# PREFACE

The major environmental problems related to climate change due to global warming have been emerged in the present era throughout the world. They affect the environment, earth, sea, human being, animals and plants in forms of heat waves, sea-level rise, floods, droughts, storms, plant crop growth alteration, etc. These issues have seen every year due to increased concentration of major greenhouse gas $CO_2$ into the atmosphere because it has been released continuously into the atmosphere from fossil fuel-based thermal power plants, iron and steel industry, cement plant, natural gas processing unit, oil refinery unit, chemical, and petrochemical manufacturing units. As a result, the atmospheric $CO_2$ concentration was reached to 415 ppm in 2018, but the concentration of $CO_2$ was 280 ppm in 1850 (pre-industrial time). Intergovernmental panel on climate change (IPCC) predicts that $CO_2$ concentration will reach to 570 ppm at the end of the twenty-first century resulting in the rise in sea level of 3.8 m and increased in the global average temperature of about 2.1°C with very serious effect on the environment.

To reduce the $CO_2$ concentration level into the atmosphere, amine-based absorption technology is the best option because it is well-established and most matured. In the amine absorption-desorption process, monoethanolamine (MEA) as conventional amine is widely used in the industry for $CO_2$ capture applications. But, high energy required for amine recovery in the $CO_2$ capture process is the major concern of carbon dioxide capture and storage (CCS) implementation at large scale. Recently, the amine blend as a mixture of tertiary amine (DEEA) and diamines can be the alternative option to overcome the limitations of a single amine absorbent for the improved $CO_2$ capture

performance, because tertiary amine requires low regeneration energy and diamine has high absorption capacity and absorption rate.

The resulting research work presented in this thesis has been arranged into separate chapters.

Chapter 1 depicts introduction which includes the major environmental issues and its effect, causes and impact of global $CO_2$ emissions, $CO_2$ reduction techniques, amine absorption technology for $CO_2$ capture, challenges for large scale implementation, amine solvent performance, etc.

Chapter 2 includes literature review related to screening of novel tertiary amines for $CO_2$ capture based on evaluation of absorption-desorption performance parameters, evaluation of DEEA performance for $CO_2$ capture, and screening of DEEA-based amine blends for $CO_2$ capture. The scope and objectives of the present work have also been discussed.

Chapter 3 illustrates detailed screening studies with the help of absorption-desorption experiments for five DEEA-based amine blends such DEEA+AEEA, DEEA+HMDA, DEEA+PZ, DEEA+EDA, DEEA+DMAPA for $CO_2$ capture. The efficient amine blend was selected on the basis of evaluation of performance parameters such as $CO_2$ loading capacity, absorption-desorption rate, $CO_2$ cyclic capacity, regeneration efficiency and the number of regeneration cycles. Then, the equilibrium solubility of $CO_2$ in selected amine blends DEEA+AEEA, DEEA+HMDA and DEEA+EDA were further investigated in subsequent chapters at various operating conditions.

Chapter 4 represents the experimental and modeling studies of equilibrium $CO_2$ solubility in DEEA+AEEA solution. The $CO_2$ solubility in DEEA+AEEA blend with influence of various operating conditions at atmospheric pressure was measured. The experimental results of $CO_2$ solubility was further used to develop an empirical solubility model.

Chapter 5 discusses the experimental and modeling studies of equilibrium $CO_2$ solubility in aqueous mixture of DEEA and HMDA. The $CO_2$ solubility in DEEA+HMDA aqueous mixture at various operating conditions was also measured. The results of $CO_2$ solubility was further used to develop an empirical solubility model. Again, with the help of solubility model, the required solubility data were evaluated within the range of operating conditions. The evaluated solubility data was further used to determine the heat of $CO_2$ absorption in studied blend.

Chapter 6 represents the experimental and modeling studies of equilibrium $CO_2$ solubility in DEEA+EDA solution. The $CO_2$ solubility in DEEA+EDA solution at various operating conditions was measured. The results of $CO_2$ solubility was further used to develop an empirical solubility model. The evaluated solubility data was further used to determine the heat of $CO_2$ absorption in studied blend.

Finally, Chapter 7 summarizes the overall conclusion of the research work. The final efficient amine blends for $CO_2$ capture were selected on the basis of comparison of entire capture performance parameters. The potential recommendations of the present research work have also been presented.

At the end, references of all chapters have been collectively arranged alphabetically according to the surname of the first author followed the institute guideline. The list of the publications and conferences attended arose out of the present work have been attached at the end of the thesis. The required additional informations have been also added in appendix.