RECOVERY OF BIO OIL FROM MUSTARD SEEDS BY THERMAL PYROLYSIS

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Abstract

Biomass fuels and residues can be converted to more valuable energy forms via a number of processes including thermal, biological, and mechanical or physical processes.Slow pyrolysis is one of the three main thermal routes, with gasification and combustion, for providing a useful and valuable bio-fuel. In this paper, the slow thermal pyrolysis of mustard seed was carried out in a semi batch reactor made up of stainless steel at temperature range from 400 °C to 500 °C to produce bio-fuel. The effect of temperature on yields of pyrolysis of liquid product, char, gaseous product and reaction time was studied. The maximum liquid yield obtained was 63.52 wt% at a pyrolysis temperature of 450°C. The liquid fractions thus obtained were analyzed for composition using FTIR and GC-MS. The chemical characterization showed that the bio-oil obtained from the above raw material may be potentially valuable as a fuel and chemical feedstock.

Keywords: Mustard Seed, Thermal Pyrolysis, FTIR, GC-MS, Biofuel

1. Introduction:

Before the discovery of fossil fuels, our society used to depend on plant biomass to meet the energy demands. The discovery of crude oil, in the 19th century, created an inexpensive liquid fuel source that helped industrialize the world and improved standards of living. World energy demand is expected to increase approximately 50% above 2002 level and will increase approximately two and half times the present level [1]. The major energy demand is fulfilled from the conventional energy resources like coal, petroleum and natural gas. These sources are in the verge of getting extinct. It was estimated that the oil sources might be depleted till 2050. With declining petroleum resources, and increased demand for petroleum products, there is an urgent need to develop economical and energy-efficient processes for the production of fuels and chemicals [2].

The main objective of the present work is to study how agricultural product can be a potential source in the production of bio-fuels. In the presentinvestigation, mustard seed was pyrolyzed in a semi batch reactor to determine the optimum conditions for the production of bio-oil. The effect of temperature on yields of liquid product, char and gaseous products were studied. The liquid fractions thus obtained were analysed for composition using FTIR and GC-MS.

2. Experimental:

The results of proximate mustard seed is given in Table.1 and are compared with other oil cakes. Pyrolysis experiment was carried out done by taking 30gms of the raw material of particle size of 3mm at the temperatures 400, 425,450,475,500 °Cand at a heating rate of 25 °C/min in a semi batch reactor made of SS (316) of 0.3 liters volume. It was heated externally by electric furnace and the temperature of the furnace is maintained by a highly sensitive PID controller. The liquid products were condensed by cooling with ice bath. The temperature is measured by a Cr-Al: K type thermocouple fixed inside the reactor and in thefurnace, one can attain a temperature of 1200 °C.The liquid fractions thus obtained were analysed for composition using FTIR and GC-MS.

Table 1: Proximate analysis and calorific value of mustard seed

Property	Moisture content (%)	Volatile content (%)	Ash content(%)	Fixed carbon(%)	Calorific value(kJ/kg)
Mustard seed	4.5	38.6	3.5	53.4	28212.03

3. Results and Discussion:

3.1. Effect of pyrolysis temperature on product yields of mustard seed:

Table2 shows the product yields for the pyrolysis of mustard seed in relation to final temperature of pyrolysis at heating rate of 25 °C/min. The liquid product obtained was reddish brown in colour with an irritant odour.The liquid yield increased with increase in temperature and is highest at 450 °C having 63.52 Wt. % of oil and later reduced beyond this temperature. As the temperature increases, weight of the char decreased. As the temperature is increased, volatiles formation first decreases and then increased.The gaseous yield decreased initially then increased with increase in temperature. This may be due to secondary cracking of the pyrolysis vapors at higher temperatures. The yield of char decreased with increase in temperature. The decrease in the char yield with increasing temperature could be either due to greater primary decomposition or depolymerisation of mustard seed to primary volatiles at higher temperatures and may be due to secondary decomposition of the char residue.

Table 2: Effect of pyrolysis temperature on product yields of mustard seed

Temperature (^{0}C)	**Mustard seed**				
	400	425	450	475	500
Weight % of oil	19.82	53.12	63.52	53.16	48.60
Weight % of char	49.91	33.44	24.29	20.12	18.98
% Volatiles	30.26	13.43	12.18	26.71	32.41
Time of the reaction(min)	53	47	41	36	28

4. Conclusion:

In the present study mustard seed werepyrolyzed in a semi batch reactor at the temperature range of400-500 °C. The maximum bio-oil yield was 63.52 wt% at an optimum temperature of 450 °C. The yield of liquid product increased initially and then decreased with increase in temperature. Gaseous yield decreased initially and then increased, char yield decreased with increase in temperature. The experimental studies show that temperature has significant effect on pyrolysis yields and conversion efficiencies. Bio-oil thus obtained, can be utilized as either synthetic fuels or chemical feedstock.

5. References:

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