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Analyzing of Exhaust Gas of Single Cylinder Diesel Engine by Injection of Sunflower 0il (Bio-Fuel)

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ABSTRACT

Many attempts to use vegetable oils as fuel have been performed since the early days of the Diesel engine. When a Diesel engine is used with vegetable oil fuel for a short period of time, the performance and global efficiency are usually very close to Diesel fuel. However, during long-term engine tests with vegetable oils as fuel, heavy deposits build-up can be observed in the combustion chamber. These deposits can lead to engine breaks. A fuel droplet vaporization experiment proved that the deposits build-up is mainly controlled by the combustion chamber temperature. A new thermally insulated combustion chamber made it possible to raise the combustion chamber wall temperature. With this combustion chamber, the deposits were greatly reduced. To use vegetable oils as fuel, DI Diesel engines need to be redesigned to accommodate the specificity of the vegetable oils combustion, one possibility is to use a thermally insulated combustion chamber. This paper is related with performance analysis of Compression Ignition Engine using sunflower oil for different engine load from 1 kg to 10 kg and different portmanteau ratios like Portmanteau:1000, Portmanteau:7525, Portmanteau:5050, Portmanteau: 2575, and Portmanteau:0010. With the injection of above Portmanteau in different portmanteau ratio and at different load we found the exhaust emission in terms of CO emission, HC emission, Exhaust gas temperature and smoke density and performance analysis of the bio-fuel.

Keywords: *Load; Engine; Portmanteau; Emission; Performance*.

1.0 Introduction

Development of the biofuel sector is a promising option for many developing countries. Given the impending energy crisis, they are much more vulnerable than wealthy countries and ensuring their energy supply at an affordable cost will become a serious challenge in the years to come.

Moreover, most southern countries do not have large investment capacities, so they have to find economical solutions to launch new economic activities in the energy production field. In this context, biofuel production is a major opportunity, particularly where large arable land areas are available and a large share of the population is involved in agriculture, such as in West Africa [1-9].

One of the most advantageous branches in the biofuel sector is seen to be the production of straight vegetable oil (SVO) for direct use as fuel in diesel engines. There has been renewed interest in this activity in recent years, for stationary applications in the fields of agriculture, power generation and industry [10-15].

These sectors are major consumers of fuel oils, either high distillates (diesel),medium distillates (DDO Distillate Diesel Oil) or heavy Fuel Oil 180 (FO180), which might be wholly or partially replaced with SVO [10, 12, 13].

This solution may contribute to reducing the cost of fossil fuel imports incurred by most developing countries, curb dependence on fossil fuels and limit greenhouse gas (GHG) emissions [14, 16-18].

This is particularly true for African countries such as Burkina Faso, Mali, Niger, Botswana, Madagascar, Malawi, Tanzania or Uganda, which import 100% of the fossil fuels they need [19].

In recent years, many initiatives for the production of oilseed-based biofuels (SVO or biodiesel) have emerged in West African countries, with the support of governments or through regional initiatives [20]. In this context, many perennial oil

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crops, especially Jatropha curcas, have been planted and large quantities of SVO are set to be produced in the coming years [21-26]. The most widespread scheme adopted by project promoters is the local production of oilseeds and their conversion into SVO by village-scale extraction units or decentralized cooperative mills, to fuel local stationary diesel engines [10, 11, 27]. This scheme has the advantage over biodiesel production of only requiring reasonable investments and offering much more flexibility in terms of production capacity, compared with large-scale centralized biodiesel production [17, 20].

At the beginning of these biofuel promotion campaigns, the concerns mainly focused on the agricultural part of the sector. Today, with the arrival of the first expected harvests, 3 years after planting in the case of Jatropha curcas, biofuel project developers are questioning the extraction and purification techniques, and the use of SVO in diesel engines. In such a decentralized scheme, the processing conditions can be very different from one unit to another, leading to a wide range of oil qualities. Using vegetable oil of unknown quality as fuel might be risky and rapidly cause fatal mechanical damage to engines [13, 14, 28]. Consequently, oil quality is a recurring issue that is impeding the development of the sector, since there is no standard defining what should be the quality characteristics of vegetable oils for fuel purposes in stationary engines.

Currently, no specific legal standard applies to vegetable oils for fuel uses, so by default they must comply with the quality standards of petroleum diesel fuel (set by standardization institutions such as ASTM and ISO). At the moment, SVOs rarely meet the requirements of petroleum fuel standards. Few initiatives have been launched in recent years to standardize the quality of SVO produced from a specific biomass: i) some studies were carried out in Germany on rapeseed oil [29, 30], ii) and an initiative would seem to be under way to define a standard for Jatropha curcas oil in Mali [31].However, in all cases, the analytical methods have been derived so far from those used in petroleum fuel standards, hence designed to characterize complex mixtures of hydrocarbons, while SVOs mainly consist of quite different chemical compounds, i.e. triglycerides. As a result, certification requires a series of complicated and expensive analyses to be carried out that are not always relevant for SVO [32]. Moreover, this does not comply with the needs of small-scale oil extraction plants, which require a quick and low-cost methodology to certify an acceptable quality of SVO for fuel use in stationary diesel engines.

Consequently, the introduction of an SVO quality standard dedicated to stationary engines with low certification costs is very likely to facilitate the development of this sector in developing countries. Regional organizations such as the West African Economic and Monetary Union (WAEMU) are interested in such a norm. Local certification laboratories could be set up and guarantee good quality SVO for consumers.

The aim of this study was to consider and propose a basic set of quality criteria that SVO must comply with, in order to be used as fuel in a stationary diesel engine without causing breakdowns or serious lifetime reductions. After a brief review of SVO production and use techniques, we propose a critical review of existing tentative standards and take a look at existing experience in fuelling diesel engines with SVO, taking into account the requirements of engine manufacturers. Based on this critical analysis and current knowledge on vegetable oil characterization, we propose a simplified, cheap and efficient basic standard that enables easy assessment of SVO quality for fuelling a stationary diesel engine.

2.0 Biodiesel. Definition of Biodiesel

The term biodiesel has no unambiguous definition. It stands for neat vegetable oils used as DF as well as neat methyl esters prepared from vegetable oils or animal fats and blends of conventional diesel fuel with vegetable oils or methyl esters. With increasing emphasis on the use of esters as DF, however, the term "biodiesel" increasingly refers to alkyl esters of vegetable oils and animal fats and not the oils or fats themselves. In an article on proposed ASTM standards, biodiesel was defined as "the mono alkyl esters of long chain fatty acids derived from renewable lipid feedstock, such as vegetable oils or animal fats, for use in compression ignition (diesel) engines." Nevertheless, clear distinction between these different vegetable oil-based or -derived alternative diesel fuels is necessary.

For use in the United States, the U.S. Department of Energy has stated, "that biodiesel is already covered in the statutory and proposed regulatory definitions of "alternative fuel" which refer to any "fuel, other than alcohol, that is derived from biological materials." The Department, therefore, is considering amending the proposed definition of "alternative fuel" specifically to include neat biodiesel." The definition of biodiesel was not extended to include biodiesel blends, with the Department of Energy stating that "the issue of including biodiesel mixtures or blends comprised of more than 20 percent biodiesel is currently under study. However, this subject is complex and will require significantly more data and information, and a separate, future rule.

3.0 Objective

The use of vegetable oils as an alternative substitute in a system, designed to run on diesel fuel will undoubtedly impose problems. Vegetable oil has an ignition quality equivalent to diesel fuel and their combustion characteristics are much the same, but there viscosity is too high for the modern fuel pumps .Higher viscosity results in incomplete atomization of neat vegetable oil fuel. So the vegetable oil was heated to lower the viscosity which has provided engine durability improvements .Our aim is to use the sunflower oil as substitute of diesel in the following proportions by volume.

Portmanteau1000	100% sunflower oil
Portmanteau 7525	75% sunflower oil + 25% Diesel
Portmanteau 5050	50% sunflower oil + 50% Diesel
Portmanteau 2575	25% sunflower oil + 75% Diesel
Portmanteau 0010	100% Diesel

By using this we want to analyze the exhaust characteristics and the performance of the engine (comparison of the power developed at various proportions).

4.0 Methodology

A Constant speed, single cylinder, four stroke, naturally aspirated, water cooled, direct injection diesel engine of 5BHP, Kirloskar make was chosen for doing the experimental work. The detailed specifications of the engine are given below:

1.	Make Type	Kirloskar Engine
2.	Engine Type	Single Cylinder
3.	Method of Injection	Direct injection
4.	Stroke	100 mm
5.	Bore	80 mm
6.	Rated Power	5 bhp
7.	Compression Ratio	16.5:1
8.	Total Displacement volume	554 cc
9.	Rated Speed	450 rpm
10.	Loading Device	Rope Dynamometer
11.	Fuel Injection Timing	22° BTDC
12.	Method of Cooling	Water Cooled

Exhaust gas analyzer was used to measure the concentration of emissions of carbon mono-oxide and hydrocarbons. Fuel was fed to the injector pump under gravity and the volumetric flow rate was measured by the use of 50cc graduated burette and a stopwatch. The speed was measured by tachometer. The engine was started on the diesel tank and runs on diesel for the first few minutes. While the vegetable oil was heated to lower the viscosity which has provided engine durability improvements

5.0 Observations

1. Properties of portmanteaus in various proportions

Properties	Portmanteau 1000	Portmanteau 7525	Portmanteau 5050	Portmanteau 2575	Portmanteau 0010
Specific gravity	0.83	0.851	0.871	0.88	0.89
Calorific value KJ/kg	42400	41200	40900	40650	39800

2. Co -Emission

Load (kg)	Port.1000	Port.7525	Port.5050	Port. 2575	Port.0010
1	0.75	0.132	0.139	0.136	0.155
3	0.130	0.164	0.154	0.154	0.174
5	0.160	0.167	0.163	0.200	0.166
7	0.185	0.240	0.185	0.177	0.155
10	0.202	0.275	0.240	0.265	0.344

3.0 Smoke Density (%)

Load (kg)	Port.1000	Port.7525	Port.5050	Port. 2575	Port.0010
1	05	04	05	05	04
3	15	10	10	11	05
5	20	21	15	15	11
7	37	38	29	35	34
10	38	39	43	44	45

4.0 Hc- Emission

Load (kg)	Port.1000	Port.7525	Port.5050	Port. 2575	Port.0010
1	360	345	322	300	290
3	572	545	523	490	485
5	515	685	677	649	594
7	455	772	726	719	722
10	400	972	940	941	922

5.0 Other Readings

S. No	R. P. M	Load (Kg)	Voltage (V)	Current (I)	Frequency (HZ)	Energy meter	Mano. Reading $\Delta h = h_1 - h_2$	Time taken for 20 ml Fuel to burn,(t) seconds	Engine cooling water flow rate m_w (kg/hr)	T_1 °C	T_2 °C	T_3 °C	T_4 °C	T_5 °C	T_6 °C
1	400	1	220	1.38	49.68	5.76	88	32	4	23	41	160	24	23	75
2	400	3	223	1.39	50	5.81	87	23	4	23	48	180	24	24	90
3	400	5	224	2.11	49.62	6	87	19	4	23	53	220	24	25	107
4	400	7	222	2.8	49.78	6.15	88	16	4	24	53	245	25	25	120
5	400	10	223	3.8	50	6.51	87	14	4	23	55	260	25	25	132

Where,

T1=Temperature of water entering the engine.

T2=Temperature of water leaving the engine.

T3=Temperature of exhaust gas leaving the calorimeter.

T4=Temperature of exhaust gas entering the calorimeter through the engine.

T5=Temperature of water entering the calorimeter.

T6=Temperature of water leaving the calorimeter.

6. Graphical Representation

Fig: 1. CO Emission Versus Load

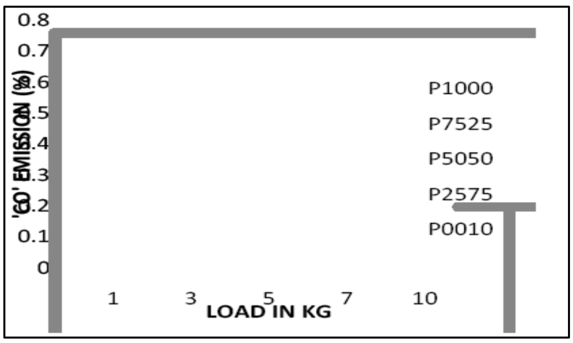


Fig: 2. Smoke Density Versus Load

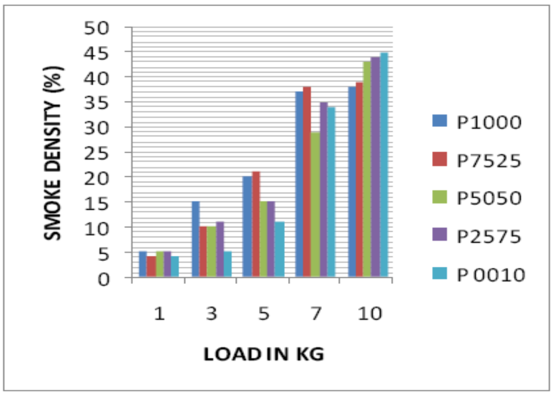
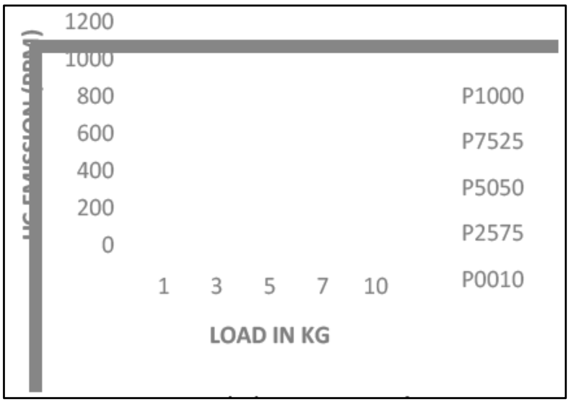


Fig: 3. HC Emission Versus Load



6.0 Conclusion

Many studies involving use of un-modified vegetable oils in blend ratios with diesel fuel exceeding 20 percent were conducted in the early 1980's. Short-term engine testing indicates that vegetable oils can readily be used as a fuel source when the vegetable oils are used alone or are blended with diesel fuel. Long-term engine research shows that engine durability is questionable when fuel blends contain more than 20% vegetable oil by volume. More work is needed to determine if fuel blends containing less than 20% vegetable oil can be used successfully as diesel fuel extenders.

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