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Upgrading biomass pyrolysis vapors to fungible hydrocarbon intermediate

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NREL's thermochemical biomass conversion research is focused on *ex-situ* catalytic fast pyrolysis also called vapor phase upgrading (VPU) as a potentially efficient and economical route to pyrolysis-based fuel precursors, fuels and chemicals. In this approach, biomass vapors are generated via fast pyrolysis (FP) and destabilizing vapor components (char, inorganics, tar aerosols) are removed by hot gas filtration with the conditioned vapors more amenable to catalytic upgrading via emerging and industrially available zeolites. We use a Davison circulating riser (DCR), a petroleum industry standard, for vapor phase upgrading while a close coupled pyrolyzer system produces consistent pyrolysis vapors as feed to the DCR. Concurrent upgrading catalyst development is focused on identifying and evaluating modifications to ZSM5-based catalysts that increase carbon content of the condensed product while also reducing catalyst coking and increasing deoxygenation activity. After initial vapor upgrading tests, system modifications that were required to efficiently operate the DCR on vapor feedstocks included adding a cyclone to the stripper outlet to return entrained catalyst to the system, adding a total carbon detector to quantify carbon content of both feed vapor and product gas to simplify carbon mass balances, and optimizing catalyst steam stripping to efficiently recover product. Subsequent catalyst screening for vapor upgrading showed marked differences in product composition with catalyst type while similar liquid product was obtained with both mixed hardwood and clean pine feedstocks using the same catalyst and process conditions. Ash, aerosols and char removal were additionally quantified for selected experiments. The work presented here will show 1) the impact on product composition from pure vapor upgrading with a suite of catalysts comprising unmodified, and P- and metal-modified zeolites, 2) comprehensive physical and chemical product composition, 3) and ash and char retention on hot gas filters. These results will be discussed and compared with other work conducted in riser systems to produce biomass derived hydrocarbon fuels.

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