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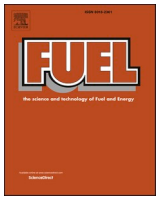

Full Length Article

Syngas-Enriched hydrogen production via catalytic gasification of water hyacinth using renewable palm kernel shell hydrochar

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ABSTRACT

Syngas produced from biomass gasification has emerged as a highly promising substitute for conventional fossil fuel, catering to various industrial applications while ensuring minimal greenhouse gas emissions. Water hyacinth (WH) has been a major concern due to its invasive nature and uncontrollable growth which impedes aquatic growth and urban management. Fortunately, WH is a potential biomass feedstock due to the comparable cellulose and hemicellulose contents alongside high carbon content and high calorific value which reflects good biofuel properties. Therefore, this study aims to investigate the conversion of WH biomass via catalytic air gasification for syngas-enriched hydrogen production using palm kernel shell hydrochar (PKSH). A parametric study was conducted in a lab-scale fixed-bed downdraft gasifier based on the response surface methodology coupled with Box-Behnken design (RSM-BBD). The combined interaction effects of the influencing parameters investigated are temperature (600–800 °C), biomass particle size (2–6 mm), catalyst loading (0–10 wt%), and air flow rate (1–3 L/min). Temperature was revealed to be the primary factor with significant influence on the H_2 and CO output. Maximum syngas (30.09 vol%) compositions of 11.14 vol% H_2 and 18.95 vol% CO were obtained at 800 °C with a particle size of 6 mm and air flow rate of 2 L/min alongside 5 wt% PKSH catalyst loading.

1. Introduction

The rapidly surging population implies high demand for resources and energy which places a downward pressure on the resources available. Consequently, various technologies and mitigation approaches arise to manage and enhance current resource utilization. Various alternative technologies and energy sources have been developed to aid the paradigm shift from conventional resources to sustainable and renewable energy sources. Thermochemical conversion of biomass into biofuels has garnered huge interest in recent years due to the attractive characteristic of biomass being carbon neutral nature, which leaves minimal to no carbon footprint while meeting the ever-increasing energy demand on a global basis [1–3]. Furthermore, thermochemical conversion, regarded as a promising viable approach for carbon monoxide (CO_2) mitigation, provides better conversion rate, flexibility, and robustness than the other conversion methods [4]. Biomass originating from the aquaculture sector is one to consider for biomass conversion into value-added products. Table 1 below summarizes recent studies on pyrolysis and gasification of aquatic plants in the past 5 years.

The aquatic weed, water hyacinth (*Pontederia crassipes*), is deemed as

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