Coconut oil as an Hybrid Fuel for Diesel Engine

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***Abstract*— In the common today's environment as the pollution level is moving up rapidly due to consumption of the fuel. So we need to derive an alternative source to eliminate the same. Using biofuels instead of the combustive fuel can help us in this case. The biofuels can be used in the starting of the diesel engine and can also smoothen its working and increase the span of the year. Comparatively cost efficient and eco friendly. The concept lies in the fact of reducing the viscosity of the pure coconut oil and adding other preservatives such as ethanol and octanol to make it volatile and low viscosity hybrid fuel comparable to combustive fuel. Although the emissions are obtained but content of the carbon monoxide in the smoke emissions can be reduced up to a certain level. Hence the hybrid fuels can be successfully used as an alternative fuel for diesel engine.**

Keywords—Potency; preservatives; combustion; emission

I. INTRODUCTION

Hybrid fuels are basically referred to as vegetable oils and some other added preservatives. Vegetable oil is much more viscous (thicker) than either petro-diesel or biodiesel. Of course in the previous course of years the extraction of the fuel from the resources is more rapid and is leading to its extinction so for a better living there is immensely a need of some new source of energy. The new source can include many alternatives such as solar energy and hybrid technology but the there are some many major problems that occur in all these alternatives. Hybrid fuels are a renewable source of energy but their direct injection depends upon the viscosity and volatility of the fuel. The vegetable oils however cannot be directly used because of their properties. The high viscosity that is present in the fuel interferes in the operational process and hence leads to the poor results. The excessive use of the vegetable oil as a fuel may result in the deposit accumulation which can interfere with the combustion process which includes carbonization of injector's tips, ring sticking, lubricated oil thickening, gelling & degradation, engine misfire and ignition delay. To overcome all these problems various techniques are employed such as dilution and blending of the oils with diesel. Transesterification and micro emulsifiers are used to make hybrid fuel. The hybrid fuels that are researched throughout the process are micro emulsions which consists of the vegetable oils, ethanol and octan-1-ol which acts as a surfactant. The solution will help us in the successful mixing of the vegetable oil and ethanol by lowering the surface tension between the two phases so that one stable homogenous mixture can be obtained. The surfactant actually adjusts itself in such a way that hydrophilic end is oriented towards the water and hydrophobic towards the oil.

II. REQUIREMENT AND METHODS

The solution consists of the 95% ethanol and octan-1-ol & the 2 types of the coconut oil mainly crude coconut oil (CCO) and the virgin coconut (VCO) extracted from using direct micro expelling method followed by their purification process. The addition of the octan-o-ol to the solution affected in miscibility by titration method. Mixture of ethanol and coconut oil was made which varied from 0 to 25% by volume in 2% increments and then from 20-100% by volume in 10% increments. The addition of the 8% ethanol resulted in the milkyness of the whole solution and then automatically after the few minutes the chemical composition of the fuel is given in table no. 2. It was separated into the two phases. The surfactant octan-1-ol was then added in order to make it clearer. The solution was kept aside for almost a week in order to become stable in the appearance after which the phase diagrams were plotted. After the research moreover all samples were kept for about a full period of 6 months. Six homogenous and highly stable fuels were designated from HFI-HF6. The density of the crude coconut oil and virgin coconut oil was measured using a 50ml pyrometer in 26 degree Celsius temperature. To measure the kinematic viscosities the Ostwald viscometer was used at 26 and 20 degree temperature. The potency tests were performed on the

Table 1: Technical specifications of the test engine

Item	Specification
Model	PowerTec 170FG
Injection type	Direct injection
Maximum output	3.8 hp
Continuous output	3.4 hp
Bore	70 mm
Stroke	55 mm
Displacement	0.211 L
Cooling system	Forced air-cooled system
Lubricating system	Forced lubrication

powertech 170FG four strokes, single cylinder, air cooled direct injection ICE. Specifications are given in table no.1

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Table 2: Physical properties of the hybrid fuels, pure constituents and diesel

Fuel type	Relative density at 26°C	Kinematic viscosity at 26°C (cSt)	Kinematic viscosity at 20°C (cSt)	Gross calorific value (kJ g^{-1})
Diesel	0.8365±0.0002	6.07±0.04	7.28±0.03	45.1±0.8
Aqueous ethanol (95%)	0.7985±0.0003	1.97±0.02	2.17±0.07	27.3±0.4
Octan-1-ol	0.8200±0.0006	8.67±0.14	10.24±0.04	44.0±0.4
Crude coconut oil	0.9159±0.0007	43.77±0.92	Freezes	38.7±0.4
Virgin coconut oil	0.9174±0.0004	43.05±0.73	Freezes	38.8±0.4
Hybrid fuels				
HF1 [85(CCO), 9, 6]	0.9021±0.0006	21.86±0.23	25.51±0.06	37.2±0.6
HF2 [67(CCO), 17, 16]	0.8808±0.0005	12.81±0.23	15.60±0.02	37.7±0.9
HF3 [50(CCO), 21, 29]	0.8640±0.0009	9.02±0.03	10.77±0.03	37.1±0.5
HF4 [86(VCO), 9, 5]	0.9019±0.0002	21.56±0.19	25.35±0.03	36.4±0.4
HF5 [67(VCO), 17, 16]	0.8820±0.0005	12.82±0.13	15.55±0.03	38.4±0.2
HF6 [50(VCO), 22, 28]	0.8635±0.0005	8.88±0.15	10.64±0.02	38.6±0.3

When the engine was started at the operational temperature the load was adjusted using the electric bulbs. Basically the engine here was tested at the numerous loads (o, 30,60 and 89%) of the maximum output. The load was monitored using the asynchronous to the loaded system. The fuel consumption was measured using the constant volume method whereas the fuel flow rate was checked with the help of measuring cylinder.

A PG-250 horiba gas analyzer was accompanied for the exhaust emissions into the exhaust pipe of the engine. The analyzer however measured the concentration of the given contents NO(ppm), So_2(ppm), CO(ppm), CO_2(VOL %) and O_2(VOL %).

III. RESULTS PROBLEMS AND SOLUTIONS:

All the curves are plotted at 26 degree temperature for the hybrid fuels . The formulations that are higher than the miscibility curve exists mutually visible innovate the shape or thermodynamically stable micro emulsions whereas those below the curves are unstable and have 2 visible distinct phases shown in figure 1 therefore only 8% of the ethanol can be totally blended with the CO and VCO without the help of the surfactant but surfactant has to be added in it in order to make it compatible with 95% ethanol after its concentration exceeds by 8%.

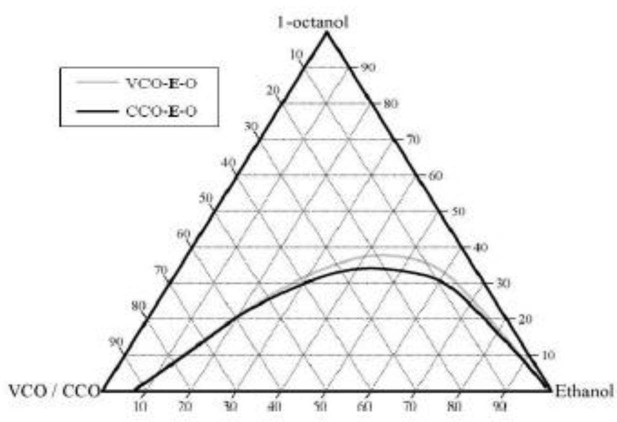

Fig1. Ternary phase of the virgin coconut oil/crude coconut oil ethanol and octan-1-ol showing phase behavior

IV. FUEL CONSUMPTION

The specific fuel consumption for the fuel mass rate of an engine to its output power of the engine for the hybrid fuel is shown by the curves plotted in Fig 2 & 3.

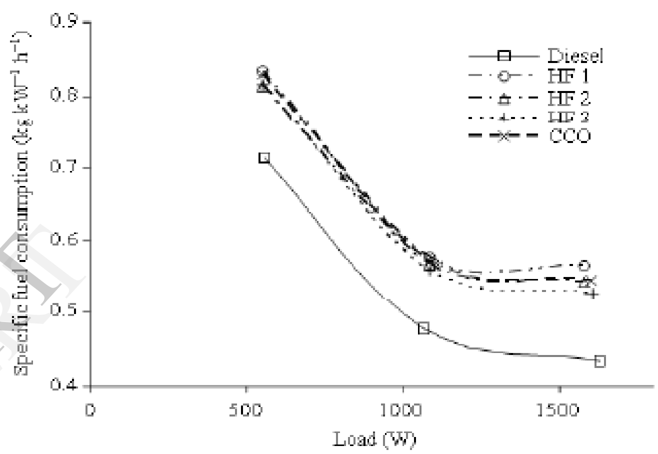

Fig2. Specific fuel consumption of crude coconut oil based on hybrid fuels and diesel.

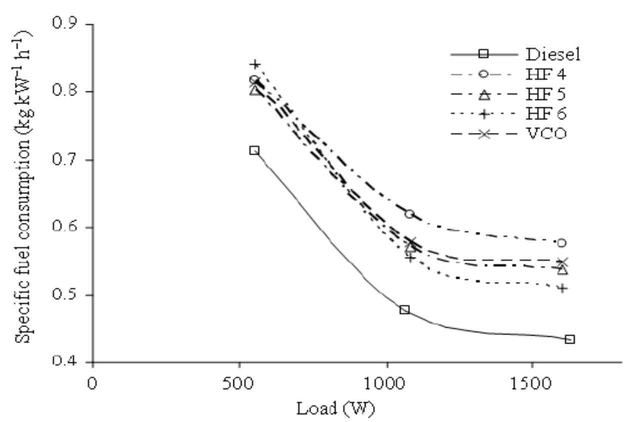

Fig3.Specific fuel consumption of the virgin coconut oil based on hybrid fuel.

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This can be seen from the above graphs that specific fuel consumption decreases as we increase on the load and also the specific fuel consumption of the hybrid fuels is higher than that of the diesel fuel. The hybrid fuel have lower calorific value as of diesel so the hybrid fuel having lowest gross calorific value has highest specific calorific value. So according to the results higher volume of the hybrid fuel are needed to produce the same amount of energy due to lower gcv and higher density as that of diesel.

V. ENGINE EFFICIENCY:

Engine efficiency of the thermal engines is given as a relationship between total energy contained in the fuel to the energy used to perform the useful work as shown in fig 4 and 5. There is a gentle increase in the potency because the load will increase for all types of the fuel varieties. The engine potency is that the lowest for both variety of coconut oils which might be attributed to their high body and density and poor mixture formation as a results of the low volatility. The small differences in the graph can be seen within the properties such as viscosity and density. The hybrid fuels hence have higher specific fuel consumption due to the lower gross calorific value so therefore the hybrid fuel has the same efficiency as that of the diesel.

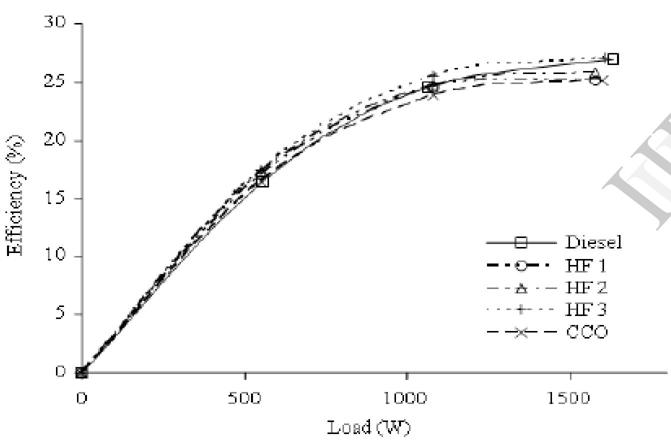

Fig4. Engine efficiency for the crude coconut oil based on hybrid fuels.

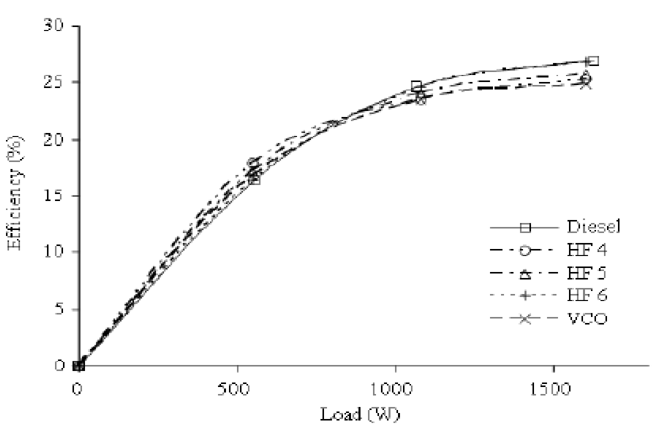

Fig5. Engine efficiency for virgin coconut oil based on hybrid fuel and diesel..

VI. EMISSION CHARACTERSTICS:

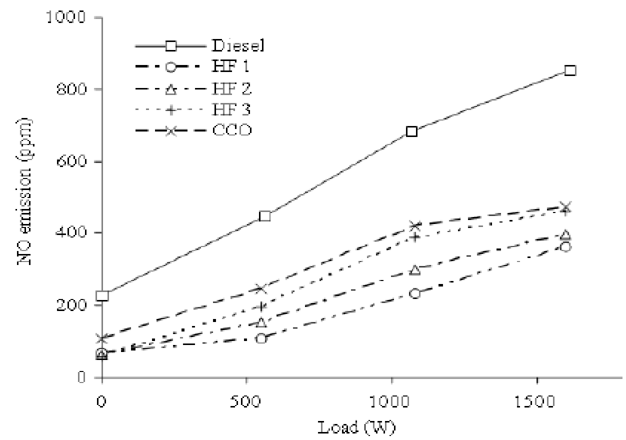

Fig6. Effect of the NO emissions for the coconut oil and diesel.

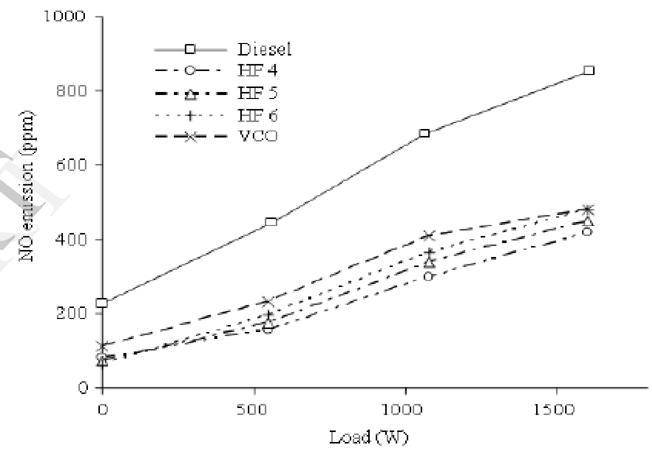

Fig7. Effect of the NO emissions from virgin coconut oil based on hybrid fuel..

It can be seen that emissions from the hybrid fuel are comparatively lower than that of the diesel. The exhaust gas temperature which is comparatively higher in all engines is lower in case if hybrid fuel mixture is used. This is denoted by peak temperature so if there is lower peak temperature lower the NO emissions will be exhausted out of the system. Different CO emissions were recorded for hybrid fuel and plotted on fig.8 & 9.CO is therefore recorded because when the engine is operated on a high air to fuel ratio and there is insufficient oxygen for complete combustion. Therefore the emissions of CO coming out from the crude and coconut oil can be decreased when the amount of concentration of the ethanol is decreased.

The SO_2 emissions were 64% for the crude coconut oil and for the virgin coconut oil it increased to 74%. The characteristics observed are plotted in fig10.

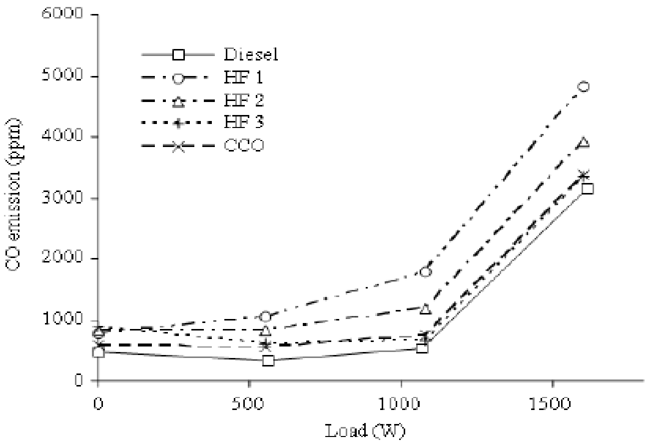

Fig 8: CO emissions from the crude coconut oil (CCO) based hybrid fuel.

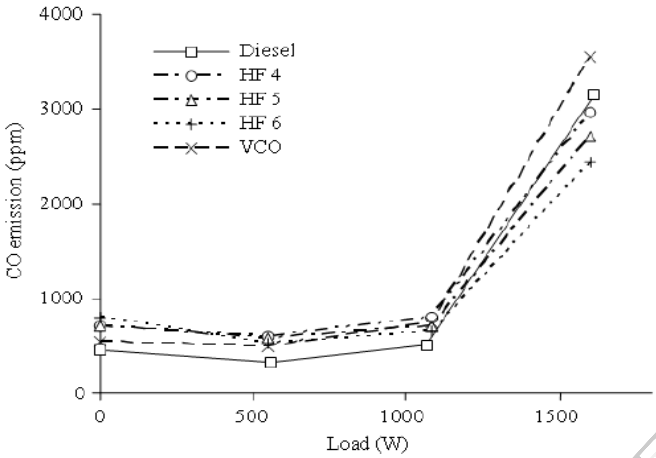

Fig 9: CO emissions from the virgin coconut oil(VCO) based on the hybrid fuel

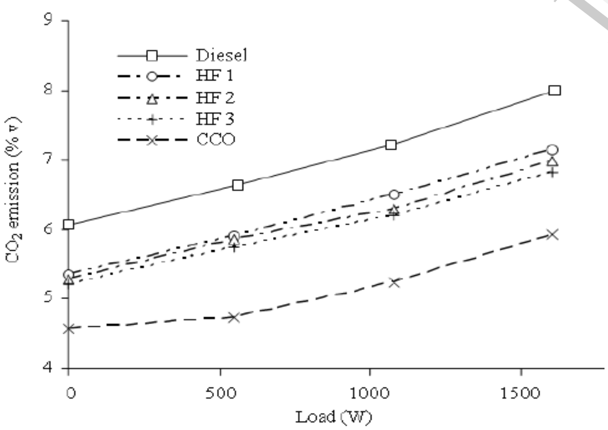

Fig 10: SO_2 emissions of the crude coconut oil based on hybrid fuel.

The CO_2 emissions are shown in fig 12 & 13 which is the byproduct of whole combustion.

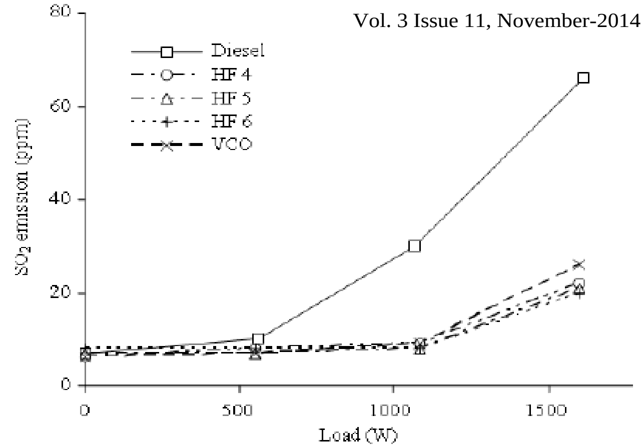

Fig11: SO_2 emissions of the virgin coconut oil based on hybrid fuel.

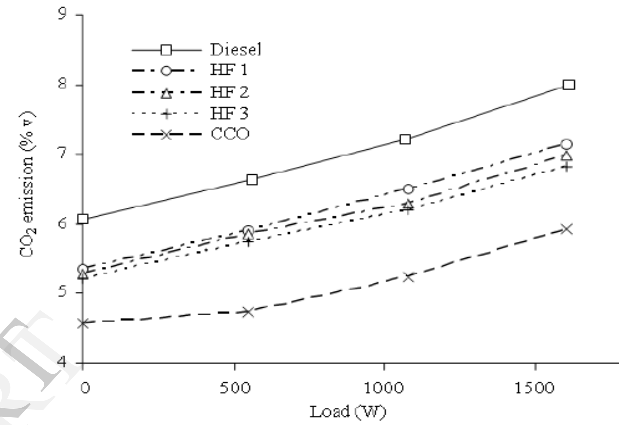

Fig 12: CO_2 emissions from crude coconut oil based on hybrid fuel.

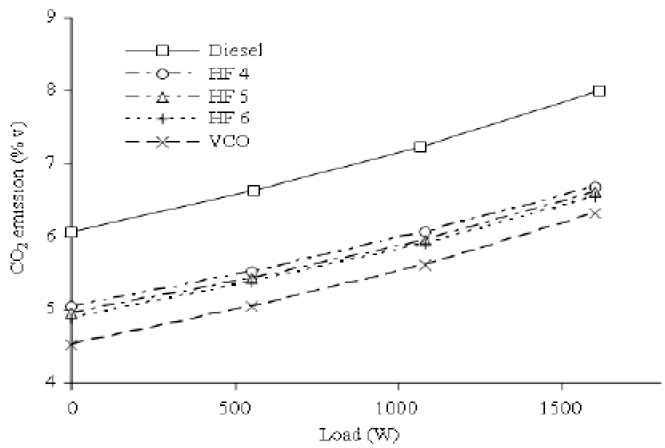

Fig 13: CO_2 emissions from virgin coconut oil based on hybrid fuel compared to that of diesel.

VII. CONCLUSION:

With the experimental work the characteristics are plotted as:

1. Octan-1-ol can be used as an effective surfactant to create a solid micro emulsion of coconut oil and ethanol of almost 95% purity.

2. Efficiency of hybrid fuel can be compared as similar to that of diesel engine.
3. Specific fuel consumption value of the coconut oil is greater than that of diesel due to lower gross calorific value.
4. These hybrid fuels can be directly used in the direct fuel injection system.
5. Emissions of CO, NO and SO_2 are lower to that compared of diesel.

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