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Research Article

Esterification of Microwave Pyrolytic Oil from Palm Oil Kernel Shell

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Microwave pyrolysis is a potential for producing alternative fuel from biomass, such as palm kernel shell (PKS). However, the resulting microwave pyrolytic oil (bio-oil) was highly acidic and has low calorific value and therefore must undergo additional process to improve the physicochemical properties. In this study, attempt was made to improve the pH and calorific value of bio-oil produced from PKS via esterification process. The effect of esterification with ethanol in the presence of sulphuric acid as a catalyst on selected biodiesel qualities was also investigated. The esterification process has successfully improved the pH value from 3.37 to 5.09–5.12 and the calorific value was increased from 27.19 to 34.78–41.52 MJ/kg. Conclusively, the EO has comparatively better properties in terms of its smell, pH, calorific value, and absence of environmentally undesirable compounds. However, future works should include ASTM 6751 specifications tests for biodiesel to evaluate the bio-oil's suitability for commercial use.

1. Introduction

Palm kernel shell (PKS) is a highly abundant waste generated from palm oil industry with high volatile matter content. PKS can be converted into renewable energy sources when subjected to suitable treatment such as microwave pyrolysis. In pyrolysis process, the biomass undergoes thermal decomposition in an oxygen-free environment to produce liquid, carbon-rich solid residue, and gases fuels synchronously.

In traditional pyrolysis, the system was performed using fixed bed, fluidized bed, circulating fluidized bed, and powder-particle fluidized bed, in which samples are heated externally using electrical heating [1]. Conventional heating has certain limitations such as heat transfer resistance, heat losses to surrounding, utilization of portion of heat supplied to biomass materials, and damage to reactor walls due to continuous electric heating [2]. Moreover, long heating period causes negative reactions in an undesirable or secondary reaction.

In the past decade, pyrolysis of biomass under microwave radiation has gained a lot of attention due to its advantages. During microwave pyrolysis, the microwave energy is accumulated precisely inside the material which creates spontaneous heat [3]. Microwave heating has been practiced to numerous kinds of biomass pyrolysis such as coal [4], oil shales [5], plastic wastes [6], sewage sludge [7, 8], wood block [9], corn stover [10], coffee hulls [11], rice straw [3], and pine sawdust [12].

In conventional heating, the heat is transported into the material through transmission, conduction, and radiation of heat from the surface of the material. In contrast, microwave energy is distributed straight into materials through molecular synergy with the electromagnetic field, thus obtaining a more uniform circulation of heat correlated with conventional heating [3, 10]. Uniform circulation of heat