

論文 / 著書情報  
Article / Book Information

題目(和文)	
Title(English)	STUDY OF CO2 PERMEATION AND SEPARATION THROUGH IONIC LIQUID MEMBRANE
著者(和文)	JindaratsameePinyarat
Author(English)	Pinyarat Jindaratsamee
出典(和文)	学位:博士(工学), 学位授与機関:東京工業大学, 報告番号:甲第9283号, 授与年月日:2013年9月25日, 学位の種別:課程博士, 審査員:下山 裕介,伊東 章,Wiwut Tanthapanichakoon,関口 秀俊,谷口 泉,松本 秀行
Citation(English)	Degree:Doctor (Engineering), Conferring organization: Tokyo Institute of Technology, Report number:甲第9283号, Conferred date:2013/9/25, Degree Type:Course doctor, Examiner:,,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

(博士課程)  
Doctoral Program

## 論文要旨

THESIS SUMMARY

専攻 : Department of	化学工学	専攻	申請学位 (専攻分野) : Academic Degree Requested	博士 (工学) Doctor of
学籍番号 : Student ID Number			指導教員 (主) : Academic Advisor(main)	下山 裕介
学生氏名 : Student's Name	Jindaratsamee Pinyarat		指導教員 (副) : Academic Advisor(sub)	

要旨 (英文 800 語程度)

Thesis Summary (approx.800 English Words)

The aim of this research is to design the CO<sub>2</sub> separation process by investigating the key parameters that affect the CO<sub>2</sub> permeability and selectivity through ionic liquid membrane. Firstly, an amine/glycol membrane was used as a permeability study to recovery CO<sub>2</sub> from air. The results show good CO<sub>2</sub> permeability but the short duration of membrane is a big problem. Thus, ionic liquids are promoted to be novel chemical for CO<sub>2</sub> capture due to low vapor pressure and high affinity with CO<sub>2</sub>. Therefore, this study mainly focuses on the application of ionic liquid membranes.

Chapter 1 Introduction: explains the background of this research and the motivation. The general descriptions of the CO<sub>2</sub> separation techniques such as adsorption, absorption, cryogenic and membrane separation including the previous works on gas separation using ionic liquid membranes are introduced. The objectives of this study and the framework are also interpreted in this Chapter.

Chapter 2 Preliminary study of CO<sub>2</sub> recovery process from air through amine/glycol liquid membranes: focuses on the use of an amine solution (diglycolamine) mixed with the glycol liquids (ethylene glycol, triethyleneglycol, polyethylene glycol 200 and polyethylene glycol 400) as the liquid membranes to recovery CO<sub>2</sub> from air. The liquid membrane durability, amine concentration and molecular structures of the amine components on the CO<sub>2</sub> permeabilities are investigated. The results show that The highest CO<sub>2</sub> recovery rate is 0.08 g-CO<sub>2</sub> h<sup>-1</sup> using DGA 50%/TEG 50%. The longest durability is around 10 days using DGA 82%/PEG200 18%. CO<sub>2</sub> loading capacity and absorption rate of alkanolamines are in the order of primary alkanolamines > secondary alkanolamines > tertiary alkanolamines. The change of amine species and their concentration affect the CO<sub>2</sub> permeability.

Chapter 3 Effects of temperature and anion species on CO<sub>2</sub> permeability and CO<sub>2</sub>/N<sub>2</sub> selectivity through ionic liquid membranes: concerns the selection of porous membrane to be a supported membrane. The effects of temperature and anion species on CO<sub>2</sub> permeability and CO<sub>2</sub>/N<sub>2</sub> selectivity through ionic liquid membranes are investigated. Six species of ionic liquid: 1-ethyl-3-methylimidazolium tetrafluoroborate ([emim][BF<sub>4</sub>]), 1-butyl-3-methylimidazolium tetrafluoroborate ([bmim][BF<sub>4</sub>]), 1-butyl-3-methylimidazolium bis(trifluoromethylsulfonyl)imide ([bmim][Tf<sub>2</sub>N]), 1-butyl-3-methylimidazolium hexafluorophosphate ([bmim][PF<sub>6</sub>]), 1-butyl-3-methylimidazolium trifluoromethanesulfonate ([bmim][OTf]) and

1-butyl-3-methylimidazolium dicyanamide ([bmim][dca]) are used in this study. The temperatures are varied from 303.15 to 343.15 K. The result suggests that PVDF porous membrane is more suitable than that of PTFE for the preparation of ionic liquid membrane. The permeability results can be explained by solution-diffusion theory. The highest and lowest CO<sub>2</sub> permeabilities are obtained from [bmim][Tf<sub>2</sub>N] and [bmim][PF<sub>6</sub>], respectively. The increase in temperature leads to the enhancement of CO<sub>2</sub> permeability but the selectivity shows the contrast phenomena.

Chapter 4 Separation of CO<sub>2</sub> from the CO<sub>2</sub>/N<sub>2</sub> mixed gas through ionic liquid membranes at the high feed concentration: discusses on other parameters i.e. total pressure difference, CO<sub>2</sub> concentration and the total flow rate at the feed side that influence on CO<sub>2</sub> selectivity and permeability. The temperature was kept constant at 313.15 K for all experiments. The decrease in pressure shows the enhancement of CO<sub>2</sub> permeability due to facilitated transport phenomena but selectivity slightly changes. High CO<sub>2</sub> concentration presents low CO<sub>2</sub> permeabilities because of the carrier saturation. The effect of feed gas flow rate on N<sub>2</sub> permeation was relatively small.

Chapter 5 Effect of water vapor at feed and permeate streams on CO<sub>2</sub> permeabilities through ionic liquid membranes: talks about the improvement of CO<sub>2</sub> permeability by addition of water vapor into the feed and permeate streams. The humid stream shows higher CO<sub>2</sub> permeation than dry feed stream around twice times. The possibility explanation is the change of absorption of CO<sub>2</sub> mechanism leads to the freedom movement of CO<sub>2</sub> molecules in the gel membrane. The presence of water in ionic liquid results in the decrease of solubility coefficient while the increase of diffusivity coefficient is observed. The results of the interaction between water molecules and anion species found that [PF<sub>6</sub>]<sup>-</sup> presented the stronger interaction with water molecules than [Tf<sub>2</sub>N]<sup>-</sup>. The water permeabilities are also measured. The results suggest that [bmim][Tf<sub>2</sub>N] membrane shows low water permeabilities whereas its CO<sub>2</sub> permeabilities is high.

Chapter 6 Prediction of the membrane area and amount of CO<sub>2</sub> mole fraction at permeate for CO<sub>2</sub> separation process: presents the computational simulations in order to optimize the required membrane area, estimate the target amount of CO<sub>2</sub> mole fraction at permeate side and predict the percent reduction of membrane area by using the experimental results from Chapters 3 to 5. The results from this simulation show that changing some key parameters result in the significant decrease in membrane area. The optimum membrane area depends on the operating conditions case by case.

Chapter 7 Summary of the research: concludes the overall results and suggests the recommendation points for the future works. The recommendations contains: improvement of the impregnation of ionic liquid into porous membrane, prediction of gel membrane viscosity and fundamental study for SO<sub>2</sub> removal unit in the industry.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 2 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 2 copies of 800 Words (English).