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Characterization of engineered corn cob biochar produced in allothermal pyrolysis reactor

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ABSTRACT

Biochar production has been explored wisely through different reactors and resulted in higher biochar yield with better quality. Besides the comprehension of production parameters, allothermal reactors has been less explored in terms of biochar production and its potential characteristics after activation. The current study presents the production of corn cob biochar in self-fabricated allothermal reactor and understanding its characteristic features. Corn cob biochar yield of 46.8% with fixed carbon content of 83.9% has been obtained. The produced biochar was modified using magnesium chloride and ferric chloride to produce the engineered biochar. The modified biochar possess numerous pores along with metal complexed and positive functional groups that could adsorb negative charged contaminants and serve as a better soil amendment.

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1. Introduction

Biomass is one of the abundant renewable energy source that shows promising benefits for energy demands in a sustainable manner. Many studies have proved that it could yield different bio-products like biochar, bio-oil through thermochemical conversion such as pyrolysis which involve heating of the biomass under limited oxygen atmosphere inside a closed container. After complete thermochemical conversion, the produced biochar can be utilized for fuel source and are being explored for various environmental and agricultural applications [1,2]. The product composition of the bioproducts mainly depends on the mode of pyrolysis and the selection of process parameters. Different modes such as slow or fast pyrolysis shall be preferred based on desired properties of final product [3,4]. The exploration of significance and advantages of biochar utilization for different technologies urges the understanding of biomass-to-biochar conversion process. Parameters such as pyrolysis temperature, time, moisture content, feedstock type, biochemical composition, reactor design and type plays vital role in determining the yield of biochar [5,6].

For many centuries, biochar has been produced through earth kilns and used in cooking, heating applications whereas results in higher gaseous emissions. Modern biochar retorts limit the gaseous emissions and produces stable biochar with better physiochemical properties. The reactor designs are typically categorized into either allothermal or autothermal reactors based on the scale of application [7,8]. Autothermal reactors use heat energy to proceed the pyrolysis reaction by biomass oxidation partially within the reactor. Autothermal reactors are commonly being used in small scale applications. On the other hand, allothermal reactors use energy from an external source for heating the biomass to carry out the endothermic pyrolytic reactions where heat is conducted through either surface or transport bed material [9]. The gas product produced in allothermal reactor consists of higher heating values in comparison with autothermal reactor [10]. Haryati *et al.* [11] produced palm kernel shell biochar through fixed bed allothermal reactor with 33–52 percent of yield and found its suitability for soil amendment and sequestration of carbon in degraded soil. However, large investment is required for technology implementation, since the reactor operation is difficult and complicated for small scale production. Proper study of the parameters in allothermal reactor is essential to determine the perfect combination of parameters to make the better quality biochar.

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