Impact of BECCS in a Fluidized-Bed Gasifier on Carbon Capture Solvent

Joshua Strege (jstrege@undeerc.org), Michael Swanson, Scott Tolbert, and Joshua Stanislowski (Energy & Environmental Research Center, Grand Forks, ND, USA)

Background/Objectives. Bioenergy with carbon capture and storage (BECCS) is one route to achieving net negative CO_2 emissions, either by utilizing 100% biomass or blends of fossil fuel and biomass with sufficiently high blend ratios of biomass. When used with gasification, BECCS has the potential to supply hydrogen while removing CO_2 from the atmosphere. However, conventional precombustion CO_2 capture technologies such as Selexol™ were developed and validated around fossil fuel-derived syngas. Biomass may contain impurities that would negatively impact the performance or life span of conventional CO_2 capture solvents, and biomass gasification could produce unexpected organic tar or syngas components that would accumulate in these solvents. The exact organic and mineral fate from biomass gasification could depend on interactions with specific coal types. As such, the relative performance of CO_2 capture solvents when gasifying different coal types blended with different types and blend ratios of biomass should be explored.

The objective of this project was to perform testing over a 15-week period that established a baseline precombustion carbon capture performance when combined with coal- and biomass-derived gas. The goals were to generate syngas from a matrix of coal, biomass, and blends and to study the potential impact on the CO_2 capture solvent of utilizing various coals, biomasses, and blends.

Approach/Activities. This study utilized a pilot-scale high-pressure fluid-bed gasifier (solid feed rates of approximately 8 lb/hr) with a water–gas shift reactor and treatment to remove particulate, sulfur, and condensable liquids. CO_2 was captured at pressure in an absorber column using a physical solvent based on dimethyl ether of polyethylene glycol. Coals tested included a North Dakota lignite, a Powder River Basin subbituminous, and a Central Appalachian bituminous. Gasification was conducted with 100% coal and with 25% and 50% blends of wood and corn stover. Extensive sampling and analyses were conducted to measure various analytes in the syngas entering and exiting the absorber column and in the recirculated solvent.

Results/Lessons Learned. Changes in fuel and biomass feed ratio had no discernible impact on accumulation of inorganics in the solvent over the course of each week of testing. However, biomass did have a significant impact on the organic content of the product streams and on the accumulation of organics in the CO_2 capture solvent. There were also interactions observed between corn stover and coal type on organic accumulations, indicating that tar production cannot be predicted purely from the biomass ratio of the fuel blend.

Given the short test durations, it is not possible to say what the long-term impacts of inorganics and other species on solvent performance might be. Long-duration exposure would be warranted to better understand how cogasifying biomass with coal might impact CO_2 capture solvent performance.