technische universität dortmund

Reactive absorption of CO_2 in MEA: A scale-up study

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Introduction

CO_2 removal by reactive absorption

- Post combustion CO_2 capture is one of the most important methods to combat global warming
- CO_2 removal by reactive absorption using amines is a very attractive option to achieve post combustion CO_2 capture
- CO_2 absorption by aqueous Mono Ethanol Amine (MEA) is one of the most widely studied reaction systems
- Most of these studies concentrate on reaction kinetics, laboratory scale absorption and finding alternative solvents for reactive absorption
- Hence, a scale-up study of absorption-desorption system using CO_2-MEA-H_2O is undertaken
- A rate-based model using Aspen Custom Modeler® (ACM) was modified for CO_2-MEA-H_2O system
- The model is currently being validated using the experimental results provided by TU Kaiserslautern

Reaction system

Kinetically controlled reactions

$$CO_2 + MEA + H_2O \rightleftharpoons MEACOO^- + H_3O^+$$

$$CO_2 + OH^- \rightleftharpoons HCO_3^-$$

Equilibrium reactions

$$HCO_3^- + H_2O \rightleftharpoons H_3O^+ + CO_3^{--}$$

$$MEACOO^- + H_2O \rightleftharpoons MEA + HCO_3^-$$

$$2\,H_2O \rightleftharpoons OH^- + H_3O^+$$

$$MEA + H_3O^+ \rightleftharpoons MEA^+ + H_2O$$

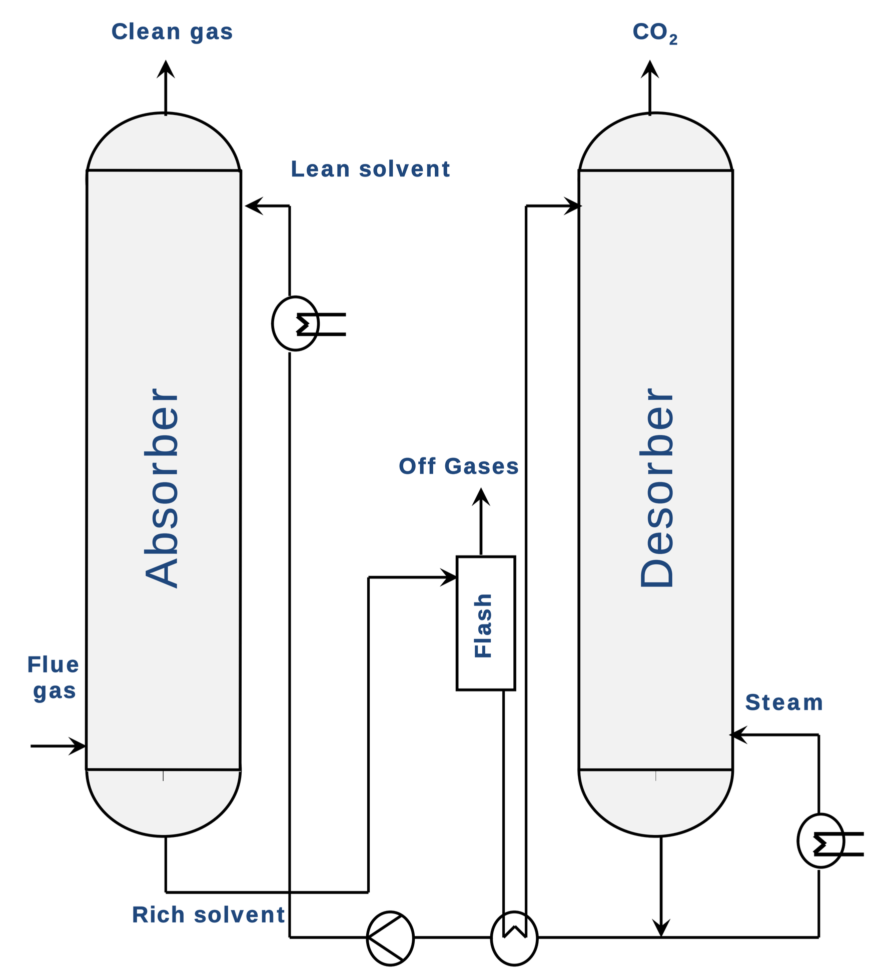

Figure 1: Absorber-desorber system

Approach

Modeling concept[a]

- A rate-based model is used for packed column which includes
  - Thermodynamic non-idealities
  - Heat and multi-component mass transfer
  - Reaction kinetics in liquid phase
  - Influence of column internals and fluid dynamics
  - Cooling effects
- Column discretisation on each stage - liquid film in several segments (fig. 2)
- Stages related by heat and mass balances

[a]: E. Y. Kenig and A. Górak, *Reactive absorption, Ch. 9, Integrated Chemical Processes*, Wiley-VCH, 2005.

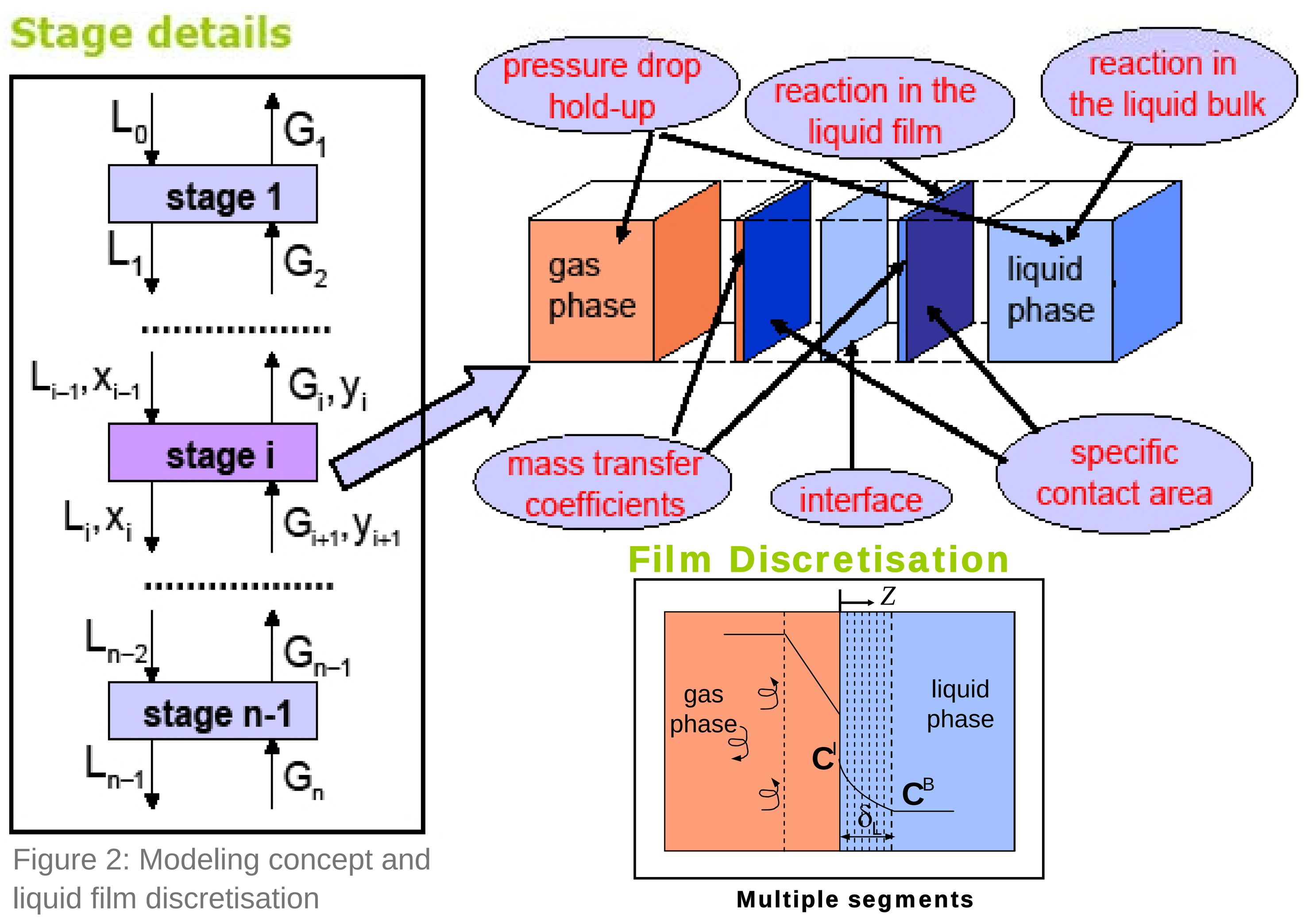

Figure 2: Modeling concept and liquid film discretisation

Results and Future Work

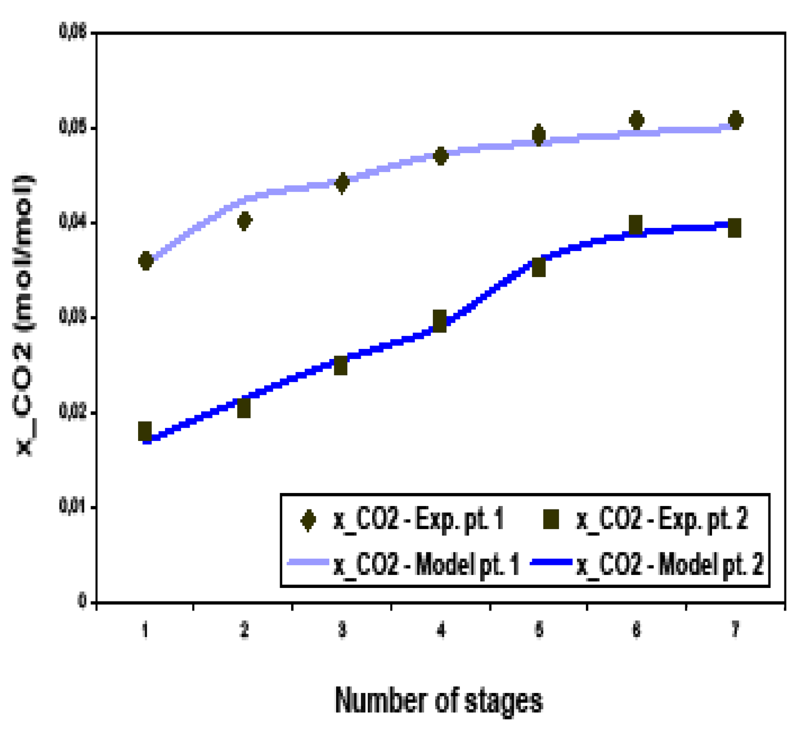

Figure 3 : Comparison of experimental and calculated concentration profiles of CO_2 in MEA

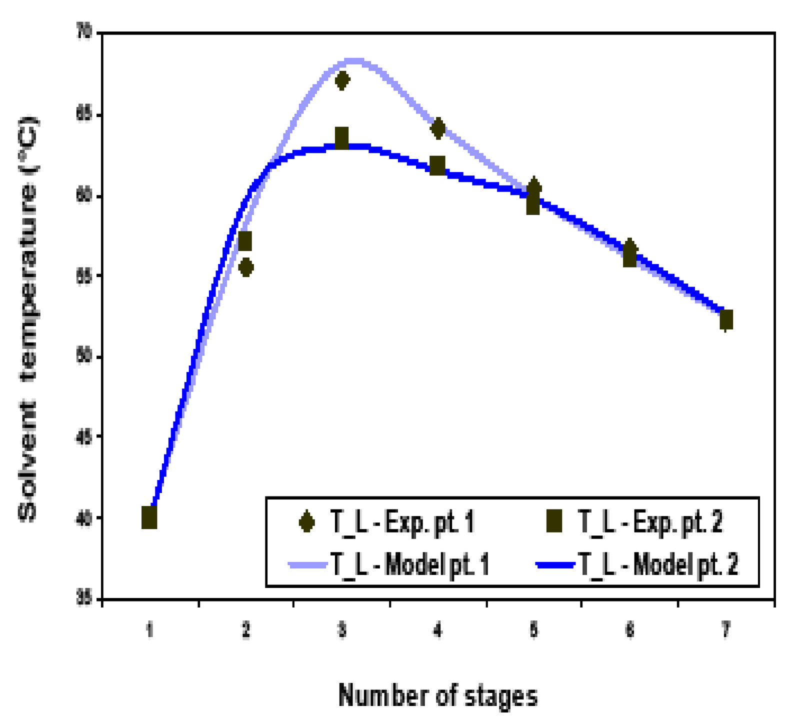

Figure 4 : Comparison of experimental and calculated temperature profiles of solvent in the absorber

Results

A good agreement was seen between the predicted values by the model and experimental results.

Future work

- Validation of the model for desorber
- Experiments on laboratory and pilot plant scale absorption-desorption system
- Scale-up studies using results from experiments and the model

Further important parameters

Column diameter	- 0.125 m
Total packing height	- 4.2 m
Packing	- Sulzer Mellapak 250Y
Mass transfer correlations	- Billet and Schultes (1999)
Gas capacity factor	- Experiment 1: 1.64 [$Pa^{1/2}$]
	- Experiment 2: 2.15 [$Pa^{1/2}$]

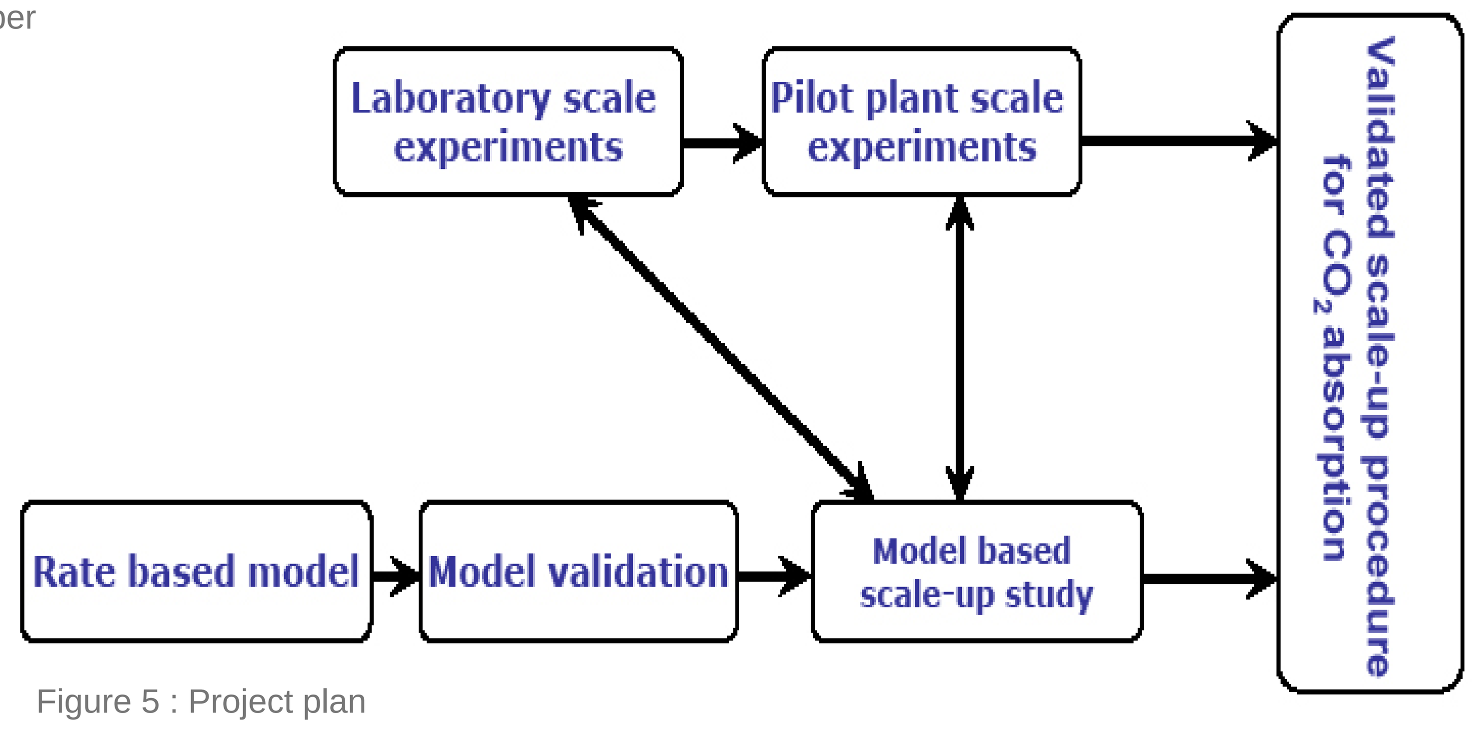

Figure 5 : Project plan

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