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Evaluation of biofuel from the torrefaction of Malaysian food waste

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A B S T R A C T

The alarming issues related to the depletion of conventional fossil-based fuel resources have sparked interest in the search for alternative resources. Being a developing country facing tremendous growth, Malaysia is generating large amounts of food waste (FW). In this paper, an investigation of the potential of FW conversion to solid, coal-like fuel is carried out through torrefaction. The torrefaction process was carried out at temperatures between 260 and 320 °C and residence times of 15 to 45 min. The results showed that a higher torrefaction temperature leads to an increase in mass loss of the initial solid FW, which is also observed with increasing residence time. The loss of solid mass, nevertheless, increased the higher heating value (HHV) of the torrefied FW. A significant improvement was also observed in the volatile matter (VM) and moisture content (MC) of torrefied FW, which both decreased, while the carbon (C) content was increased. This suggests the improvement in the fuel properties of FW and its potential as a renewable energy source.

Selection and peer-review under responsibility of the scientific committee of the Engineering Technology International Conference.

1. Introduction

Rapid urbanization along with tremendous population growth are some of the factors that contribute to the increased generation of food waste (FW) in Malaysia, which is projected to increase annually. Being organic, FW usually, one way or the other, ends up in the landfill along with other municipal solid wastes (MSW), though there are other methods to handle FW as composting for biomass and fertilizer production. This is alarming, as it may pose a potential threat to the environment and society, as landfills are filling up rapidly and their dedicated area is decreasing. Almost 17,000 tons of FW are being produced in the country daily and are projected to increase by 10 % yearly [1]. The abundant FW will cause the production of methane, which is one of the main contributors to the greenhouse gas effect along with carbon dioxide [2], from natural degradation, on top of other toxic gases and odours that are harmful to humans and the surrounding areas [3]. In addition, the accumulated FW may also cause water pollution, affecting aquatic biodiversity through leachate production in landfill [4].

Alternatively, the utilization of FW as a renewable energy source can be adopted to overcome these problems [5]. Interest in bioenergy has been mainly triggered by the increased energy demand [6] and the search for solutions to resist climate change [7]. FW has the potential to generate renewable energy such as biogas through anaerobic digestion, though this process is relatively slow in its production rate. However, FW cannot be used directly in energy production processes in its raw form. This is because raw FW has a low calorific value and high-water content [8]. It is also hydrophilic, which makes it challenging to use on large scales [9]. Therefore, torrefaction has been introduced to overcome these weaknesses by improving its physical and thermal properties. Torrefaction is a thermal pre-treatment process that may be considered a promising method to improve the quality of FW as a solid fuel. The torrefaction process operates in an inert atmosphere at 200–300 °C [5,10].

To date, there are only a limited number of studies focused on FW as its main fuel source through torrefaction [11–14], while only two of them specifically studied the effects of temperature and residence time on torrefied FW. On top of that, both evaluations were based on FW obtained on campuses in South Korea and Mauritius [11,12]. In South Korea, the torrefaction of FW was studied by Poudel et al. by observing the effect of residence time on the characteristics of the torrefied samples in the temperature range of 250–400 °C [11], which may be categorized as severe torrefaction. Another study investigated the torrefaction process using FW obtained from a cafeteria inside the University of Mauritius [13], at a slightly lower temperature range of 225 to 300 °C.

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