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Upgrading biomass pyrolysis vapors to hydrocarbon fuels and chemicals

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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 and 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 deoxygenating activity. 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 feedstock's using the same catalyst and process conditions. Ash, aerosols and char removal were additionally quantified for selected experiments. The work presented here will show: The impact on product composition from pure vapor upgrading with a suite of catalysts comprising unmodified and P- and metal-modified zeolites; comprehensive physical and chemical product composition; product fuels from hydrotreating; and chemicals from aqueous phase organics. These results will be discussed and compared with other work conducted in riser systems to produce biomass derived hydrocarbon fuels.

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