SIIC103

Torrefaction of Palm Pressed Fibre in a Fixed Bed Reactor

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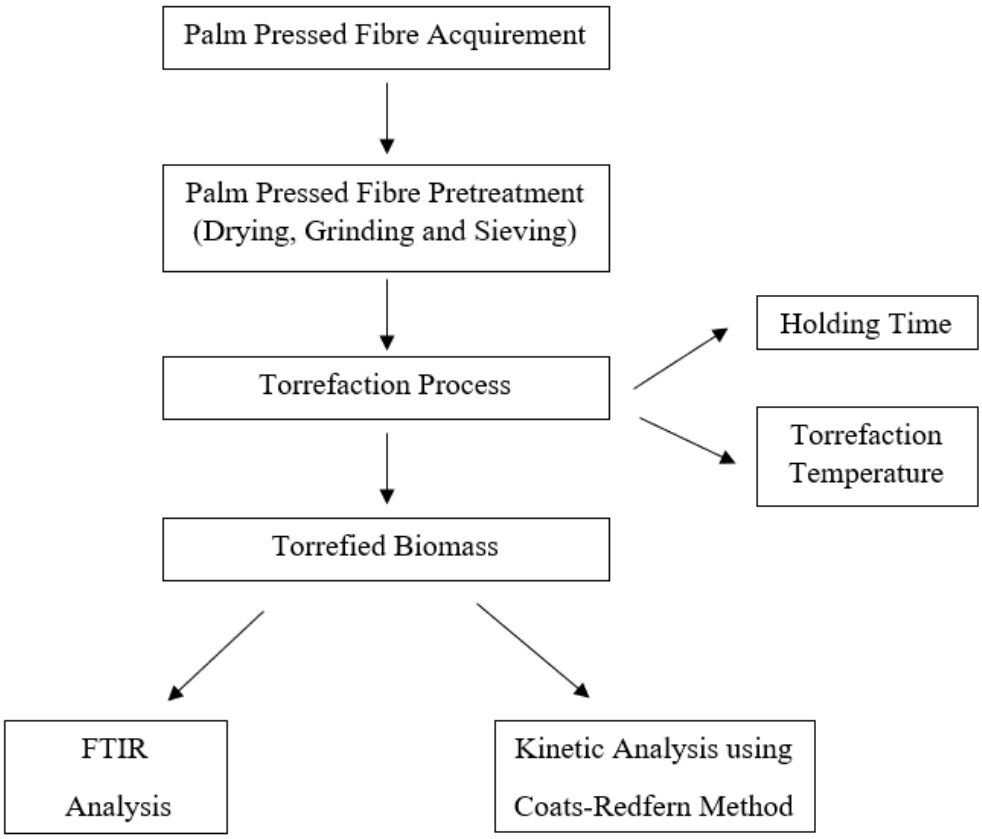
Abstract:
The accumulation of the palm pressed fibres which are the wastes and by-products from the palm oil milling industry and the potential to be reused and utilized as potential biofuels have resulted in palm pressed fibre to become an alternative energy to replace the conventional fossil fuel. However, the direct usage of raw biomass as a source of biofuel is not efficient due to its high moisture content and low energy density value. Hence, the pre-treatment of biomass via torrefaction is required before the biomass is used as a biofuel since torrefaction can increase the energy value of the biomass and reduces the moisture content of the biomass. Torrefaction of palm pressed fibre was performed under an inert environment in a fixed-bed reactor. The effects of on the mass yield, torrefaction temperature (200˚-300˚C) and holding times (20, 40, 60 minutes) were investigated. The kinetic parameters for the torrefaction process at different holding times were analyzed by using the Coats-Redfern method. The results showed that the highest value of activation energy obtained was 29.418kJ/mol at 20 min holding time. From the FTIR analysis, it was found that degradation of the hemicellulose, cellulose and lignin occurred during the torrefaction process.

***Keywords*:**
Torrefaction, Palm Pressed Fibre, Activation Energy, Coats-Redfern, FTIR

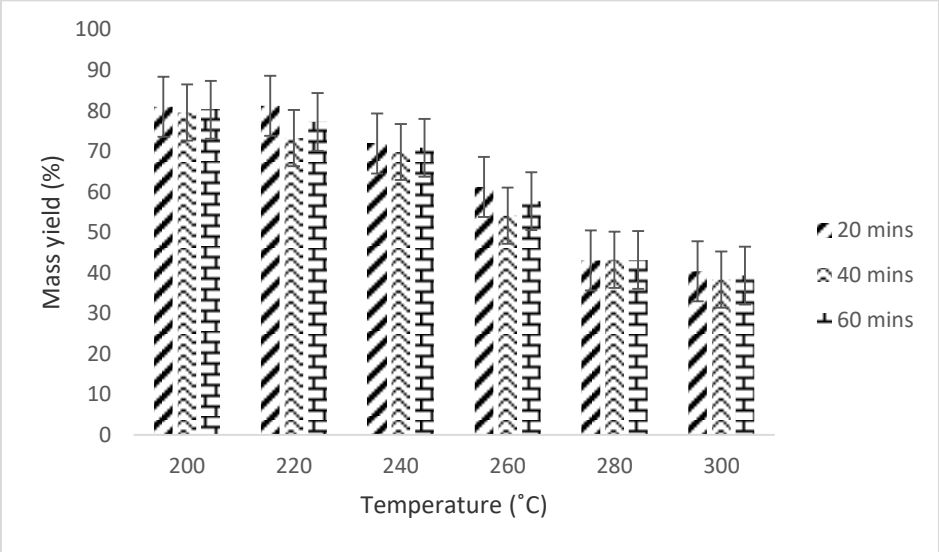
Objectives:

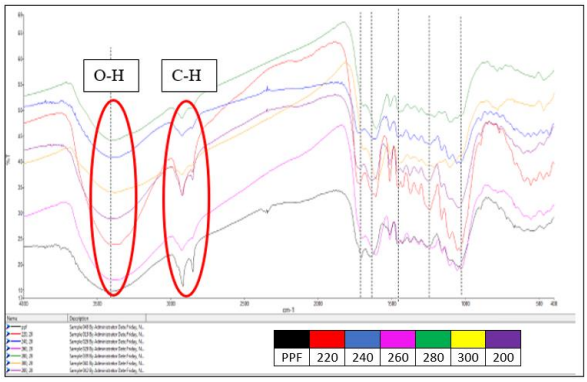
- To conduct torrefaction of palm pressed fibre at different torrefaction temperatures in the range of 200-300˚C and at different holding times of 20, 40, and 60 minutes in a fixed-bed reactor.
- To analyze the values of activation energy for the torrefaction of palm pressed fibre using the Coats-Redfern method
- To identify the functional groups of the chemical composition of raw and torrefied palm pressed fibres by using Fourier Transform Infrared Spectroscopy (FTIR).

Methodology:


Palm Pressed Fibre Acquirement
Palm Pressed Fibre Pretreatment (Drying, Grinding and Sieving)
Torrefaction Process
Holding Time
Torrefaction Temperature
Torrefied Biomass
FTIR Analysis
Kinetic Analysis using Coats-Redfern Method

Results:





Conclusion:

In conclusion, the experiment on the torrefaction of palm pressed fibre via a fixed bed reactor in an inert environment was conducted successfully. Based on the findings from the torrefaction of the biomass within the at temperature 200-300˚C at different holding times of 20, 40 and 60 minutes, it is found out that the colour of the biomass changes into darker colour when the torrefaction temperature increases due to the torrefied biomass contain higher fixed carbon content after torrefaction. The mass yield of the palm pressed fibre also decreases as the torrefaction temperature increases with respect to the holding time. Based on the kinetic parameters from the Coats-Redfern method, the activation energy of the palm pressed fibre torrefaction decreases as the holding time of torrefaction is increased, signifying that a higher holding time of torrefaction is preferred as it produces a lower activation energy for the biomass torrefaction, hence less energy is required to break the bonds of the biomass.