PROCESSING OF HYDROTHERMAL LIQUEFACTION BIOCHAR FROM BIOGAS RESIDUE FOR DIRECT USE AS FERTILIZER

Kamaldeep Sharma, Department of Energy, Aalborg University
ksh@energy.aau.dk
Thomas Helmer Pedersen, Department of Energy, Aalborg University

Key Words: Biogas residue; Hydrothermal Liquefaction; Biochar; Characterization; Fertilizer.

Improved yields from farming practice and food processing are necessary to sustain positive growth around the world. Biogas plants produce, along with biogas, digestate, which is an excellent plant fertilizer, rich in both organic matter and in macro- and micronutrients. However, biogas digestate also contains organic molecules of emerging concern that are currently disposed of. Biogas digestate can be used as feed for the hydrothermal liquefaction (HTL) which will be converted to biocrude and biochar (by-product). HTL process is unique as the nutrients in the biogas digestate are concentrated in the biochar (around 90-95%) during the HTL process with a high recovery rate. These minerals and nutrients can subsequently be distributed back to the farmers as a fertilizer thereby contributing to recycling of resources. Despite of having mineral and nutrients that can stimulate plants and soil microorganisms, HTL biochar can also have ecotoxic effect on soil organisms as heavy transition metals, polycyclic aromatic hydrocarbons (PAHs), linear alkyl sulfonates, nonyl phenol ethoxylates, di (2-ethyl hexyl phthalate) and other organic contaminants are present at elevated concentrations. It is therefore important to assess potential effects of biochar on the soil biota before new biochar products are applied in full scale on arable land. However, there is no unified approach in the published literature about what defines digestate processing for nutrient recovery.

Figure 1 – Production of biochar from biogas residue

Therefore, this study focuses on the determination and evaluation of biological properties, toxicity, and bioavailability of the HTL biochar produced from biogas residue (Figure 1) and compare with standard legislation (Slambekendtgørelsen) for their direct use as fertilizer or soil improvement product for agriculture. Furthermore, this study investigates the downstream processing of the HTL biochar with processes such as leaching and purification, to offer amenable and commercial formulations that can be used as fertilizers, such as mineral fertilizers used nowadays in the agricultural sector. Therefore, this study aims at the extraction and characterization of phosphorus from the HTL biochar as well as evaluating its bioavailability to the plants. Additionally, this study also investigates how best to recycle the nutrient rich HTL biochar into conventional marketable phosphorous products such as struvite ($NH4MgPO4{\cdot}6H_2O$), diammonium phosphate ($(NH_4)_2HPO_4$,) or hydroxyapatite ($Ca_5(PO_4)3(OH)$). The overall scope of this study is to obtain knowledge regarding valorization of a waste product for safe agricultural use including assessment of relationships between application doses and effects.

References:

1) Godlewska, P. et al. 2021. THE DARK SIDE OF BLACK GOLD: Ecotoxicological aspects of biochar and biochar-amended soils. J. Hazardous Materials. 403 (2021) 123833. doi.org/10.1016/j.jhazmat.2020.123833
2) Jatav H.S. et al. 2021. Sustainable Approach and Safe Use of Biochar and Its Possible Consequences. Sustainability. 13, 10362. https://doi.org/10.3390/su131810362
3) Rosendahl, L. A. et al. 2013. Bioresource Technology. 131, 413–419. doi.org/10.1016/j.biortech.2012.12.144