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Hybrid biomass-methane thermochemical processing for high conversion and selectivity to H_2 and CO: Advances in co-feed conversion systems

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Feedstock hybridization has been shown to increase end-product yields and improve overall process efficiency for fungible liquid fuel production from bio-based resources. Presented is a co-feed thermochemical processing system to non-catalytically covert natural gas and biomass to synthesis gas. At ultra-high temperatures (>1400°C), tar destruction is complete, hydrogen content is elevated, and nearly all of the carbon and oxygen in the system is converted to CO. Experimentally, a 60 kVA was used in an entrained flow configuration with three biomass types: Microalgae, rice hulls, and cotton stalk. Overall carbon conversions were demonstrated at ≥95% and CO selectivity was shown to achieve ≥90%. Out of the reactor, $H_2/CO \approx 2.2$ and $CO_2/CO < 0.1$. With these results, process simulations in ASPEN Plus for a 2000 dry t/d showed a two-fold increase in liquid fuel yield per tonne of input carbon compared to state-of-the-art gasification technologies. Challenges and practical limitations for indirectly-heated gasifiers include materials of construction and severe heat transfer limitations for solid fuel conversion. Operational greenhouse gas emissions, for a once-through process, are at least 40% less than conventional gasification processes, but overall lifecycle GHG are higher due to the natural gas component. However, the economic incentive for this co-feed configuration represents a bridge to truly sustainable fuel production.

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Predicting the effects of climate change on biomass production of loblolly pine plantations across the Southeastern US using the 3-PG model

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The 3-PG model was used to predict the growth under the future climate scenarios. 20 Multivariate Adaptive Constructed Analogues (MACA) down-scaled the climatic simulations which provided the climate data to run the 3-PG model for 36 loblolly pine plantations, distributed across the range. It was previously demonstrated that this model had shown well growth at these sites under the current climatic conditions (Gonzalez-Benecke et al. 2016). We found that, biomass production generally increased under both Representative Concentration Pathways (RCP) 4.5 and 8.5 scenarios for rotations in the near future (years 2025 to 2050) as well as at the end of the century (years 2075 to 2100). However, the relative increment in aboveground biomass was much greater at cooler sites (current mean temperatures between 15 and 18°C) than at warmer sites in the region, i.e., the lower Coastal Plain. In addition, the response to the predicted future climates varied with the site quality. Plantations with a high Site Index (>25m at age 25) showed very little change in the productivity relative to the current baseline climate, and in some cases (warmest sites) it exhibited a slight decrease in the productivity. This pattern was more pronounced in the RCP 4.5 simulations than those for RCP 8.5, probably due to the compensating effect on growth from the large predicted increase in the atmospheric CO_2 concentration in the RCP 8.5 scenario. We conclude that, cooler sites and lower quality sites will have greater relative increases in productivity in the future when compared to the warmer and higher quality sites in the region.

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