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IMPACT OF RESIDENCE TIME ON THE COALIFICATION OF MICROALGAL BIOMASS: A HYDROTHERMAL CARBONIZATION APPROACH

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ABSTRACT

Hydrothermal carbonization (HTC) is an emerging thermochemical process for converting wet biomass into hydrochar, a carbon-rich material with potential applications as a solid fuel. Operating at moderate temperatures (~190–300 °C) and self-generated pressures (~25 bar), HTC facilitates the transformation of biomass through hydrolysis, dehydration, and decarboxylation. Among various feedstocks, microalgal biomass has gained attention due to its high growth rate, minimal land requirements, and lower greenhouse gas emissions, making it a promising candidate for sustainable energy applications.

This study investigates the HTC of carbon-sequestered Spirulina sp. and assesses the fuel characteristics of the produced hydrochar as a substitute for sub-bituminous coal. HTC was conducted in a 50 mL Teflon-lined autoclave reactor at 190 °C, with a solid-liquid ratio of 0.1, and residence times ranging from 1 to 4 hours. Ultimate analysis, high heating value (HHV), and thermogravimetric analysis (TGA) were used to characterize the hydrochar. A 30% increase in HHV was observed for hydrochar produced at a 4-hour residence time, while the highest energy yield (72%) was obtained at 1 hour. Although prolonged residence time enhanced energy densification, it also resulted in lower hydrochar yield due to increased biomass degradation. These findings highlight the potential of microalgal hydrochar as a coal substitute and provide a foundation for further research into its field-scale applicability in coal-fired power plants, contributing to sustainable waste management and energy recovery.

KEY WORDS

Hydrothermal carbonization; hydrochar; microalgae; carbon sequestration.

BIOGRAPHY

I am currently pursuing my M.S. in Environmental Engineering from the Department of Civil Engineering at IIT Kharagpur. My research primarily focuses on waste valorization, with interdisciplinary interests in solid waste management, ceramic materials, 3D printing, catalysts, and wastewater remediation. I am passionate about developing sustainable and innovative solutions to address environmental challenges by integrating advanced materials and green technologies. I have authored in 3 papers and a published book chapter (1 published and 2 communicated).Through my work, I aim to contribute to the circular economy and promote resource-efficient practices for a cleaner future.

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