

# Chemical Engineering Doctoral Defense

## Production of Renewable Fuels from Bio-Based Feedstocks: A Viable Path to Enhance Value Chain and Sustainability

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### Abstract

The continued reliance on fossil fuel for energy resources has proven to be unsustainable, leading to depletion of world reserves and emission of greenhouse gases during their combustion. Therefore, research initiatives to develop potentially carbon-neutral biofuels were given highest importance. Among the available biomass feedstocks, microalgae are a technically viable alternative energy resource to produce biofuels and has a potential to be used for carbon capture and storage in the process. Hydrothermal liquefaction (HTL, a thermochemical conversion process) of microalgae is recognized as a favorable and efficient technique to produce liquid biofuels from wet feedstocks. In this work, three different microalgae (*Kirchneriella* sp., *Galdieria sulphuraria*, *Micractenium* sp.) grown and harvested at Arizona State University were hydrothermally liquefied to optimize their process conditions under different temperatures (200-375 °C), residence times (15-60 min), solid loadings (10-20 wt.%), and process pressures (9-24 MPa). A one-factor-at-a-time approach was employed, and comprehensive experiments were conducted at 10 % solid loadings and a residence time of 30 min. Co-liquefaction of *Salicornia bigelovii* Torr. (SL), Swine manure (SM) with *Cyanidioschyzon merolae* (CM) was tested to see the influence of synergy. A positive synergistic effect was observed during the co-liquefaction of biomasses, where the experimental yield of biocrude oil was higher than the theoretical value. Co-liquefaction also led to an increase in the energy content of the co-liquefied biocrude oil and a higher energy recovery rate. The HTL biocrude was measured for energy content, elemental, and chemical composition using GC-MS. HTL aqueous phase was analyzed for potential co-products by spectrophotometric techniques and is rich in soluble carbohydrates, dissolved ammoniacal nitrogen, and phosphates. HTL biochar was studied for its nutrient content (nitrogen and phosphorous) and viability of its recovery to cultivate algae using the nutrient leaching. HTL biochar was also studied to produce hydrogen via pyrolysis using a membrane reactor. The versatile applications of HTL biochar were also proposed from the findings using FT-IR, SEM, XRD, and TGA. The metal impurities in the algae, bio-oil, and biochar were identified and quantified by ICP-OES where algae and biochar contain a large proportion of phosphorous and magnesium.



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Zoom Link: <https://asu.zoom.us/j/4030150908>