Design and simulation of rate-based CO2 capture processes using carbonic anhydrase (CA) applied to biogas

Today the mix of the energy sector is changing from reduction of CO2 emission from fossil fueled power industry into a general focus on renewable industry which is emitting less greenhouse gases. Renewable fuels like biomass for electricity production or biogas for bio-methane production have a potential to create negative emissions using bio-energy carbon capture and storage (BECCS).

All sectors are still in the need for applying more sustainable carbon capture and storage (CCS) technologies which result in lower energy consumption while reducing the impact on the environment. Recently several promoters have been developed for solvent based technologies, but there is still a need to develop new approaches which can potentially reduce energy consumption even further. Solvents typically used for CCS have the tendency to form carbamate. They are characterized by the speed at which they react with CO2. Advantageous kinetics results in smaller equipment size. But this is not the only benefit.

In this study we deliberately apply a slow reacting solvent, MDEA (methyldiethanolamine). It is in the category of noncarbamate forming tertiary amines, for the same reason it binds less hard to CO2. The advantage is a noticeably lower regeneration energy compared to primary and secondary amines. As a result the cost for stripping is significantly lower. Reactivated slow tertiary amines are applied in this study with the aim of reducing energy consumption. This is achieved by using carbonic anhydrase (CA) enzymes as additives in the slow solvent. The aim of this work is to develop a rate-based model for tertiary MDEA mixed with various amounts of CA. The results show that the properties for biogas are significantly different compared to air and may need to be treated accordingly accurate. This work proves that the typical mass transfer resistance observed in the biogas phase is low compared to the resistance in the liquid phase. The consequence is a reduced requirement for accurate properties for the biogas and the biogas can easily be modelled as being similar to air. In this work we calculate engine which is capable of BECCS, thereby enabling prevention of CO2 emissions from renewable technologies giving a potential for zero-emission scenarios which can help to reach the new low emission CO2 target set up by COP21.