Experimental Analysis of the Performance of *Hevea brasilensis* and *Jatropha curcas* Oils as Biodiesel

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Abstract

Biodiesel is an alternative fuel made from renewable biological sources such as edible and non-edible oil. Biodiesel has the potential of providing viable alternative to petroleum diesel fuel. *Jatropha curcas* and *Hevea brasilensis* oils were produced and applied to a Yoshita R175AN four stroke single cylinder diesel engine with declared speed of 2600 rpm and rated power of 4.85kw unmodified. The experiments involve measuring the speed of the engine when loaded with 30kg load and when not loaded using a Tachometer. The exhaust gases were similarly analyzed using SV – 5Q Automobile Exhaust Gas Analyzer. The results show that the power and speed generated by 100% of both Biodiesels is higher than that of 100% Petroleum diesel. In the percentage of 20% petroleum diesel and 80% biodiesel, *Hevea brasilensis* biodiesel produces more speed and power than *Jatropha curcas* biodiesel.

Keywords: Source of energy, fossil fuels, impending gap, biodiesel, *Jatropha curcas*, *Hevea brasilensis*.

Introduction

From the sources of energy known and already in use, it is clear that fossil fuels, particularly crude oil, are at the epicentre of the world energy demand. With the source now showing signs of depletion [1], facts clearly indicate that there has to be a major change in the pattern of usage of energy in order to maintain a healthy world economic society for the very near future. This is because the present delineated and known reserves of the basic energy raw materials exist in ratios which when compared with the ratios of consumption give frightening results, thus beyond all efforts at economizing its use, the time approaches when even the world supply will become inadequate [2]. Biodiesel is an alternative fuel made from renewable biological sources such as edible and non-edible vegetable oil. The non-edible vegetable oil of *Jatropha curcas* and *Hevea brasilensis* has the potential of providing viable alternative to diesel fuel without changes in the design or modification in the operational features of the diesel engines[3]. *Biodiesel* has many comparative advantages over petroleum diesel in terms of the environmental implications. The most obvious is that using *Biodiesel* as fuel creates a closed carbon (iv) oxide ($C0_2$) cycle. Combustion of biodiesel has been reported severally as having lower emissions compared with petroleum diesel, ie, lower emission of SO_2, soot, carbon monoxide (CO), hydrocarbon (HC), polyarametic hydrocarbons (PAR) and aromatics as present in the petroleum diesel [4-6].

The aim of this study is to compare the performance of *Jatropha curcas* and Rubber seed oils as sources of viable renewable substitute for petroleum diesel.

Methodology

The *Jatropha curcas* and *Hevea brasilensis* oils were produced by first collecting, de – husking, drying and grinding the seeds before extracting the oil using a screw press machine. 10.14kg of milled Jatropha was used for the experiment and the volume of oil extruded was about 2 liters while 4.2kg of milled *Hevea brasilensis* seeds yielded about 2.5 liters. A mixture of methanol and sodium hydroxide (NaOH) formed the methoxide which was used for the transesterification of the two oils. A Yoshita R175AN four stroke single cylinder diesel engine with declared speed of 2600 rpm and rated power of 4.85Kw unmodified was used for the experiment by measuring its speed when loaded with 30kg load and when not loaded using a Tachometer. The engine was left to run for 5 minutes each time before the readings were taken.

Result

Nine different types of fuel were used for the experiment, they are: A. Petroleum Diesel(PD), B. *Jatropha curcas(JC)* oil, C. Hervia Brasilensis(HB) oil, D. 50% *Jatropha curcas* oil and 50% Petroleum Diesel, E. 50% Hervia Brasilensis oil and 50% Petroleum Diesel, F. 20% *Jatropha curcas* oil and 80% Petroleum Diesel, G. 20% Hervia Brasilensis oil and 80% Petroleum Diesel, H. 80% *Jatropha curcas* oil and 20% Petroleum Diesel, I. 80% Hervia Brasilensis oil and 20% Petroleum Diesel. The results are as shown in figures 1 to 8.

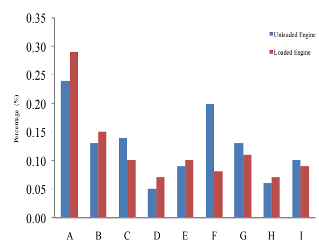

Fig. 1: Percentage Carbon Monoxide for the Different Fuels

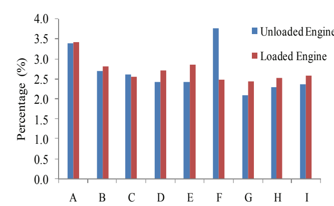

Fig. 2: Percentage Carbon Dioxide for the Different Fuels

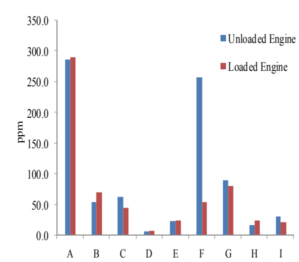

Fig. 3: Hydrocarbon for the Different Fuels

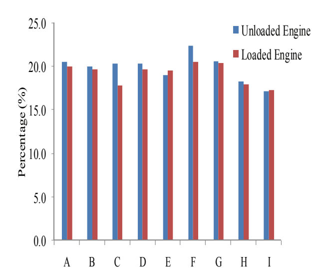

Fig. 4: Percentage Oxygen for the Different Fuels

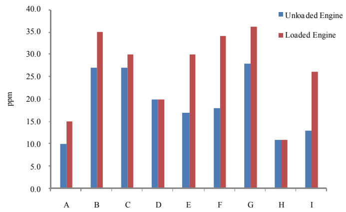

Fig. 5: Nitrogen Monoxide for the Different Fuels

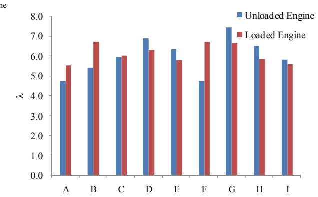

Fig. 6: Percentage Excess Air for the Different Fuels

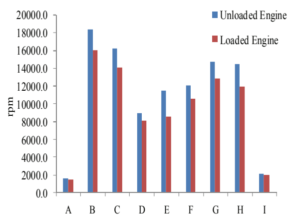

Fig. 7: Engine Speed for the Different Fuels

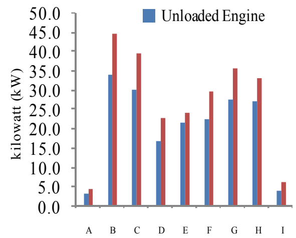

Fig. 8: Engine Power for the Different Fuels

Discussion

From the results as depicted in figures 1 to 8, it can be clearly seen from the values obtained from the exhaust gas of various fuels as analyzed using SV – 5Q Automobile Exhaust Gas Analyzer, that petroleum diesel has the highest emission of Carbon monoxide, CO, as shown in Fig. 1. The 50/50 and 80/20 mixtures of *Jatropha curcas* oil and petroleum diesel manifested low carbon monoxide in the exhaust. The percentage Carbon dioxide CO_2 did not show significant variation with the different fuels as shown in fig. 2, however, fig. 3 showing the quantity of Hydrocarbon HC in the exhaust for the different fuels, manifested significant variation for the different fuels. Again as depicted in fig. 3, the 50/50 and 80/20 mixtures of *Jatropha curcas* oil and petroleum diesel stand out. Whereas there is no significant variation in the Oxygen, O_2 in the exhaust from the respective fuel mix as shown in fig. 4, Nitrogen monoxide manifested noticeable variation as can be seen in fig 5. Fig. 6 shows that the variation in percentage excess air between the petroleum diesel and the biodiesel is not much even as are with the mixtures. The behaviour of the parameters when the engine is loaded and when not loaded with the various fuel mixes is also interesting. Figures 1 to 6 show that the commercialized mixture of the transesterified oils of the seeds of *Jatropha curcas* and Petroleum diesel at 20:80 does not behave too strangely from the other mixtures and even that of the oil of *Hevea brasilensis*. However, very strangely, comparing the speeds and powers generated by the engine using the different fuel mix, it is clearly seen that the power and speed generated by 100% transesterified *Jatropha curcas* oil and 100% transesterified oil of the seeds of Hervia brasilensis is higher than that of 100% Petroleum Diesel. The 20:80 ratio mixture of Hervia brasilensis and Petroleum diesel even shows better promises than the presently commercial mixture of 20:80 of *Jatropha curcas* and Petroleum diesel as shown in figs 7 and 8. It can also be seen that the transesterified oil of the seeds of Hervia brasilensis has lower emission of carbon monoxide, carbon dioxide, hydrocarbon, oxygen and nitrogen than the transesterified oil of the seeds of *Jatropha curcas* even when they are in varying ratios with petroleum diesel and when the engine is loaded and when not loaded. Also the speed and power generated with Hervia brasilensis is favourably comparable to that of transesterified *Jatropha curcas* oil. It can also be seen that whether the engine is loaded or not, in the percentage of 50% petroleum diesel and 50% biodiesel, the transesterified *Hevea brasilensis* oil generates more speed and power when compared with the transesterified *Jatropha curcas* oil. The exhaust values of transesterified Hervia brasilensis oil are, however, higher than that of transesterified *Jatropha curcas* oil. Figs 7 and 8 also show that in a percentage of 20% petroleum diesel and 80% biodiesel, the transesterified *Jatropha curcas* oil has less engine speed and power in comparison with transesterified *Hevea brasilensis* oil.

Conclusion

It is, therefore, evident that the biodiesel of *Hevea brasilensis* oil produces more speed and power than the biodiesel of *Jatropha curcas* oil. The work has also shown that the seeds of Hervia brasilensis have higher oil content than the seeds of *Jatropha curcas*. It is, therefore, recommended that the seeds of *Hevea brasilensis* should be a major target in the pursuit of a renewable replacement for fossil diesel considering the cost and production rate or yield. It is also to be noted that the plantations of *Hevea brasilensis* already exist in commercial quantities as they have great commercial values that will in no wise interfere with its availability for energy production. Producing rubber and fuel from *Hevea brasilensis* will make the plantations of *Hevea brasilensis* the living crude oil.

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