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Editorial

Special Issue "Hydrothermal Technology in Biomass Utilization & Conversion II"

David Chiaramonti [1,2,*], Andrea Kruse [3] and Marco Klemm [4]

1 Energy Department "Galileo Ferraris", Polytechnic of Turin, Corso Duca Degli Abruzzi 24, 10129 Turin, Italy
2 Record—Renewable Energy Consortium for Research and Demonstration, 50038 Florence, Italy
3 Department of Conversion Technologies of Biobased Resources, Institute of Agricultural Engineering, University of Hohenheim, Garbenstrasse 9, 70599 Stuttgart, Germany; Andrea_Kruse@uni-hohenheim.de
4 DBFZ Deutsches Biomasseforschungszentrum Gemeinnützige GmbH, 04347 Leipzig, Germany; marco.klemm@dbfz.de
* Correspondence: david.chiaramonti@polito.it

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Hydrothermal processing (HTP) has gained a large amount of attention from the scientific community, the industrial stakeholders, and the economic operators given the significant technology and process developments that have occurred during the last decade. Hydrothermal liquefaction (HTL) and carbonization (HTC), thanks to their very peculiar nature, can very well match with a wide variety of different and mostly residual wet feedstocks, such as organic wastes, sludges, algae, lignin-rich streams, and many others: Thus, HTP offer unique opportunities for deployment in biomass cascade schemes. Furthermore, biorefinery schemes, based on hydrothermal processing of biomass and valorizing waste streams, targets both biobased materials and bioenergy. The room for fundamental and applied research is large, as well as the effort needed to scale-up the processes to full commercial applications. Understanding the combination of process conditions, feedstock characteristics, reactor configurations, and technological solutions still requires in-depth investigations, tailored to case-specific conditions and market conditions.

This HTP II Special Issue, the second one on the HTP subject published in Energies, reports about some of the most recent findings in HTP processing of biomass. The majority of the articles in this HTP II Special Issue focus on waste and residual streams, while one examines a novel process configuration.

Lappalainen et al. [1] investigated sub- and super-critical water liquefaction of kraft lignin and black liquor derived lignin. The authors carried out a detailed review work of the fundamental behavior of these feedstocks under the high pressure and temperature conditions of HTP for producing biocrudes, water-soluble organics, gaseous products, and biochar. The chemical composition of Black Liquor from Kraft puling was reported and discussed versus thermal treatment. Optimal conditions to convert these feedstocks were identified, such as short-residence time in both near- or super-critical states. Alkali salts were identified as a critical element for hydrothermal processing, from which can originate clogging problems in reactor and process tubes.

Dell'Orco et al. [2] examined Lignin-Rich Stream (LRS) feedstock from lignocellulosic ethanol for hydrothermal liquefaction. Micro-batch reactors were used to carry out the experimental investigation, focusing the analysis mostly on temperature and residence times, ranging from 300 °C to 370 °C and 5 to 10 min, respectively. Two different fractions of biocrude were considered and analyzed: A lighter and a heavier phase, in addition to the water-soluble organic-rich aqueous phase. The effects of both base and acidic catalysts were studied, and their influence on the depolymerization of phenolic components: Two different biocrude collection methods were then developed, and performances analyzed and reported.

Hoffman et al. [3] focused their research work on the conversion of potato waste in carbon materials for supercapacitors as electrodes. This work covered and compared both hydrothermal processing (HTC) and pyrolysis, with HTC operated at three temperatures and two different durations, and slow pyrolysis applied to both biomass and HTC char at two distinct temperatures. Products were fully characterized, in particular by measuring elemental composition, specific surface area, bulk density, surface functionalities, and electrochemical characteristics (electrical conductivity and specific capacity). The analysis showed how these biobased materials from HTC/pyrolysis of agricultural residues can be suitable and thus considered for applications in supercapacitors.

Klemm et al. [4] developed a novel two-stage approach to HTL processing of biomass. Here a first catalyzed/uncatalyzed degradation step is followed by a second stage, where the hydrogen accepting products from the previous phase are upgraded in the presence of hydrogen donor substances as formic acid in a heterogeneously catalyzed HTL step. By doing so, oxygen content is further reduced and products are more stable, in view of the use as biofuel/bioliquid. Possible core products for the proposed two-step HTL process in the chemical domain are g-valerolactone (GVL), phenols, and aromatic compounds.

Arauzo et al. [5] studied the combustion behavior of both hydrochar and pyrochar produced from a waste material: Anaerobically digested sewage sludge (SSL). Different residence time at the pre-defined temperature of 260 °C were applied to the HTP step, and the effect of reaction conditions on product characteristics assessed. The combustion kinetics of both feedstocks and derived HTC/pyro-chars were evaluated, as well as the obtained yield in the two processes at the different conditions. Hydrochars generally showed lower carbon recovery and energy yield than pyrochar, with raw SSL having a better combustibility index than hydrochar. The activation energy of char, in particular pyrochar, is lower than that of SSL, a positive element towards energy valorization.

The contributions from the research works included in this HTP II Special Issue offer new data, information, and findings to continue the R&D effort in the field of HTP, with the aim of stimulating the research community to further contribute to the development of the field.

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