

Popular science summary of the Ph.D project

CO₂ capture has been identified as a key technology in the fight against the climate crisis. CO₂ capture technology can be integrated in power plants and industrial sites, to rapidly reduce CO₂ emissions. The captured CO₂ can either be permanently stored underground or utilized in the industry. In Denmark, CO₂ capture is rapidly advancing, with multiple full-scale projects in development.

CO₂ capture is typically achieved with a liquid solvent based on chemicals known as amines. The primary downside of amine CO₂ capture is that the process requires large amounts of energy, which increases the operational costs for the technology. Because of these high operational costs, cost-reductions in CO₂ capture has been a major topic for research and development activities.

This Ph.D work investigated CO₂ capture with computational models and experimental work. The experimental work centered around a CO₂ capture testing plant at the Amager Bakke waste-to-energy facility in Copenhagen, Denmark. This CO₂ capture plant can capture 4 tonnes of CO₂ every day and cool it to liquid form for utilization in industry by local consumers.

The results of the Ph.D covered innovative optimization technologies, CO₂ liquefaction and cleaning systems, and environmental challenges related to amine CO₂ capture. The costs could be significantly reduced by implementing heat pumps that recycle heat in the amine unit. An alternative approach that also provided cost-savings was to use heat from the CO₂ capture unit to produce district heating. The costs for liquefying and cleaning captured CO₂ were found to be defined based on the contents of undesirable components in the capture CO₂. Finally, the experimental works found several challenges related to undesirable emission products in the cleaned gas.

The knowledge gained in the project can assist the development of a framework for cost-optimization of CO₂ capture and CO₂ conditioning, underlines the importance of emission prevention systems, and provides recommendations for strategies to reduce the emission of undesirable components.