5,716,527	A	2/1998	Decman et al.	
5,985,475	A	11/1999	Reynolds et al.	
6,083,297	A *	7/2000	Valus et al.	95/44
6,326,326	B1	12/2001	Feng et al.	
6,464,742	B1	10/2002	Leung et al.	
6,846,554	B2	1/2005	Fryxell et al.	
6,929,705	B2	8/2005	Myers et al.	
6,946,015	B2	9/2005	Jorgensen et al.	
7,014,948	B2	3/2006	Lee et al.	
7,740,965	B2	6/2010	Richards et al.	
2002/0050054	A1	5/2002	Noh	
2004/0149127	A1	8/2004	Lyons et al.	
2004/0247996	A1	12/2004	Smith et al.	
2005/0003957	A1	1/2005	Vaughn et al.	
2007/0160898	A1	7/2007	Takamura et al.	
2008/0115667	A1	5/2008	Lee et al.	
2008/0210087	A1 *	9/2008	Ku et al.	95/51
2009/0053594	A1	2/2009	Johnson et al.	
2009/0053607	A1	2/2009	Jeong et al.	
2010/0190043	A1	7/2010	Nakanishi	
2010/0297531	A1	11/2010	Liu et al.	
2010/0304953	A1	12/2010	Liu et al.	
2011/0059355	A1	3/2011	Zhang et al.	
2011/0059364	A1	3/2011	Zhang et al.	
2011/0114254	A1	5/2011	Xu et al.	
2011/0155662	A1	6/2011	Liu et al.	
2012/0180945	A1	7/2012	Zhang et al.	

FOREIGN PATENT DOCUMENTS

JP	2008-036463		2/2008	
JP	2008-36463	*	2/2008	B01D 71/38
WO	WO00/53297		9/2000	
WO	WO2006/049940		5/2006	
WO	WO2006/050531		5/2006	
WO	WO2009/005745		1/2009	
WO	WO2009/013629		1/2009	

OTHER PUBLICATIONS

PCT Application No. PCT/US2011/031342, filed Apr. 6, 2011, 42 pages.

Final Office action from U.S. Patent and Trademark Office for U.S. Appl. No. 12/557,455, mailed Nov. 8, 2012.

Office action from U.S. Patent and Trademark Office for U.S. Appl. No. 12/557,452, mailed Dec. 6, 2012.

International Search Report and Written Opinion for PCT/US2010/035543 (Mailed Dec. 6, 2010).

International Search Report and Written Opinion for PCT/US2010/041213 (Mailed Feb. 8, 2011).

International Search Report and Written Opinion for PCT/US2010/041214 (Mailed Feb. 8, 2011).

Bao, L. et al., "Facilitated transport of CO_2 across a liquid membrane: Comparing enzyme, amine, and alkaline," *Journal of Membrane Science*, vol. 280, pp. 330-334 (Mar. 2, 2006).

Bara, J. et al., "Guide to CO_2 Separations in Imidazolium-Based Room-Temperature Ionic Liquids," *Ind. Eng. Chem. Res.*, vol. 48, No. 6, pp. 2739-2751 (Feb. 11, 2009).

Camper, D. et al., "Bulk-fluid solubility and membrane feasibility of Rmim-based room-temperature ionic liquids," *Ind. Eng. Che. Res.*, vol. 45, pp. 6279-6283 (Aug. 8, 2006).

Chen, H. et al., "Immobilized glycerol-based liquid membranes in hollow fibers for selective CO_2 separation from CO_2-N_2 mixtures," *Journal of Membrane Science*, vol. 183, No. 1, pp. 75-88 (Feb. 28, 2001).

Deng, L. et al., "Facilitated transport of CO_2 in novel PVAm/PVA blend membrane," *J. Mem. Sci.*, vol. 340, pp. 154-163 (May 23, 2009).

Dong, J. et al., "Multicomponent Hydrogen/Hydrocarbon Separation by MFI-Type Zeolite Membranes," *AIChE Journal*, vol. 46, No. 10, pp. 1957-1966 (Oct. 2000).

El-Azzami, L.A. et al., "Parametric Study of CO_2 Fixed Carrier Facilitated Transport through Swollen Chitosan Membranes," *Ind.& Eng. Chem. Res.*, vol. 48, No. 2, pp. 894-902 (Jan. 21, 2009).

Favre, E., "Carbon dioxide recovery from post-combustion processes: Can gas permeation membranes compete with absorption," *Journal of Membrane Science*, vol. 294, Nos. 1-2), pp. 50-59 (Feb. 9, 2007).

Gu, X. et al., "Synthesis of Defects-Free FAU-Type Zeolite Membranes and Separation for Dry and Moist CO_2/N_2 Mixtures," *Ind. Eng. Chem. Res.*, vol. 44, No. 4, pp. 937-944 (Feb. 16, 2005).

Gu, Y. et al., "Ionic liquids-based catalysis with solids: state of the art," *Adv. Synth. Catal.*, vol. 351, pp. 817-847 (Apr. 6, 2009).

Hanioka, S. et al, "CO_2 separation facilitated by task-specific ionic liquids using a supported liquid membrane," *Journal of Membrane Science*, vol. 314, pp. 1-4 (Jan. 24, 2008).

Harlick, P.J.E. et al., "Applications of Pore-Expanded Mesoporous Silicas. 3. Triamine Silane Grafting for Enhanced CO_2 Adsorption," *Ind. Eng. Chem. Res.*, vol. 45, pp. 3248-3255 (Mar. 22, 2006).

Harlick, P.J.E. et al., "Applications of Pore-Expanded Mesoporous Silica. 5. Triamine Grafted Material with Exceptional CO_2 Dynamic and Equilibrium Adsorption Performance," *Ind. Eng. Chem. Res.*, vol. 46, pp. 446-458 (Jan. 17, 2007).

Harris, F. et al., "Solubilities of Carbon Dioxide and Densities off Aqueous Sodium Glycinate Solutions before and after CO_2 Absorption," *J. Chem. Eng. Data*, vol. 54, pp. 144-147 (Jan. 8, 2009).

Huang, J. et al., "Carbon Dioxide Capture Using a CO_2-Selective Facilitated Transport Membrane," *Ind. Eng. Chem. Res.*, vol. 47, No. 4, pp. 1261-1267 (Jan. 16, 2008).

Hwang, K. et al., "Reaction kinetics between carbon dioxide and glycidyl methacrylate using trihexylamine immobilized ionic liquid on MCM41 catalyst," *J. Ind. and Eng. Chem.*, vol. 15, pp. 854-859 (Nov. 25, 2009).

Ilconich, J. et al., "Experimental investigation of the permeability and selectivity of supported ionic liquid membranes for CO_2/He separation at temperatures up to 125° C.," *Journal of Membrane Science*, vol. 298, pp. 41-47 (Apr. 6, 2007).

Kai, T. et al., "Development of cesium-incorporated carbon membranes for CO_2 separation under humid conditions," *Journal of Membrane Science*, vol. 342, pp. 14-21 (Jun. 17, 2009).

Koros, W. et al., "Pushing the limits on possibilities for large scale gas separation: which strategies?," *Journal of Membrane Science*, vol. 175, No. 2, pp. 181-196 (Aug. 10, 2000).

Koros, W. et al., "Pushing the limits on possibilities for large scale gas separation: which strategies?," *Journal of Membrane Science*, vol. 181, p. 141 (Jan. 15, 2001).

Li, L. et al., "Stabilization of Metal Nanoparticles in Cubic Mesostructured Silica and Its Application in Regenerable Deep Desulfurization of Warm Syngas," *Chem. Mater.*, vol. 21, pp. 5358-5364 (Oct. 22, 2009).

Li, Y. et al., "Pervaporation and vapor permeation dehydration of Fischer-Tropsch mixed-alcohols by LTA zeolite membranes," *Separation and Purification Technology*, vol. 57, p. 140-146 (Oct. 1, 2007).

Lin, H. et al., "Materials selection guidelines for membranes that remove CO_2 from gas mixtures," *Journal of Molecular Structure*, vol. 739, pp. 57-74 (Apr. 2005).

Liu, W. et al., "Critical Material and Process Issues for CO_2 Separation from Coal-Powered Plants," *JOM*, vol. 41, No. 4, pp. 36-44 (Apr. 2009).

Luis, P. et al., "Facilitated transport of CO_2 and SO_2 through Supported Ionic Liquid Membranes (SILMs)," *Desalination*, vol. 245, pp. 485-493 (Sep. 15, 2009).