Eli Berg
CHEN E3810
Final Blog

CO2 Capture with Carbon and Beyond

In the lab on separations we explored a method for separating CO2 from a gas stream in a packed tower filled with activated carbon. The separation works by adsorption, where CO2 selectively adsorbs to the activated carbon filling the column in an exothermic reaction, resulting in a reaction front traveling up the column which is monitored with thermocouples spaced evenly over the column. The lab scale column allows for the reaction conditions (e.g. temperature, flow rate) to be changed quickly between trials, however as the activated carbon is quite effective at adsorbing CO2 the trials take a significant amount of time as the reaction front travels up the column relatively slowly (~1 hour per trial). The carbon was trivially purified by flowing a pure He gas stream through the column once the column was saturated with CO2.

Our lab setup seemed quite thorough for our desired experiments based on a comparison to a paper published by Pellerano et al. which explored CO2 capture on activated carbon and zeolites as a function of pressure[1]. Their setup included a lab scale packed bed adsorber with thermocouples for monitoring temperature and pressure controls. As this paper also considered zeolites in the same set up, our lab could potentially be expanded to include zeolites as long as this would not add significantly to the time spent on this lab. One crucial difference between our experiment and that of Pellerano et al. is that they spent 24 hours regenerating their activated carbon/zeolites, even though we were able to regenerate our carbon nearly completely in closer to 20 minutes.

Carbon capture is ubiquitous in many industries such as oil and gas and power generation to meet environmental regulations on carbon emissions and avoid catalyst poisoning, and activated carbon is a common adsorbant to this end. The particular set up we use in lab is representative of industrial methods for removing CO2 from flue gas via gas swing adsorption, but more interestingly CO2 removal from the atmosphere via carbon capture has recently been proposed as a method for mitigating the anthropogenic emissions driving climate change. A major innovator in this field is Carbon Engineering, a start up in Canada that recently completed a pilot plant to demonstrate their proposed carbon capture and recycle process. Carbon Engineering does not use activated carbon, but rather monoethanolamine (MEA) as their adsorbant. I think this speaks to the wide array of available carbon capture technologies available, perhaps future labs could look at different separations techniques for CO2 removal from a gas feed. There is certainly enough dead time in the current lab setup to accomodate a second separations set up, so learning about innovation in the carbon capture field in the lab could be really valuable.

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[1] Pellerano M, Pascaline P, Mariem K, Arnaud D. CO2 capture by adsorption on activated carbons using pressure modulation. Energy Procedia 2009; 1: 647-53.