UNIVERSITI TEKNOLOGI MARA

# EQUILIBRIUM SOLUBILITY OF CARBON DIOXIDE IN AQUEOUS N-BUTYL-3-METHYLPYRIDINIUM TETRAFLUOROBORATE, 2 - AMINO-2-METHYL-1-PROPANOL AND THEIR MIXTURES

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## CONFIRMATION BY PANEL OF EXAMINERS

I certify that a Panel of Examiners has met on 18th November 2015 to conduct the final examination of Syamila binti Nordin on her Master of Science thesis entitled "Equilibrium Solubility of Carbon Dioxide in Aqueous N-Butyl-3-Methylpyridinium Tetrafluoroborate, 2-Amino-2-Methyl-1-Propanol and Their Mixtures" in accordance with Universiti Teknologi MARA Act 1976 (Akta 173). The Panel of Examniners recommends that the student be awarded the relevant degree. The panel of Examiners was as follows:

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# ABSTRACT

There is an urgent need to find a new solvent that has large capacity of absorption, non-corrosive and require low regeneration energy for $CO_2$ capture. One of the promising chemical solvents which had been recognized to execute the task is mixtures of alkanolamine with ionic liquids. The lack of available literature data on the $CO_2$ solubility in the mixture of alkanolamines and ionic liquids, especially pyridinium based ionic liquids leads to the initiation of this research. In this work, $CO_2$ absorption capacity in aqueous 2-amino-2-methyl-1-propanol, (AMP), N-butyl-3-methylpyridinium tetrafluoroborate, $[B_3MPYR][BF_4]$ and their mixtures was measured at pressures from 200 kPa up to 5000 kPa and temperatures of 303.15 K - 333.15 K. The AMP concentration was maintained at 1 M while the $[B_3MPYR][BF_4]$ concentration ranges from 0.05 M, 0.1 M, 0.3 M and 1 M. All of the experiments were conducted in a high pressure jacketed reactor. It was found that $CO_2$ loading capacity increases when the pressure increased. Nevertheless, increasing of temperature will decrease the $CO_2$ loading. From the experimental results, it was shown that the aqueous AMP-$[B_3MPYR][BF_4]$ mixtures have less $CO_2$ absorption capacity compared to single aqueous AMP. In fact, increasing the $[B_3MPYR][BF_4]$ concentration in the mixtures will decrease the $CO_2$ loading. It was observed that 0.05 M $[B_3MPYR][BF_4]$ shows the highest $CO_2$ solubility compared to aqueous AMP alone, or aqueous $[B_3MPYR][BF_4]$ or even in their mixtures of AMP-$[B_3MPYR][BF_4]$, with $CO_2$ solubility reaching 10.86 mol $CO_2$/mol $[B_3MPYR][BF_4]$. A simple correlation, as suggested by Jou and Mather was used to predict the $CO_2$ loading from the experimental results. The predictions of the model were in acceptable agreement with the experimental data where only 16.1% of the overall predicted values deviate more than 20 % compared to the experimental values.

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# CHAPTER ONE
# INTRODUCTION

## 1.1 GENERALITIES

Global warming is one of the main issues that has been a main concern in the world today. Northern hemisphere was reported to experience the most warm 30 years period of the last 1400 years, precisely from year 1983–2012 [1]. The effects of global warming included rise in sea level, glacial retreat and melting of the ice in Antarctic and Arctic specifically [2]. Global warming is caused by the heat trapped of the greenhouse gases and carbon dioxide, ($CO_2$) is recognized as one of the major contributor of greenhouse gases which lead to global warming. This has brought great intention to $CO_2$ capture and sequestration.

The $CO_2$ emission worldwide was 33.4 billion tonnes in 2011 [1]. Since fossil fuel combustion is the major contribution to $CO_2$ emission, the coal consumption increment will lead to the increase in emission of $CO_2$ [3], [4]. Since 2002, the coal consumption's growing rate is 9.7 per year in Malaysia. By the year 2020, emission of $CO_2$ from coal fired power plants is estimated to increase at the rate of 4.1% per year to reach 98 million tons in Malaysia [5].

Carbon capture and storage (CCS) technology is being considered as potential method of restrictive the emission of $CO_2$ in the atmosphere [3]. CCS consist of three steps, namely carbon dioxide capture, transport and storage [6]. There are many technologies to capture $CO_2$, namely post-combustion, pre-combustion, oxy-fuel and chemical looping [7].

$CO_2$ capture facilities in most of the existing commercial are based on wet scrubbing process consuming the aqueous alkanolamine solution. The most commonly used alkanolamines in industry is monoethanolamine (MEA). It was reported that absorption using MEA is the most promising method to capture $CO_2$ for CCS [1]. Other examples of alkanolamines are 2-amino-2-methyl-1-propanol (AMP), methyldiethanolamine (MDEA), diethanolamine (DEA), and triethanolamine (TEA).