Exergy Analysis of Woody Plant Biomass Torrefaction

Perkins, L

Mechanical Engineering, Stanford University, United States

E-mail: lena.perkins@stanford.edu

Many studies have analyzed high temperature pyrolysis of woody-plant biomass, with emphasis on the production of bio-oil or syngas. Here we investigate the exergy efficiency and losses of the lower temperature torrefaction (230-290^{o}C). We model a low-temperature processing system optimized for maximum biochar output, in addition to the energy and exergy losses in the process in transportation, chopping, heating and aromatic destruction. Thermodynamic process modeling was carried out using ASPEN-plus.

Using this same analysis we investigate the radius of carbon neutrality for a biochar operation where the biochar is derived from waste feedstock from a plantation perennial bioenergy crop, such as coconut or oil palms. For this study we use the test case of coconut palm as the energy crop and model processing the coconut husk and other waste byproducts in a low-temperature torrefaction process (230-290^{o}C) to create the biochar. The processing facility is modeled to be in the center of the bioenergy crop plantation, with the biochar then re-distributed and buried equally throughout the plantation land area.

Using this model system we compare an approximate radius of carbon neutrality for the biochar system where biochar is spread throughout plantation, and a radius of carbon neutrality where 50% of the biochar is combusted at the charring location, and 50% is spread throughout the plantation. For each scenario we show analyze the system considering the energy from the primary energy crop (copra oil) and excluding it. In this way we hope to shed light on the potential of bioenergy plantation crops such as coconut or oil palms and biochar systems to create completely accounted carbon neutral or carbon negative systems.

Albedo modification of the plantation soil due to addition of the biochar is likely, and we estimate its possible impact. Here, we do not consider additional indirect carbon uptake due to increased activity of soil microbes and increased standing biomass, but we will include it in future analyses in order to quantify a complete carbon impact for the system. Enhanced nutrient retention due to biochar as it relates to the avoided artificial fertilizer and associated carbon intensity of these fertilizers is also not considered, but could constitute significant additional avoided CO_2 released in the full-cycle processing and should be studied in the future.

Soil Biofumigation - An Adaptation and Mitigation Strategy for the New Green Economy and a Safe Solution for the Global Warming. Toward a New Biochar and Terra Preta. Case Study in Brazil and Egypt

Salem, MF*; El Ansary, MS

Molecular Plant Pathology and Organic Farming Research Unit, Head of Organic Farming and Medicinal Mushroom Research Unit, Department of Environmental Biotechnology, Genetic Engineering and Biotechnology Research Institute, GEBRI, Sadat, Egypt

*E-mail: salemkairo@gmail.com

The phase-out of methyl bromide for soil fumigation under the Montreal Protocol indicates to the world that chemical pesticides that harm and damage the world environment will no longer be useful for our sustainable agriculture. This wise phase-out is a major and an important turning point for plant pathologists all over the world, and especially those whom working in organic farming sector. Moreover, the issue for the food and feed safety and the recent regulations for the organic production. This led and stimulated a massive and shuttle research efforts to find a safe and eco-friendly means instead of this toxic soil fumigant. This proper and safe approach is the biofumigation. Organic farming scientists considered the new technology could be developed and adopted by farmers in both developing and developed countries as well. We have to notice that Brazil is the world's largest producer of plant charcoal (38.5% of the production).

Renewable energy accounts for 50% of its total energetic matrix, contrasting with the world average of 14%; Alcohol from sugarcane, the main feedstock in Brazil's renewable energy matrix, generates a fantastic quantity of residues appropriate for biochar production. The emergent biofuels (biodiesel) industries will potentially produce tons of residues.

So, one of the objectives of my presentation to produce a both a compost that is enriched with biofumigant and use in the same time as Biochar and Terra Preta.

The reduction of GHG emissions from farming activities is a challenge for agriculture as, globally, the sector is also called upon to increase production in order to keep pace with growing global food and energy demand. Agriculture should continue to contribute to the global food balance while increasing its overall environmental performance, including reducing its impact on the atmosphere and the climate. Unlike other businesses, agriculture is a biological process inherently linked to GHG emissions and removals from natural systems (plants, animals, soils, agricultural by-products). When evaluating the possibilities of curbing emissions, account has to be taken of the limits that these natural processes set for the reduction potential. Further challenges for the adoption of biofumigation to produce a Biochar and Terra Preta will be discussed during the presentation.