INTENSIFICATION OF CO_2 CAPTURE: CROSS-FLOW MEMBRANE CONTACTOR AND IONIC LIQUIDS

J. Albo, P.Luis, and A.Irabien

Departamento Ingeniería Química y Química Inorgánica. Universidad de Cantabria. 39005 Santander. Spain

Summary

Carbon dioxide capture and storage is a key issue in climate change mitigation. Membrane processes have great interest in gas recovery and ionic liquids have been found to have high solubility capacity for CO_2. In the present study, the application of cross-flow membrane contactors for CO_2 absorption with ionic liquid as absorption liquid is explored. A detailed model is developed allowing the comparison with results obtained when a contactor with parallel flow in countercurrent is considered.

Keywords

Cross-flow hollow fiber membrane contactors, Ionic liquids, Carbon dioxide capture, Modeling.

Motivation

Carbon dioxide (CO_2) is one of the major contributors to the greenhouse effect. The power and industrial sectors combined account for about 60% of the global CO_2 emissions [1, 2]. CO_2 capture and storage (CCS), which involves the processes of capture, transport and long-term storage of carbon dioxide, is a technology aimed at reducing greenhouse gas emissions from burning fossil fuels during industrial and energy-related processes. However, CO_2 capture is the bottleneck step where efforts have to be applied in order to develop technically and economically available processes.

Monoethanolamine (MEA) is used as common absorption liquid for the chemical absorption of CO_2 and its use in combination with a membrane device is being studied in the recent literature [3, 4] because of the number of advantages of membrane processes [5]. However, the volatile character of MEA produces solvent losses due to their evaporation into the gas stream. Thus, the use of solvents with lower vapour pressure such as ionic liquids as absorption liquids may contribute to the performance of a zero solvent emission process. In addition, ionic liquids have been found to have higher solubility capacity of carbon dioxide. [6].

Aims

In this work, mass transfer modelling is carried out for the removal of carbon dioxide absorption into ionic liquids using a cross-flow hollow fiber membrane contactor [7]. In this kind of contactors the concentrations of both fluids vary significantly in both directions i.e. in the direction of flow as well as in the direction normal to the flow and thus the change is bi-axial for both fluids. Experimental validation is carried out and a comparison with the expected results using a membrane contactor with parallel flow is also performed [8, 9].

References

[1] C.-S. Tan, J.-E Chen, Absorption of carbon dioxide with piperazine and its mixture in a rotating packed bed. *Separation and Purification Technology*. **2006,** *49*, 174.

[2] Intergovernmental Panel on Climate Change (IPCC). IPCC special report on carbon dioxide capture and storage. *Cambridge University Press* **2005.**

[3] S.Katja., K.Nijmeijer., M.Wessling. Gas-Liquid membrane contactors for CO2 removal. *J. Membrance Sci.* 340 . **2009**, 214–220

[4] S.Khaisri., D. deMontigny.,P.Tontiwachwuthikul., R. Jiraratananon. Comparing membrane resistance and absorption performance of three different membranes in a gas absorption membrane contactor. *Separation and Purification Technology*. 65, **2009**, 290–297

[5] A. Gabelman, S. Hwang, Hollow fiber membrane contactors. *J. Membrane Sci.*, **1999**, 61-106, 159.

[6] A.N. Soriano, B.T.Doma, JR. Meng-Hui Li. Carbon dioxide solubility in some ionic liquids at moderate pressures. *J. of the Taiwan Institute of Chemical Engineers*.**2009**, 40, 387-393.

[7] V.Y.Dindore, D.W.F. Brilman, G..F. Versteeg. Modelling of cross-flow membrane contactors: Mass transfer with chemical reactions. *J. Membrane Sci.***2005**. 255, 275-289.

[8] Luis P., Garea A., Irabien A., Sulfur dioxide non-dispersive absorption in N,N-dimethylaniline using a ceramic membrane contactor, *J. Chemical Technology and Biotechnology*, 83,**2008**. (11) 1570 – 1577.

[9] Luis P., Garea A., Irabien A., Zero solvent emission process for sulfur dioxide recovery using a membrane contactor and ionic liquids, *J. Membrane Science*, **2009,** 330 (1 – 2) 80 – 89.