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The Effect of Additives on Performance of CI Engine Fuelled With Bio-Diesel

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ABSTRACT

The considerable amount of energy is expensive in transportation & industrial sector and also a vital demand in meeting through diesel engine in all over the world due to their higher performance as compared to the conventional fuels. However, there w as a tremendous alarm regarding the crude oil products which are going to be depleted in near future. So, in this connection it is necessary to reach, the suitable fuels other than the fossil fuels and also on the other hand it is mandatory to control the expense of the both fuels. In this work an attempt is to be made to investigate the commercial use of suitable and non-toxic additives in order to improve the performance of an engine without sacrificing the functionality parameters. The main concern of this work is to utilize the maximum effective way to control the asserted parameters like emissions and combustion characteristics. This investigation carried out on a diesel engine fuelled with B100 (ja tropha) with two additives, Nitro methane (Nm) and Methyl Tetra Butyl Ether (MTBE) are tested in kirloskar computerized diesel engine. Jatropha biodiesel is a non-toxic, biodegradable, environment friendly, renewable fuel and do not add to global warming. The additives selected are based on the biodiesel properties, toxicity and economic feasibility. Additive MTBE is used for oxygenated and the other additive Nm is used as cetane booster.

Keywords:—*Additives, Transestification, Bio-diesel, CI engine, Emissions*

I. INTRODUCTION

In present energy scenario of world energy crisis, the fuels of bio-origin can provide a feasible solution. The enormous growth of world population, increased technical development, enhancement in the stranded of living and industrialization has led to this intricate situation in the field of energy supply and demand. The price of crude oil keep rising and fluctuating on a daily basis.

The variations in energy prices are very heavy in the last decade. Environmental consents have increased significantly in the world over the past two decades. Excessive use of fossil fuels has led to global environmental degradation effects such as green house effect, acid rain, ozone depletion, climate changes etc. The above factors necessitate developing and commercializing fossil fuels alternatives from bio-origin. The growing awareness and interest for non conventional bio energy sources and fuels led the authors to work on biodiesel. They have already used biodiesel with Jatropha curcas (Ratab-gyit), Pongamia Pinnata (Karanji) and now in this research paper we used Jetropha bio-fuel. We have also make use of Nitro methane (Nm) and Methyl Tetra Butyl Ether (MT BE) as additives [1, 2].

1.1 Fuel additives

Fuel additives are compounds formulated to enhance the quality and efficiency of the fuels used in motor vehicles. In some cases, the supplier incorporates the additive into the gasoline its elf; at other times, the fuel additive is s old as a separate product that consumers may us e to improve or maintain the performance of their engines. While some auto mechanics place a great deal of emphasis on using fuel additives or purchasing gasoline that is infused with the additional protectants or performance boosters, others question the effectiveness of additive products. There are several benefits associated with the use of fuel additives. One of the main advantages has to do with engine performance. With some fuel oil additives, the product is claimed to boos t the octane level of the gasoline, providing the engine with more power fro m the same a mount of gas. The end result is the ability to travel further on gas infused with additives than would be possible otherwise. Engine maintenance is another common benefit cited by the supporters of fuel additives. With these types of enhancement products, the focus is on preventing the buildup of sludge and other deposits in different areas of the engine. Because there is les s buildup in the lines and many of the oving parts on the motor, less stress is placed on the engine during operation, effectively prolonging the life of the vehicle [3, 4].

II. Literature Review

2.1. Production of Biodiesel, Performance and Emission Characteristics of C.I. Engine Fuelled With Biodiesel.

Hoekman and Robbins [5] reviewed the effects of biodiesel on NOx e missions. Compared to conventional dies el fuel, use of biodiesel is generally found to reduce emissions of hydrocarbons (HC), carbon monoxide (CO), and particulate matter (PM); but to increase oxides of nitrogen (NOx) emissions. This paper reviews and summarizes relevant literature regarding the so-called “biodiesel NOx effect, and presents theories” to explain this effect. In modern diesel engines, several factors related to fuel composition and engine control strategies are important, though no single theory provides an adequate explanation of the biodiesel NOx effect under all conditions. There is evidence to suggest that effect on injection timing, ignition delay, adiabatic flame temperature, radiative heat loss, and other combustion phenomena all play some role. The biodiesel NOx effect can be mitigated by modifying engine control settings particularly by retarding injection timing and increasing exhaust gas recirculation (EGR). The absolute magnitude of the biodiesel NOx effect appears to be reduced with modern engines, although there are cases where the percentage change is still substantial. Sophisticated after-treatment systems required to achieve the 2010 diesel engine emissions standards do not appear to be significantly affected by use of biodiesel. However, longer term study is warranted, as such systems have only been in commercial use for a short time.

2.2. Method of Biodiesel Product Ion

To obtain biodiesel, vegetable oil is subjected to a chemical reaction known as transesterification [6]. In transesterification vegetable oil is treated with in the presence of acatalyst (usually a bas e) with an alcohol (usually methanol) to give the corresponding alkylesters (or for methanol, the methylesters) of the FA mixture that is found in the parent vegetable oil or animal fat. Biodiesel can be produced from a great variety of feeds tocks. These feed stocks include most common vegetable oils (e.g., soybean, cottonseed, palm, peanut, rapeseed/canola, sunflower, safflower, coconut) and animal fats (usually tallow) as well as waste oils (e.g., used frying oils). The choice of feeds tock depends largely on geography. Depending on the origin and quality of the feeds tock, changes to the production process may be necessary. The harvested Jatropha seeds are used for production of Jatropha oil and biodiesel. The first step is to extract the oil in the seeds, which can later be converted into biodiesel.

III. Experimental Procedure

The details of the experiment setup, specifications of test engine, loading and instrumentation are described in this section. Experiments are conducted on a Kirloskar A V-1 stationary diesel engine of the IC Engines laboratory of Mechanical Department of JNTU College of Engineering, Hyderabad.

Table 3.1, Specifications of the Engine

Make and Model	Kirloskar, TV1
Type of engine	4 stroke, Variable compression diesel engine
No. of cylinders	Single cylinder
Cooling media	Water cooled
Rated capacity	5.2 kW @ 1500 RPM
Cylinder diameter	87.5 mm
Stroke length	110 mm
Connecting rod length	234 mm
Compression ratio	17.5:1
Orificediameter	20 mm
Dynamometer	Eddy current dynamo meter
Dynamometerar m length	145 mm

3.1. Experimentation

First the experimentation is performed with dies el (for getting the base line data of the engine) and then Jatropha bio-diesel, and then bio-diesel with additives. The performance of the engine is evaluated in terms of brake thermal efficiency, brake specific energy consumption, exhaust gas temperature, and e mission of the engine is analyzed in relation with HC, CO and NOx.

3.2. Exhaust Gas Analyzer:

The gas analyzer measures, Oxygen (O2), Hydrocarbons (HC), Carbon Dioxide (CO2), Carbon Monoxide (CO), and Nitrogen Oxide (NOx) at the exhaust of the engine.

3.3. Selection of Additives

The selection of additives for oxygenating the fuel depends on economic feasibility, toxicity, fuel blending property, additive solubility, flash point of the biodiesel, viscosity of the fuel and water partitioning of the additive. A number of oxygen containing materials such as propylene carbonate, ethylene and propylene glycols, diethyl ether are available for use. Based on the biodiesel properties, toxicity and economic feasibility methyl tetra butyl ether is selected. The other additive selected is nitro methane which is used as cetane booster.

Table 3.2. Specifications of Exhaust Gas Analyzer

Sl. No.	Specifications	Gas Analyzer
1	Warm up time	7 minutes
2	Operating Temperature	5 to 45ºC
3	Storage Temperature	0 to 50ºC
4	Inclination	0 to 90º
5	Dimension (w *d * h)	27 0 mm * 320 mm * 85 mm

Table 3.3. Additives characteristics

Properties	MTBE	Nitro methane
Density (kg/ m3)	740.4	1137.1
Calorific value (MJ/ kg)	40.72	11.3
Molarmas s (g/mo l)	88.15	61.04
Flashpoint (° C)	-10	35
Boiling point (° C)	55.2	100-103

3.4. Methodology

The engine is first started by using Diesel as a fuel at injection pressure of 180 bars and the operating characteristics and emissions such as Oxygen (O2), Carbon Monoxide (CO), Carbon Dioxide (CO2), Hydrocarbons (HC) and Nitrous Oxide (NOx) of the engine from the exhaust gas are noted down. The obtained results of diesel are standard parameters and are used for comparison of performance and emissions of biodiesels and their blend. The engine is then runned by Jatropha biodiesel at an injection pressure of 180 bars. The engine after starting is allowed to run for 10-15 minutes to reach steady state conditions before noting the readings. After the steady state conditions are achieved the observations are made for incremental loads ranging from no load to full load. For each loading the inlet air flow rate, the time for 10 cc of fuel consumption, the ambient temperature, the exhaust gas temperature, the outlet cooling water flow rate, the temperature readings and the five emissions such as O2, CO, CO2, HC and NOx from the gas analyzer are noted.

IV. Performance and Emissions Results

The performance and emission characteristics were conducted on a typical four-stroke, single cylinder, constant - speed, water-cooled, direct-injection diesel engine, largely used in the agricultural sector. The engine is coupled with an eddy current dynamometer and an electrical loading device. The performance parameters were investigated using different fuel a long with additives.

4.1. Performance Results

4.1.1. Brake Specific Fuel Consumption

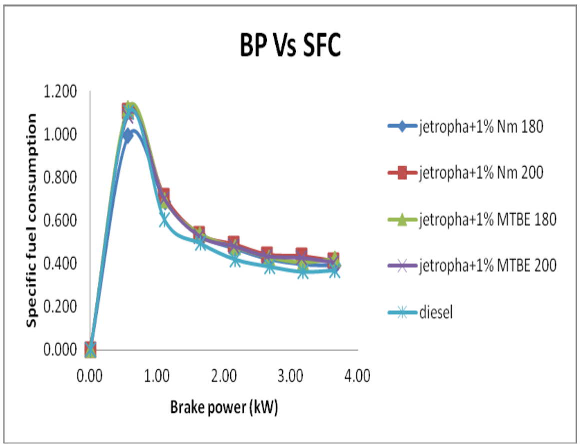

Figure 4.1. illustrates break specific fuel consumption (BSFC) variations for all the fuels with change in brake power.(BP)

Figure 4.1. Variations in specific fuel consumption with change in brake power At 1 kW b rake power, brake specific fuel

consumption is maximum for the all biodiesel and diesel. After that the brake specific fuel consumption decreases continuously with increase in brake power. But BSFC in case of jetropha biodiesel remains more than in case of diesel. It is due to lower energy content of jetropha biodiesel. At initial BP values BSFC of jet ropha+1% Nm is less than diesel. Whereas at final conditions BSFC of biodiesels almost 11.9% more than that of dies el.

4.1.2. Mechanical Efficiency

Change in mechanical efficiency of biodiesel + additives, and diesel with respect to change in brake power is shown in the figure 4.2. Initially mechanical efficiency of diesel and biodiesel + additives is same. As break power increases, mechanical efficiency increases because mechanical efficiency is directly proportional to break power and brake power increases as the load on engine increases. At full load conditions, jet ropha+1% Nm biodiesel is 3.5% more than that of the diesel. Mechanical efficiency of jetropha+1% Nm and jetropha+1% MTBE is almost same.

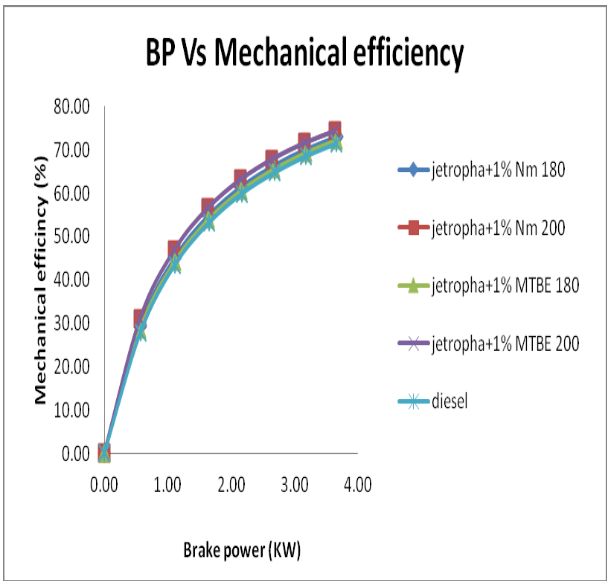

Figure 4.2. Change in mechanical efficiency with change in brake power

4.1.3. Brake Thermal Efficiency (B TE)

Figure 4.3. Illustrate change in BTE of biodiesel and diesel with respect to change in brake power as shown below. At initial brake power condition, BTE of biodiesels and ordinary diesel is same. As the brake power value of engine increases, BTE value increases because BTE is function of BP. The BP increases as the load on the engine increases. At part load conditions, the BTE of jetropha+1% MT BE is more than diesel because calorific value of jetropha biodiesel less than that of diesel.

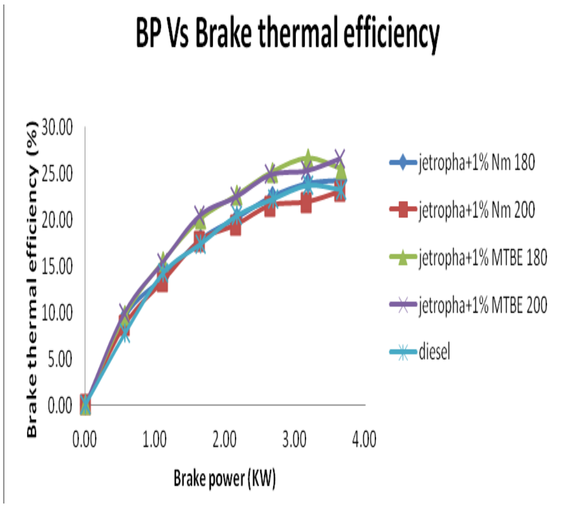

Figure 4.3. Change in brake thermal efficiency w.r.t change in brake power

4.2. Emissions Results

The emissions of carbon monoxide, unburned hydrocarbons and nitrogen oxide were examined and the results are shown below. Carbon monoxide and unburned hydrocarbons are the products of incomplete combustion whereas oxides of nitrogen are produced at very high temperatures.

4.2.1. HC Emissions

Figure 4.3 shows the variation in the quantity of unburnt hydrocarbons with change in brake power (in kw.) at 17.5 compression ratio. Initially diesel emits more amount of unburnt hydrocarbons than the all other biodiesel+1% additives. At brake power around 1 kW diesel emits less unburnt HC a long with jetropha+1% Nm additive. At maximum BP value all jetropha+1% additives emits less unburnt hydrocarbons than the ordinary diesel. These biodiesel+1% additives emits around 80% less HC than the dies el. The higher cetane number of fuel decreases in HC emissions due to increased temperature of burnt gases in biodiesel helps in preventing in condensation of hydrocarbons thus reducing un-brunt HC e missions.

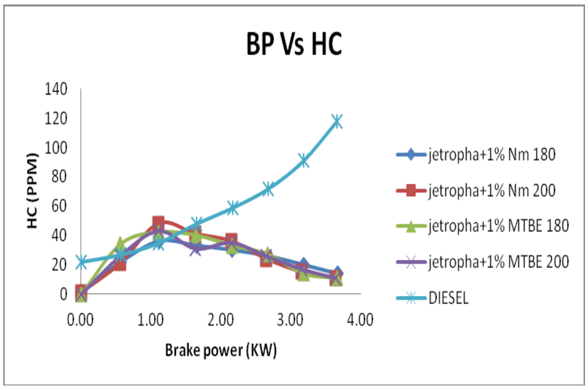

Figure 4.4. Change in quantity of unburnt hydrocarbons with change in brake power

4.2.2. NOx Emissions

Figure 4. 5. Shows variation in the quantity of nitrous oxides (in ppm) with change in brake power (in kw.) at 17.5 compression ratio. At initial brake power, all biodiesel+1% additives emitsless amount of NOx than the dies el. As the load on engine increases brake power increases and NO xexhaust increases because the temperature in the combustion chamber increases, at higher temperature more a mount of NOx is produced. But dies el emits comparatively more NOx in the exhaust at maximum brake power. Jetropha+1% additives emits around 30% les s NOx in the exhaust. The addition of 1% additives decreased the considerable a mount of NOx in the exhaust.

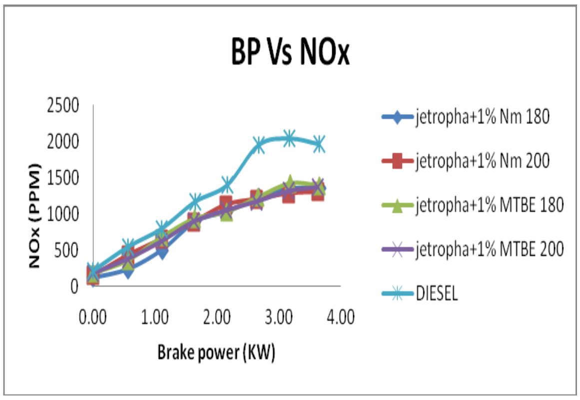

Figure 4.5. Variations in quantity of NOx with change in brake power

V. CONCLUSIONS

Based on the experimental investigation carried out on CI dies el engine fuelled with jatroha (B100+1%) biodiesel with additives are analyzed the effect of additives on engine performance and exhaust emissions. These test results are compared with ordinary diesel fuel. The following conclusions are drawn.

- Fuel B100+1% Nm produces 1.94% of more BP than the diesel. This is due to higher cetane number for B100+1% Nm which reduces the ignition delay leads to complete combustion liberates more power.
- As the load increases on the engine, the mechanical efficiency of fuel B100+1% Nm is 4.02%, and fuel B100+1% MTBE is 3.15% more than that of diesel fuel.
- These biodiesel+1% additives emits around 80% less HC than the dies el. The higher cetane number of fuel decreases in HC emissions due to increased temperature of burnt gases in biodiesel helps in preventing in condensation of hydrocarbons thus reducing un -brunt HC emissions.
- As the load on engine increases brake power increases and NOx exhaust increases because the

temperature in the combustion chamber increases, at higher temperature mo re a mount of NOx is produced. But dies el emits comparatively more NOx in the exhaust at maximum brake power. Jetropha+1% additives emits around 30% less NOx in the exhaust.

- B100+1% additives showed the lower emission characteristics compared to dies el fuel irrespective of operating conditions.

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