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HIGH THROUGHPUT BIOMASS CONVERSION IN SUPERCRITICAL WATER AND PRODUCT SEPARATIONS AS AN "END OF PIPE" TECHNOLOGY IN A BIOMASS REFINERY.

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ABSTRACT
At Mizzou's Carbon Recycling Center (CRC), we believe that supercritical water gasification (SCWG) has great potential as "end-of-pipe" technology for producing high-pressure, high-value fuel gas from wet solids including biomass and other carbonaceous residues. We take a non-catalytic approach as we believe catalysts complicate operation and have shown that catalysts are not necessary for full conversion during SCWG. We have demonstrated the broad utility of this approach using our batch reactor and documented unprecedented reaction rates using our continuous reactor. We have observed full conversion of a variety of feed materials including algae, coal, biomass wastes (rice straw, corn cob, and others) as well as several model compounds to go along with gasification rates that are an order of magnitude higher than reported in other SCWG studies. Along with promising results with high throughput conversion, we will present some of the advances in upstream and downstream processing of SCWG that have been made on our continuous SCWG apparatus. These advances bring supercritical fluid technologies closer towards commercialization.

Two of the largest engineering challenges encountered in a biorefinery are: 1) feeding and 2) separations. To address problems with feeding (upstream processing), we have developed a novel feeder capable of precisely delivering a large variety of solid slurries into high-pressure (and high-temperature) environments using fluid power. At the CRC, we use the feeder for continuous SCWG, but the feeder has applications in other supercritical fluid technologies. The feeder has proved capable of feeding slurries over 50% solids (thick pastes) against pressures of over 45 MPa. This feeder is currently used on a laboratory scale, but is amenable to scale up.

Novel work in downstream processing (i.e. separations) during SCWG will also be presented. The main products of SCWG are H_2, CH_4, and CO_2. We have shown that this product mixture forms an equilibrium separation at temperatures at or below ambient and pressures above 20 MPa. Experiments were done in an isolated high pressure equilibrium phase separator. Dense phase CO_2 can be removed from the bottom of the separator and light phase H_2 and/or CH_4 can be removed from the top. In this way, CO_2 is removed during 'carbon capture' leaving a valuable mixture of H_2 and CH_4. Increases in pressure and decreases in temperature increased the separation efficiency. We will soon attempt to demonstrate this equilibrium separation in our continuous SCWG apparatus.