

SIIC080

TORREFACTION OF EMPTY FRUIT BUNCH IN A FIXED BED REACTOR

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Abstract:

The natural forest in Malaysia had produced a largest biomass resource due to the agricultures activities. Not only that, Malaysia also produces a lot of solid waste such as empty fruit bunch because Malaysia is the second top producer of palm oil. In this study, the empty fruit bunch (EFB) is used as the biomass because of its abundant resources. Biomass has a higher moisture content and lower calorific value than coal. In response to the issues related to environment pollution, renewable energy such as biomass has been recognized as a solution to overcome the problem related to the degradation of natural resources. In this study, torrefaction process has been introduced to increase the calorific value, lower the moisture content and also to produce a better fuel quality. Therefore, the purposes of this study are to study the effect of torrefaction temperature and holding time on the mass yield of torrefied EFB and to assess the activation energy, E_a of torrefaction process by using the Coats-Redfern method. The torrefaction of EFB was performed in a fixed-bed reactor under an inert environment. The effects of various torrefaction temperatures between 200 and 300 °C and holding times of 20, 40 and 60 minutes on the mass yield of EFB were investigated. The results showed that temperature significantly influenced the mass yield of EFB during torrefaction. It was determined that the mass yield decreased upon increasing torrefaction temperature. The highest activation energy values for EFB was 37.09 kJ/mol at holding time of 20 minutes, respectively. In this study, the torrefaction process can be proven that the torrefied biomass can improve its characteristic of biomass.

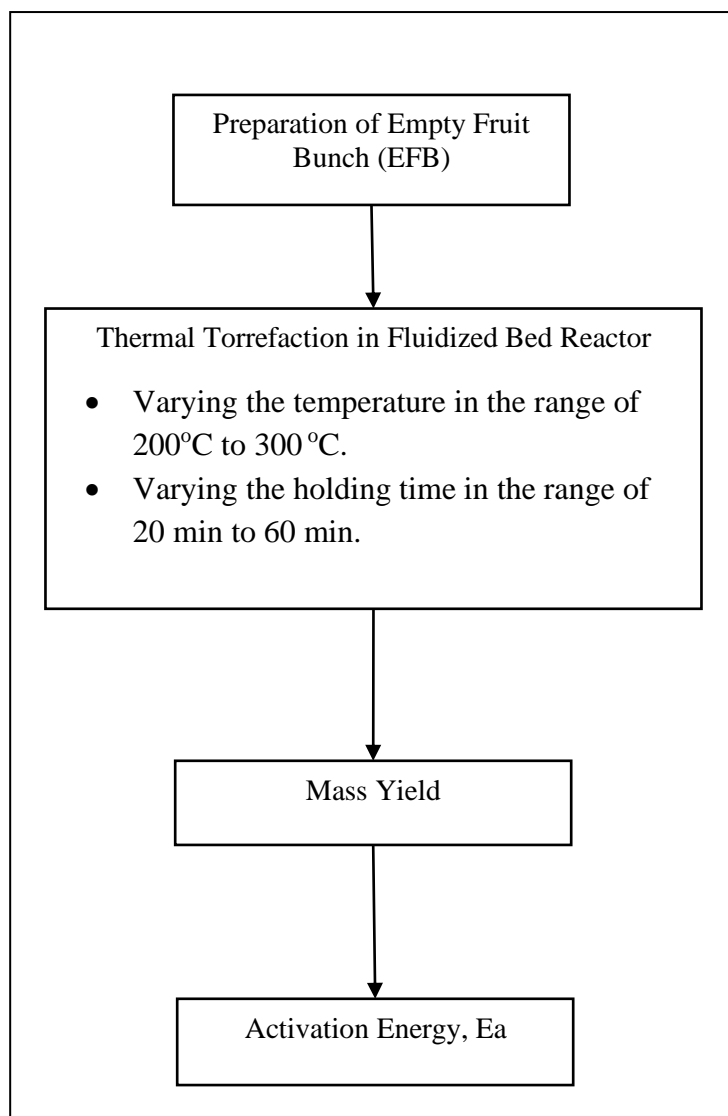
Keywords:

Empty fruit bunch, renewable energy, torrefaction, fixed bed reactor, activation energy.

Objectives:

- To investigate the effects of torrefaction temperature and holding time on the mass yield of torrefied EFB.
- To assess the activation energy, E_a of torrefaction process by using the Coats-Redfern method.




















Methodology:



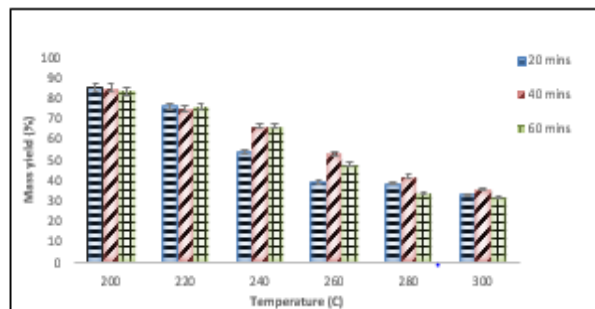
Results:

Colour appearance of raw and torrefied biomass

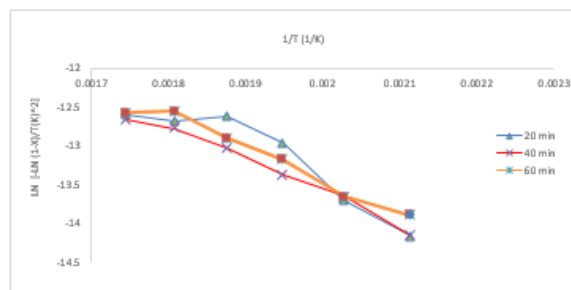
Biomass : Empty Fruit Bunch

Raw			
Torrefaction temperature	Holding time (min)		
	20	40	60
200°C			
220°C			
240°C			
260°C			
280°C			
300°C			

Mass yield of torrefied biomass



Kinetic parameter by Coats-Redfern Method



Result from graph of 1/T (1/K) against ln [-ln (1-X)/T(K)^2].

Holding time (min)	Equation	R ²	Ea (kJ/mol)	ln A
20	y = -4461.5x - 4.5575	0.8697	37.09	3.8462
40	y = -4050.6x - 5.4963	0.9813	33.677	2.8107
60	y = -3972.2x - 5.4971	0.9653	33.02	2.8311

Conclusion:

This study was conducted to investigate the torrefaction process of empty fruit bunch in a fixed bed reactor. The effect of torrefaction temperature was investigated at various temperatures from 200°C to 300°C and holding times of 20, 40 and 60 minutes. The product of torrefaction process which is biochar were identified to calculate the mass yield of torrefied EFB. From the results, it was found that the mass yield of torrefied EFB increases when temperature increases. The kinetics analysis was performed by using Coats-Redfern method. The highest value of Ea is at a holding time of 20 minutes which is 37.09 kJ/mol while the lowest is at 60 minutes which is 33.02 kJ/mol. The activation energy of empty fruit bunch torrefaction decreases when the holding time of the torrefaction process is longer. It can be concluded that the torrefaction process has improved the characteristic of the EFB biomass.