CHAPTER I

INTRODUCTION

The greenhouse gases rise in the atmosphere allow incoming solar radiation to pass through, but do not allow solar radiation to reflect back into space. As a result, solar energy is trapped in the atmosphere and acts to warm the Earth's surface. This is known as the "greenhouse effect" and human-caused increases in the concentrations of greenhouse gases are increasing this effect artificially. The greenhouse gases include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). Although, the proportion of the greenhouse gases in the atmosphere appears relatively small, they can still have a big impact on climate change. CO_2 is believed to be the main contributor to the accumulation of greenhouse gases in the atmosphere although there are a number of others such as CH_4, N_2O and halogenated gases that also require consideration.

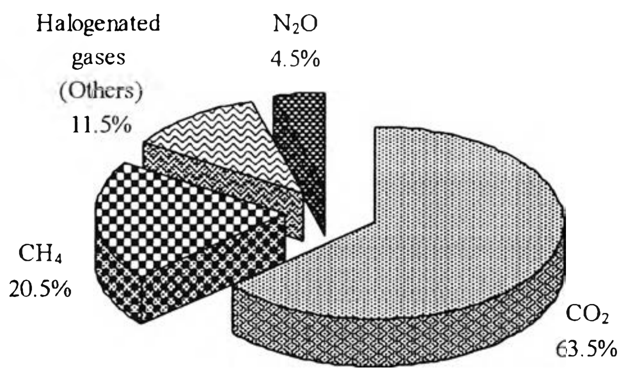

Figure 1.1 Direct contributions due to anthropogenic emissions from pre-industrial times to date (IPCC, 1995)

Some greenhouse gases occur naturally in the atmosphere (e.g. the emissions from volcanoes, forest fires, and biomass decomposition); while others resulting from human activities (e.g. burning of fossil fuels such as coal-fired power plants and automobiles) have become a major concern.

The increased concentrations of CO_2 in the atmosphere and a corresponding increase of other man-made gases might lead to an enhanced greenhouse effect. The consequence is global warming, which is predicted to result in increasing global temperature that will cause global climate change and severe weather conditions. Therefore, it is important to think about possible technologies for dealing with these increased emissions.

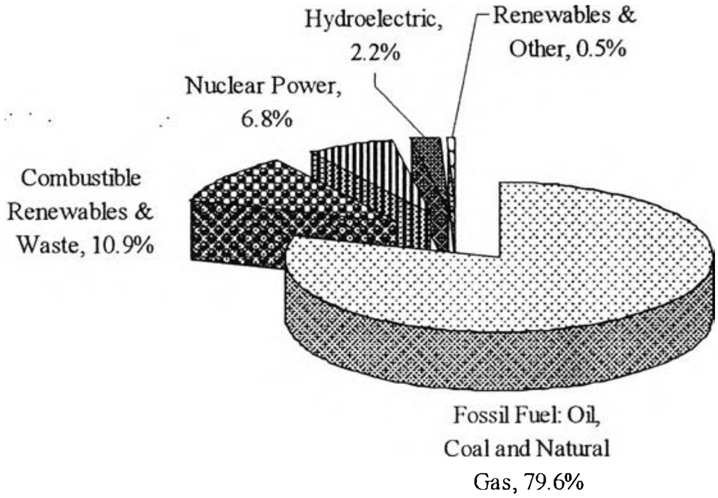

Figure 1.2 World Energy Supply 2002 (IEA, Key World Energy Statistics 2004)

Fossil fuels are responsible for ~80% of the world's energy supply (2002) as shown in Figure 1.2. The combustion of fossil fuels is one of the most significant sources of CO_2 emissions worldwide. Because of concern about the effect of CO_2 emissions on the global climate, as well as the world's great dependence on fossil fuels, the development of strategies for the reduction of CO_2 emissions has become increasingly important. Therefore, the international response to mitigate global warming was to ratify the Kyoto Protocol, in Japan in December 1997. Industrialized countries agreed to cut the CO_2 emissions down to approximately 5% less than the emissions in 1990, in a five year period going from 2008 to 2012. The regulations on CO_2 emissions are coming in the near future.

Although there are several different methods that have been proposed for the capture CO_2 from large point sources such as flue gas from power plants, the only method that has been proven to work on an industrial scale is chemical absorption using monoethanolamine (MEA) as a solvent. In this method, MEA absorbs CO_2 through chemical reaction in CO_2 capture processes. Since the reaction is reversible, the MEA may be recycled through the process. Unfortunately, a major problem associated with chemical absorption using MEA is the degradation of the solvent through irreversible side reactions with CO_2 and other flue gas components such as O_2 and SO_2. MEA degradation causes economic losses, performance losses and potential environmental impacts.

The purpose of this work is to develop a degradation prevention technique using degradation inhibitors and evaluate the effectiveness of degradation inhibitors in minimizing O_2-SO_2 induced MEA degradation in the CO_2 absorption from coal-fired power plant flue gases (i.e. MEA-H_2O-O_2-SO_2 and MEA-H_2O-O_2-SO_2-CO_2 system).