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Development of a biofuel lamp and its comparison with a kerosene lamp

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Abstract
An attempt has been made to explore the suitability of crude Jatropha curcas seed oil (biofuel) as a fuel in substituting fully one of the important petroleum products like Kerosene. Expeller is used for the extraction of oil which is further filtered. This crude oil has a very high viscosity and, as result, cannot flow through capillary action in a standard lamp and, hence, requires viscosity reduction by a trans esterification process to convert it into biodiesel or by any other processes. But this is a complex chemical reaction and the cost of production becomes almost doubled unless glycerine is not recovered as a by-product. Hence, the paper describes the development of a unique lamp (lantern) fuelled by 100% biofuel (crude jatropha oil) for its illumination and its comparative performance with respect to a standard kerosene lamp.

Keywords: Jatropha curcas, biofuel, illumination

Introduction

A *Jatropha curcus* plant is drought resistant, growing well in poor soil and waste land. The oil content in the seed is more than 30% by weight. India has vast wasteland, and there is a need for awareness among the rural people and self-help groups for plantation of *Jatropha curcas* and its marketability.

The present work intends to promote the direct use of Crude Jatropha oil (named as biofuel) as rural fuel and for rural illumination purposes, instead of biodiesel as the conversion cost of crude to biodiesel is high and involves a complicated transesterification process requiring a reactor (jatrophaworld, jatrophasource, indobiofuel websites; Chakraborty & Sarkar, 2007).

In the scenario of 'energy crisis', the question of 'alternative fuel' comes to meet our current energy demand. Jatropha oil can be an important alternative fuel to substitute petroleum fuel to some extent. This paper aims at the solution of the problem by encouraging the use of crude oil.

Experimental procedure

1. 100 kg of Jatropha seeds of high quality were procured from the M/S Jatropha Foundation, Nalghar Chowk, Chhotapara, Raipur, India.
2. Oil was extracted by using an oil expeller from the whole seeds.
3. The oil was collected**.** Oil cakes were subjected to repeat squeezing (4 times) to extract most of the oil in it.
4, The oil obtained was passed through a filter press for filtration. About 30% of the mass of the seeds was recovered as oil from the oil bearing *Jatropha Curcas*.
5. Oil obtained was analyzed for fuel characteristics such as flash point, fire point, pour point, cloud point, calorific value etc.
6. Burning characteristics were evaluated in Pradip and in standard lanterns / lamps using extracted oil directly.
7. A comparative study of burning characteristics was carried out in a standard lantern with kerosene and using 100% extracted oil (biofuel) in a specially designed and developed lantern to sustain burning with crude jatropha oil having very high viscosity.

Results and discussion

To judge the quality of the crude oil (bio kerosene) as fuel, the characterization values of parameters

like the flash point, fire point, calorific values, viscosity, pour point and cloud point are required. All these parameters were measured and are tabulated in Table 1.

Table 1: Fuel characteristics of crude *Jatropha curcas* oil (bio kerosene)

Properties	Values
Sp. gravity	0.915
Flash point	250°C
Fire point	296°C
Cloud point	11°C
Pour point	-6°C
Viscosity (at 35°C)	59.8 CentiStoke (0.598m^2/sec)
Calorific value (HHV)	40 MJ/Kg (approx)

The data suggests that oil is not highly inflammable as its flash point is as high as 250^{0}C, whereas kerosene has a flash point of only 35°C. The calorific value is found to be 40 MJ/ Kg (approximate) which is attractive for its use in heating, if its high viscosity is taken care by modification of burners or by reducing viscosity. The pour point and cloud point suggest that oil will cease to flow at –6°C and it becomes opaque at 11°C and hence, can be transported above 11°C and is sufficiently below its flash point.

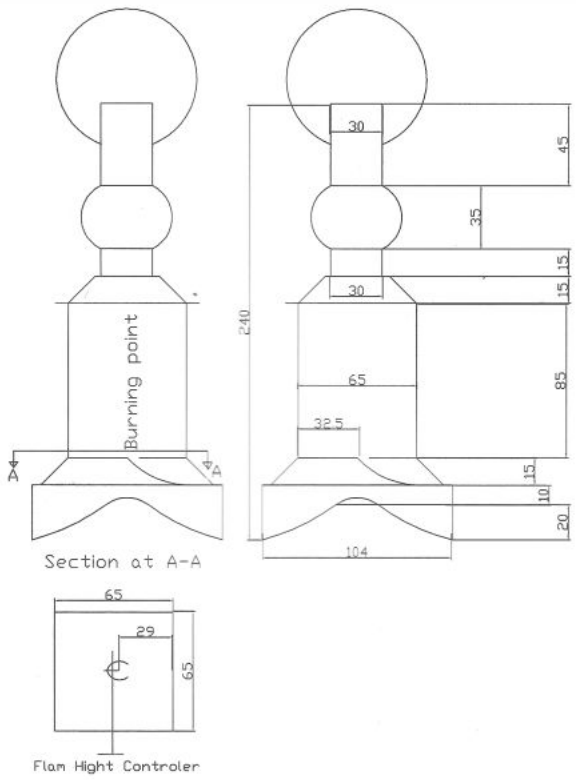

Figure 1: Burner design for biofuel lamp

Burning flame characteristics

The raw oil (bio kerosene) burns with an excellent flame in an earthen lamp with wick (Pradip)/ wide surface and flat-bottomed lamp) for a long period until the entire oil in the lamp is depleted.

A poor result was obtained with raw oil for a normal wick lamp/lantern where wick is placed vertically. Capillary action of the Jatropha oil through the wick is poor due to high viscosity of oil.

New design of lantern

A new design of lantern has been developed and fabricated in which crude Jatropha oil can be burnt directly for several hours. The material of construction is galvanized tin. The oil tank is located below the line A-A. The tank capacity of the small tank is 50 cm^3, which can sustain illumination overnight. Details of the design are shown in Figure 1.

The newly designed lantern has been used for an illumination study along with a conventional lamp using kerosene. The results are presented in Table 2.

It is observed that it burns without any smoke and a given amount of Jatropha oil can sustain illumination much longer than the same amount of kerosene and, hence, economical considerations can be justified.

Table 2: Comparative illumination study data for the conventional lantern using kerosene and biofuel lantern using 100% crude Jatropha oil

	Biofuel lantern[1]	*Kerosene lantern[2]*
Duration of illumination using same volume of fuel	3 times more	—
Luminosity or luminous flux	2.27 Lumen	2.89 Lumen
Chromaticity coordinate [X]	0.535	0.546
Chromaticity coordinate [Y]	0.416	0.412
Colour temperature [T_c]	1900K	1820K
Colour appearance	Yellow	Reddish yellow
Substantial residue	Not found	Not found
Soot formation	No soot	Soot present
Reproducibility	Repeated 3 times	

1. Non-conventional lantern specially designed for burning high viscosity fuel
2. Conventional lantern, designed for low viscosity fuel

Conclusion

With crude Jatropha oil, the flame did not continue to burn for a longer time as its flow through the long wick is restricted by the high viscosity of the crude. Therefore, with some modification of the burner design as explained in this paper, 100% crude Jatropha oil (bio fuel) can be used for illumination purpose, and it can sustain illumination 3 times more than what is obtained from a normal kerosene

lamp having same volume of oil with less or no smoke and soot formation.

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