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Optimization of biodiesel production from *Jatropha curcus* oil by transesterification

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Abstract

India is looking at renewable alternative fuel sources to reduce its dependence on foreign oil. In the present study, different variation of methanol 20 %, 18 %, and 22 % sodium hydroxide 1 %, 0.75 % and 1.2 % reaction time 120, 70 and 90 minute and reaction temperature 40 ^{0}C, over adapted in order to optimize the experimental condition for maximum ester yield from alkali-catalyzed transesterification of *Jatropha curcus* oil. The preliminary studies recorded that the methyl ester yield varied widely in the range of 86 to 92 % in the laboratory scale production reactor.

Keywords: *Jatropha curcus*, Transesterification, Methanol, NaOH.

Introduction

India currently imports about 72 % of its petroleum requirements. India is looking at alternative fuel sources to reduce its dependence on imported oil. Thus there is an urgent need to find alternative renewable form of energy before mineral oil supplies run dry. Biodiesel extracted from vegetable oil is a renewable alternative fuel[1]. These biodiesel are extracted from the non edible oil source. *Jatropha curcus*, belonging to *Euphorbiaceae* family, found to be the most appropriate renewable alternative source of biodiesel[2]. The extracted oil could not be used directly in diesel engines because of its high viscosity. High viscosity of pure vegetable oils would reduce the fuel atomization and increase fuel spray penetration, which would be responsible for high engine deposits and thickening of lubricating oil[3].The use of chemically altered or transesterified vegetable oil called biodiesel does not require modification in engine or infection system or fuel lines and is directly possible in any diesel engine[4]. The present study was undertaken to optimize the oil percentage and biodiesel conversion rate of *Jatropha curcus*, same fuel properties and chemical properties were determined according to the standard test methods for raw oil and biodiesel.

Material and methods

Methanol was chosen as the alcohol used for the transesterification of *Jatropha curcus* oil because of its low cost and the alkaline catalyst sodium hydroxide was chosen since it is cheaper and reacts much faster than acid catalysts[5]. The important factors that affect the transesterification reaction are the amounts of methanol and sodium hydroxide, reaction temperature and reaction time[6]. A laboratory scale extraction of *Jatropha curcus* oil was done in a small spiller, seed coats was crushed with spiller 100 grams. of seed was placed inside the small spiller. Titration of vegetable oil was done for neutralization of free fatty acid, for which quantity of KOH/NaOH in form of grams was taken. The vegetable oil was firstly mixed with propanol, than a mixture of NaOH and water was added until all free fatty acid was reacted pH a confirmed the reaction of all free fatty acid. A stock solution with 10 gm. NaOH to 100 ml distilled water was made as 1 % solution. 100 ml of 1 % solution was added to 900 ml of distilled water, as 0.1 % NaOH solution created. 0.1 % NaOH solution drop by drop was adds to propanol oil mixture for neutralization of free fatty acid. For the transesterification reaction, 3moles of methanol were required to react with 1 mole of vegetable oil[7].

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For that NaOH pellets were completely dissolved in methanol and added into oil. Reaction temperature was maintained below boiling point (65^0C) of methanol for 3 hours that maintains yield of ester. After transesterification reaction mixture was allowed to separate and settle over night by gravity settling into a clear, golden liquid biodiesel on the top with the light brown glycerol at the bottom. Next day the glycerol was drained off from the separating funnel, leading the biodiesel at the top. Ester washing was done for the removal of any soap formed during the transesterification reaction. Use of hot water (120-140 ^{0}F) prevents precipitation of saturated fatty acid esters and retards the formation of emulsions with the use of a gentle washing action. Three ways washing was done amount of water was equal to amount of oil, and was drained throughout the washing process. After the water was drained air washing process started. Bobbling was done for the agitation of biodiesel surface and the final drain was done.

Results and Conclusion

For extraction of Jatropha oil best temperature given was 40^0C, by which 50 % of Jatropha oil was extracted results of oil percentage shows on table 1. The exact amount of NaOH required for the transesterification was obtained by neutralization. Amount of NaOH was obtained in ml and converted to grams. Results are shown in table1 for neutralization of 1 ml oil of Jatropha curcus 1 % NaOH required. In order to optimize the reaction time the different reaction times selected for this study were 70, 90, 120, 120, 120 minutes.

Effect of methanol quantity

To optimize the amount of methanol required for the reaction, experiments were conducted with 22%, 18%, 20%, 20% and 20% the average results of this study are presented in graph 1.The results clearly indicate that the optimum concentration of methanol required for effective transesterification of Jatropha oil was 20%. Moreover, it was found that when the concentration of methanol was increased above or decreased below the optimum, there was no significant increase in the biodiesel production, but the excess or shortfall in concentration of methanol only contributed to the increased formation of glycerol. The variation in methanol concentration versus ester yield percentage is shown in Table 1 clearly shows that the maximum ester yield of 92% was obtained using 20% methanol.

Effect of NaOH concentration

The catalyst NaOH concentration variation adopted in this study was 1.2%, 0.75%, 1%, 1%, and 1%, the average results of this study are presented in graph 2. The best ester yield obtained in 1% NaOH at 20% methanol concentration. The average results of this study are presented in Table 1.

The total yield of 218 ml biodiesel was obtained from 244 ml Jatropha oil and glycerol was 23.4 grams. The average yield of biodiesel was 89.35% and glycerol 4.68 grams.

During the appropriate reaction time mixture was allowed to separate and settle overnight by gravity into a clear golden liquid biodiesel on the top with the light brown glycerol at the bottom. Unused methanol was recovered by distillation that saves input costs for the process and essentially eliminates the emissions of methanol to the surrounding. By water wash treatment the fuel obtained was washed for removal of NaOH from ester. After that washing fuel was ready to use.

Among all the treatment variations adopted it was found that the maximum methyl ester yield of 89.35% was obtained using 20% methanol and 1 % NaOH at 40^0C reaction temperature. The minimum reaction time required for maximum ester yield was found to be 120 min. After optimizing the concentration of methanol & NaOH, reaction time and reaction temperature in alkali catalyzed transesterification of *Jatropha curcus* oil. After comparison with BIS specifications biodiesel were found to use commercially.

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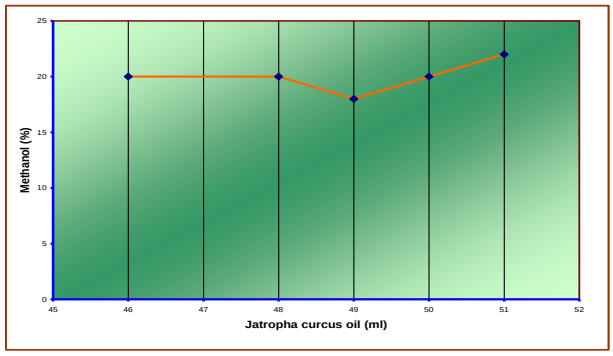
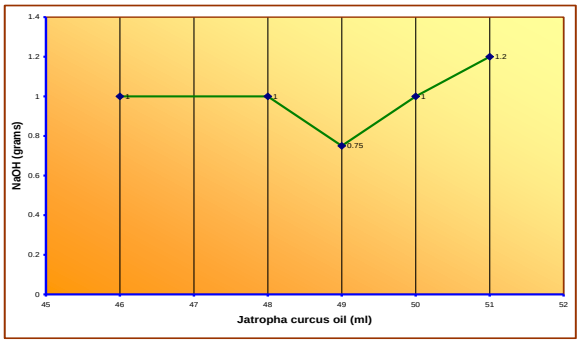
Table 1: Laboratory scale transesterification of *Jatropha* oil

Input				Output	
Jatropha curcus beens (grams)	*Jatropha curcus* Oil (ml)	Methanol (ml)	NaOH (grams)	Biodiesel (ml)	Glycerol (grams)
100	51	11.2	0.61	44	6.3
100					
100	49	8.8	0.37	43	5.4
100					
100	46	9.2	0.46	41	4.5
	48	9.6	0.48	44	3.6
	50	10.0	0.50	46	3.6
Total yield by alkali transesterification				218	23.4
Average yield				43.60 (89.35%)	4.68

Graph 1



Graph 2



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