INFLUENCE OF HYDROTHERMAL PRETREATMENT ON THE PYROLYSIS OF SPENT GRAINS

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Hydrothermal carbonization process (HTC) is a thermochemical process which operates at elevated temperature and pressure, where liquid water is used as a reaction medium [1]. The biomass is converted into a lignite-like solid product called hydrochar [2]. The advantage of hydrothermal treatment is a possibility to convert high moist bio-waste streams without thermal drying. A two-step carbonization process (Figure 1) consisting of HTC and pyrolysis may improve the properties of final biochar (e.g., carbon content, surface area, and electrical conductivity). Hydrothermal conversion occurs using different mechanisms (e.g., hydrolysis and polymerization of intermediates) compared to pyrolysis, due to the liquid water environment, which also improves the heat transfer across the particles [1,3]. Hydrochar can be easily mechanically dewatered, due to higher hydrophobicity than the initial feedstock [2]. The mass of initial biomass is also reduced according to the HTC yield, which results in a lower mass flow of material for pyrolysis reactor and previous drying step. The two-step carbonization concept may spread the range of feedstocks used for biochar production and improve the overall energy efficiency as well as economic feasibility of pyrolysis, using wet biomass streams.
The aim of this study was to investigate the influence of hydrothermal pretreatment on the properties of biochar produced from pyrolysis of brewer's spent grains (BSG). BSG was selected as a feedstock for the research due to high water content 70-90% wt. moreover, huge worldwide production. Two pathways (Figure 1) were compared: two-step HTC + pyrolysis and one-step pyrolysis. The hydrothermal carbonization experiments were carried out in a batch stainless steel reactor (250 cm^3) coupled with temperature and pressure sensor. The hydrochars were produced at three different temperatures: 180, 220, and 260 °C. The reactor was kept for four hours at the desired temperature. Three hydrochars and biomass were pyrolyzed for two hours in muffle oven in an inert atmosphere provided by the nitrogen gas. The pyrolysis experiments were performed at 400, 600 and 800 °C to analyze the changes in the materials properties caused by hydrothermal treatment. The obtained biochars, hydrochars, and biomass were characterized by proximate and ultimate analysis. The nitrogen adsorption isotherms were measured to determine the surface area of biochars. Fourier-transform infrared (FTIR) spectroscopy and scanning electron microscopy (SEM) were used to characterize the structural properties of biochars produced in one-step and the two-step process. Moreover, the effect of HTC temperature on the final biochar yield and biochar properties was analyzed.

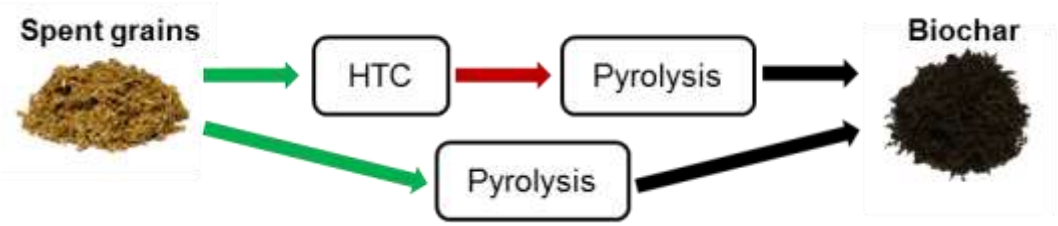

Figure 1 - The overview of two-step and one-step biochar production process.

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