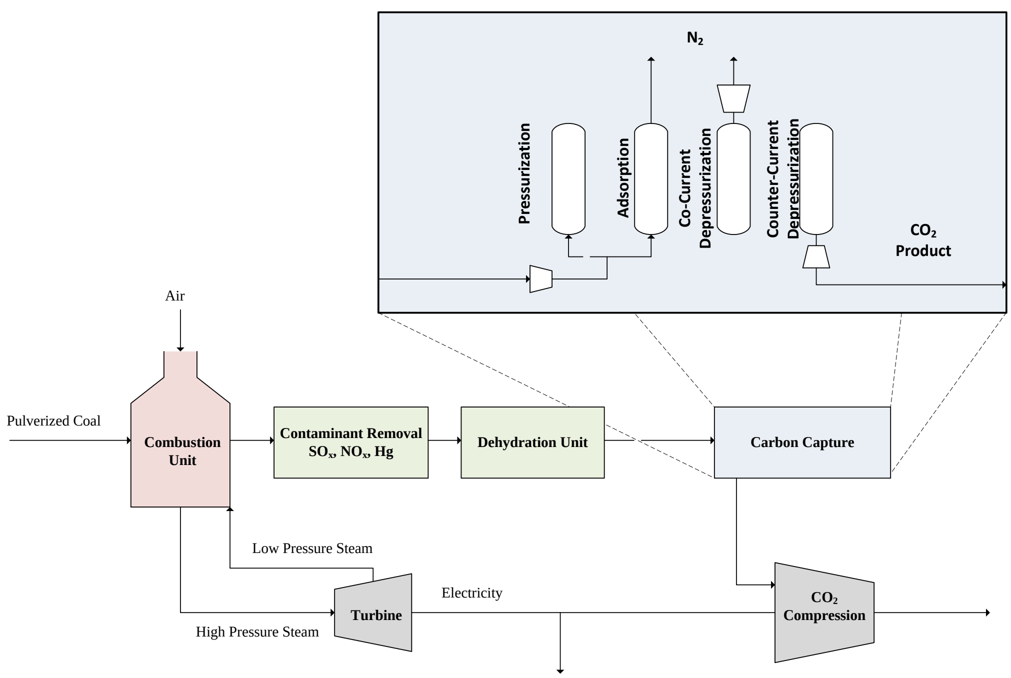
Pressure Swing Adsorption Development utilizing Hydrophobic Materials

Dr. Fengqi You, Roxanne E. and Michael J. Zak Professor
Process-Energy-Environmental Systems Engineering
fengq.you@cornell.edu | you.cbe.cornell.edu

In 2010, 30.6 gigatons of CO2 were emitted into the atmosphere worldwide, with around 38% of the emissions in the US coming from the generation of electricity. To reduce these emissions, there are substantial efforts to develop renewable energy technologies with minimal net carbon emissions. However, over the next few decades, fossil fuels will continue to play an important role in our energy mix. Therefore, there is significant interest in reducing the CO2 emissions from existing power plants via Carbon Capture and Sequestration (CCS). Of all the technologies available for CCS, Pressure/Vacuum Swing Adsorption (PSA/VSA) is perhaps the most promising due to its higher performance and lower energy requirements compared to the other technologies.3 This has led to increased interest in PSA/VSA cycles for carbon capture. However, in the majority of recent publications, the inlet flue gas stream is assumed to contain no water. In reality, flue gas from power plants is usually saturated with water, containing around 3-5 mol%. While some works have looked into humid flue gas, they have utilized hydrophilic adsorbent materials and allowed the first section of the bed to act as the desiccant. However, this leads to additional operating costs associated with deadsorbing the water from the adsorbent. One way to reduce these operating costs is to use hydrophobic materials, which will not adsorb water and only collect CO2.



In order to examine the effectiveness of hydrophobic materials for carbon capture, we will investigate several different hydrophobic adsorbent (e.g. activated carbon, ZIF-8) and calculate the cost of capturing CO2 under dry and humid conditions with a Fractionated Vacuum Pressure

Swing adsorption cycle as a base case. These results will be compared to hydrophilic adsorbents to determine the best hydrophobic material and future directions for adsorbent development. Finally, we will develop a new PSA cycle around the best hydrophobic material in order to minimize cost and maximize the amount of CO_2 captured.