CHAPTER I

INTRODUCTION

1.1 Motivations

At present, the global warming caused by emissions of anthropogenic greenhouse gases is one of the most serious environmental problems. Carbon dioxide (CO_2) is the main component of greenhouse gases and an increase in CO_2 at atmospheric level is accelerating global climate change. Global average temperature has increased by 0.6°C per year since 1900, by the end of the twenty-first century; temperature may increase drastically at around 1.4–5.8°C in total (Pipitone and Bolland, 2009). Effects of global warming vary in nature, but they will surely have their global consequences such as changes in weather, sea level rise, etc.

To mitigate climate change, reductions in CO_2 emissions are required. There are many CO_2 reduction approaches including physical, chemical, and biological methods, for example; adsorption by hydrogel membrane and wetted porous material (physical methods) (Ishibashi et al., 1999 and Yokoyama, 2003), absorption by amine process (Je et al., 2009; You et al., 2008; Bai et al., 2005), cyclic carbonation/de-carbonation reactions process (chemical methods) (Abanades et al., 2004b; Wang et al., 2004) and CO_2 biological uptake via photosynthetic living organisms (biological method) (Sydney et al., 2010; Ryu et al., 2008; Huntley et al., 2007), etc. The world's most widely used method is amine process using gas scrubber or absorber to sweetening natural gas and carbonation process for ammonia plant. Among these approaches, the biological method using microalgal photosynthesis is recently considered as an effective method to remove CO_2 from stack or flue gas. By this approach, CO_2 is turned into the form of microalgal biomass by photosynthesis. Most microalgae use CO_2 as an inorganic source for their growth through photosynthetic pathway, and CO_2 naturally is transformed to oxygen, biomass and many useful chemical substances such as lipids and proteins. Due to mass transfer limitation between gas bubble and liquid, CO_2 in gaseous form cannot dissolve well as aqueous solution at a desire rate, and in most cases, CO_2 is freely released to the atmosphere. Other CO_2 transformation is required in an alternative choice which helps sequestrate CO_2 from stack gas.

This study aims to investigate the capture and storage of CO_2 into other inorganic soluble forms such as aqueous CO_2, carbonate and bicarbonate compounds which can potentially be consumed by microalgae, and also to examine the possibility in using this dissolved CO_2, most likely in bicarbonate form, in cultivating microalgae.

1.2 Objectives

The main objective of this work was twofold. Firstly, the work attempted to sequestrate CO_2 by maximizing its dissolution in the special design gas-liquid contactor. Secondly, the use of dissolved carbon dioxide in the form of bicarbonate CO_2 in the cultivation of microalgae, *Chlorella vulgaris*, at various pH ranges was examined.

1.3 Scopes of the research

1.3.1 The determination of optimal conditions for the CO_2 dissolution in bubble columns was performed by varying the following parameters:

- pH level at 6, 8 and 10
- Height of reactor from 1 to 3 meters
- Salinity in a range of 0-30 ppt (parts per thousand)
- Gas flow pathway induced by packing material
- Liquid flow configuration induced by recirculating liquid in the gas-liquid contacting bubble column, using recycle flow in a range of 1-3 LPM (Liters per minute)

1.3.2 The effect of bicarbonate on microalgal growth was examined by initially manipulating pH in range 5-9, and varying initial bicarbonate concentration in the range of 0-200 $mg \cdot L^{-1}$. Furthermore, the algal growth under the addition of CO_2 captured from Section 1.3.1 was also investigated where the efficiency of the cultivation systems was indicated by Cell concentration and Specific growth rate.