Chemical Engineering Thesis Defense

Mathematical Modeling of Moisture Swing Sorption in Ion-Exchange Resins (IER) for Passive Direct Air Capture of CO2

School for Engineering of Matter, Transport and Energy

Mohammad Abu Talha

Advisor: Dr. Matthew Green

Abstract

The cost of capturing carbon dioxide (CO_2) from ambient air needs to be greatly reduced if it is to contribute significantly to mitigating climate change. Ion-exchange resin (IER) with quaternary ammonium cation binds CO_2 when dry and releases it when wet, making the process attractive for economical Direct Air Capture (DAC). In this study, a design case basis was developed for a system of collectors capable of capturing 1000 tons/day of CO_2 via moisture swing absorption. The model uses varying weather parameters such as temperature, wind speed, and relative humidity to understand the impact of weather on the sorbent loading, cycle time (capture and regeneration), and net water loss. Two independent isotherm models, namely Flory Huggins and the modified Langmuir isotherm model were used to estimate the water and CO_2 loading of the resin respectively as a function of relative humidity. The capture model suggests a higher capture rate during the summer and daytime (in a diurnal cycle) as the relative humidity is lower. A design optimization model was developed to minimize the capture time and maximize the sorbent loading. The crude rate production and the net water loss can help conduct an economic analysis to determine the cost of carbon capture.

August 31, 2023; 3 PM; DH L1-33;

Zoom Link: https://asu.zoom.us/j/83387471375