Hawai‘i Natural Energy Institute Research Highlights

Alternative Fuels

Novel Biocarbons

OBJECTIVE AND SIGNIFICANCE: Biomass can be a renewable resource for the production of energy, fuels, chemicals, and materials. Most biomass materials have a carbon content of ~50% by weight. Slow pyrolysis is a thermochemical conversion process designed to produce a stable solid material with enriched carbon content and reduced amounts of oxygen. The intended end use of the solid carbonaceous material will dictate desirable properties (e.g. volatile matter, carbon and fixed carbon contents, reactivity, surface area, density, tensile/compressive strength, grindability, etc.). The solid product can be used as fuel for cooking, for water purification, as soil amendment, or as a coal replacement in industrial applications. Depending on end use and desired properties, the solid materials are referred to as charcoal, char, biochar, or biocarbons. All have uses in Hawai‘i and can be produced from lower or negative value biomass materials (wastes) as feedstock.

BACKGROUND: The production of biocarbons with high, fixed-carbon content has been an ongoing HNEI research effort. Exploring the conversion of biomass under constant-volume reactor conditions resulted in the production of biocarbons that exhibit characteristics consistent with having undergone a transient plastic phase (TPP) (Figure 1). Under less severe reactor conditions, the same biomass feedstock is converted to a powdered, free-flowing, biocarbon (Figure 2). Yields of these unique and novel biocarbons from constant volume pyrolysis and their fixed carbon contents have proven to exceed those previously reported in the literature using conventional carbonization methods and less developed techniques, such as hydrothermal carbonization. The current research effort uses an instrumented constant-volume reactor system to map reactor temperature and pressure conditions that result in TPP biocarbon formation. The TPP biocarbons are characterized to provide secondary maps of biocarbon properties. Characterization of these novel materials will provide the data necessary to conduct preliminary assessments of potential use across the spectrum of applications. Identifying applications will provide guidance on targeted material properties and inform design of future experiments.

PROJECT STATUS/RESULTS: Experiments at controlled reactor pressures are underway to better understand pressure’s role in TPP biocarbon formation. These parametric tests will provide preliminary data needed to design a factorial experimental campaign to identify control variable interactions. Variables available to control reaction conditions include temperature, pressure, particle size, moisture content, bulk density, reactant gases, and reaction time, etc.

Figure 1. Transient plastic phase biocarbons.

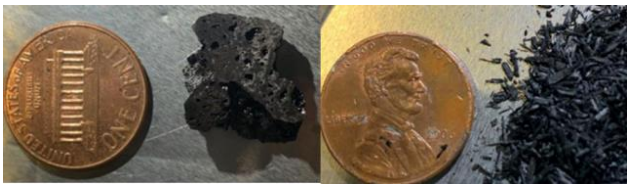

Figure 2. Transient plastic phase biocarbon on left and non-transient plastic phase biocarbon on the right. Both products made from the same biomass feedstock.

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