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Optimization of fuel briquette made from bi-composite biomass for domestic heating applications

K.O. Oladosu [a,b,*], S.A. Babalola [c], M.W. Kareem [a], H.A. Ajimotokan [d], M. Y. Kolawole [a], W.A. Issa [a], A.S. Olawore [a], E.A. Ponle [e]

[a] Department of Mechanical Engineering, Kwara State University, Malete, Nigeria
[b] Centre for Sustainable Energy, Kwara State University, Malete, Nigeria
[c] Central Mechanical Engineering Research Institute (CMERI), Durgapur, West Bengal, India
[d] Department of Mechanical Engineering, University of Ilorin, Ilorin, Nigeria
[e] Department of Mechanical Engineering, Osun State Polytechnic Iree, Osun State, Nigeria

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ABSTRACT

This study aimed at optimizing the fuel briquettes produced from flamboyant pod (FBP), and corn cob (CC) mixed with cassava starch (SB) as a binder using custom design methodology (CDM). The compressive strength, ash yield, and emission analysis of the briquettes produced were determined. The combustion efficiency parameters as well as CO, NO_2, $PM_{2.5}$, and PM_{10} of the emissions were compared to optimal fuel briquettes and charcoal fuel. The optimal combination of compressive strength and ash yield was obtained for the briquette fuel blend formulated from 30 wt.% flamboyant pod, 51 wt.% corn cob and 17 wt.% starch. While the water boiling time of the fuel increased by about 35–48% compared to charcoal fuel, the ignition time and the specific fuel consumption rate decreased by ~34% and 16%, respectively. Furthermore, the major air pollutants were reduced from 222 to 196 ppm for CO, 3.63–2.34 ppm for NO_2, and 0.21–0.09 ppm for $PM_{2.5}$. These properties of the briquette align with charcoal, thus supporting the use of flamboyant-corcob-starch (FBCS) briquettes as a supplementary source of energy to charcoal.

Introduction

Concerns over the supply limit of fossil fuels coupled with their environmental impacts have prompted extensive research and development of renewable fuels as alternatives. Consequently, densification of agricultural residues into briquettes has received attention in recent years due to its environmental friendliness, being entirely renewable and ease of implementation. The exponential increase in global population is putting pressure on its energy demand and economy [1]. Increased population enables higher fossil fuel consumption which consequently leads to source depletion [2]. To ameliorate these challenges, the search for clean energy has amplified in recent years. The fuels most commonly adapted for cooking in developing countries are wood, charcoal, kerosene, and cooking gas. However, the combustion of these cooking fuels brings about the release of hazardous greenhouse gases such as methane (CH_4), carbon dioxide (CO_2), nitrous oxide (N_2O), and fluorinated gases (F–gases). These gases cause various environmental issues such as air pollution and global climate change amongst others [2,3].

Anxieties over the supply and impact of fossil fuels on the environment have prompted further research and development into

* Corresponding author at: Department of Mechanical Engineering, Kwara State University, Malete, Nigeria.
E-mail address: kamoru.oladosu@kwasu.edu.ng (K.O. Oladosu).

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