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The elimination of gas contaminations, such as CO_2 and H_2S, from synthesis gas streams is an important operation in gas treatment. For this purpose, the reactive absorption is mainly applied. Reactive absorption is a suitable and advanced technology, which represents an up-to-date integrated operation comprising chemical reaction and separation. The application of reactive absorption has become important for the gas cleaning up to high purities. Compared to physical absorption (without reactions), reactive absorption is often advantageous, as it is able to provide high solution capacity at moderate partial pressures and without requiring large amounts of solvent; hence, it can be seen as an intelligent technological solution.

However, reactive absorption is coupled with the solvent regeneration, the latter being a very energy demanding process. This is because high reboiler heat duties are required to regenerate the solvent, which, in fact, is the main disadvantage of this technology. The energy requirement strongly depends on the CO_2 loading, operating conditions (temperature and pressure) and the type of column used (diameter, height), as well as on the kind of internals used. Also, the characteristics of the solvent (usually primary, secondary or tertiary amines) have an essential influence on the energy, which is required for its regeneration.

The energy requirement can be reduced by replacing solvents consisting of primary amines by tertiary amines. For example, monoethanolamine (MEA) is a primary amine with high reactivity and low raw material cost, which is widely used in CO_2 absorption processes. However, the maximum CO_2 loading in MEA is limited by stoichiometry by 0.5 mole of CO_2 per mole of amine. Methyldiethanolamine (MDEA) is a tertiary amine providing a better loading capacity (1 mole of CO_2 per mole of amine) in comparison to MEA. In addition, a lower heat of reaction with CO_2 leads to a decrease of energy required for solvent regeneration. Considering both enthalpies of absorption of MEA and MDEA, i.e. 88 and 60 kJ/mol CO_2, respectively, a theoretical energy savings potential of approximately 30 % can be achieved.

An application of such a process improvement can be identified in unit 3 (WP5 Deliverable D5.3) of the demo plant. For this purpose, a rate-based model for the simulation of CO_2 absorption processes was developed within WP2 (Deliverable D2.1). The model was used to evaluate the technical feasibility and energy savings potential, in terms of required low pressure (LP) steam, for a solvent replacement in reactive absorption processes. Detailed information regarding the model can be found in Deliverable D2.1.