COMPARISON OF HYDROCHAR FRACTIONATION AND COMPOSITION IN BATCH AND CONTINUOUS HYDROTHERMAL LIQUEFACTION

Maria J. Rivas-Arrieta, Department of Biological and Chemical Engineering, Aarhus University, Denmark
mjrivas@bce.au.dk
Patrick Biller, Affiliation, Department of Biological and Chemical Engineering, Aarhus University, Denmark

Key Words: Hydrochar, continuous HTL, manure, bioeconomy, nutrients recovery.

Supplying nutrients for agriculture within a circular bioeconomy demands the recovery of valuable fractions from waste streams. Biological waste such as manure is rich in nutrients, and over 90% of the generated manure in the EU and UK (>1.4 billion tonnes) is directly applied to agricultural land [1]. However, this contributes to nutrient losses, GHG emissions, and soil contamination by heavy metals and pathogens.
Hydrothermal liquefaction (HTL) is a thermochemical processing technology that can produce sustainable biofuels from wet feedstocks. Its main product is bio-crude, but it also generates an aqueous, a gaseous and a solid fraction (hydrochar). The latter consists mostly of the inorganic fraction of the feedstock; it has the potential for nutrient recovery and carbon sequestration.

The distribution of nutrients in the HTL product phases has been studied for several biomasses [2]–[4]. However, research has focused on batch reactors. Limited information is available for continuous operation where studies do not account for in-line solids separation at reaction conditions [5], [6]; thus, it is unclear if previously published mass balances on P, N and C, as well as their speciation, correlate to continuous reactors. The current investigation evaluated the performance of in-line filtration within a continuous reactor configuration and compared the results to batch reactions. Cattle manure was tested at 300, 325 and 350 °C with a total residence time of 20 min. The HTL products were compared to determine to which extent the batch product characteristics can be extrapolated to the continuous operation and subsequently at industrial processes.
The differences in yields, thermal stability, elemental composition, inorganics, crystalline structure, organic phase composition and particle size distribution are assessed employing TGA-DSC, elemental analyses, ICP-OES, XRD, pyro-GCMS, and laser diffraction.

Compared to batch reactions, continuous reactions show lower hydrochar yields (17-24% vs 10-12%), lower carbon and nitrogen content and higher ash content (38-48% vs 66-78%). Although there seems to be no temperature dependency on the hydrochar yields, the carbon and ash contents do seem to correlate.
The inorganics recovery shows that all the P in the feedstock can be recovered in the solids from both reaction types. Moreover, the biocrudes from batch reactions tend to be contaminated by Ca, Mg, Na, K and Fe, while in continuous reactions, only Fe seems to be migrating to the biocrudes.

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