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# Engine Performance and Emission Analysis of DI Diesel Engine Fuelled with Blends of Neem Bio Diesel

Dr.M.S. Vijayanand[1], Dr.A.P.Sivasubramaniam[2],Dr.S.T.Kumaravel[1].

[1] Associate Professor, Department of Mechanical Engineering, Paavai Engineering College, Pachal, Namakkal.

[2] Professor Department of Mechanical Engineering, Paavai Engineering College, Pachal, Namakkal.

***ABSTRACT***

*Continued use of petroleum sourced fuels is now broadly recognized as unsustainable because of the decreasing supplies and the contribution of these fuels to the addition of carbon dioxide and carbon monoxide in the environment. Renewable, carbon neutral, transport fuels are essential for environmental and economic sustainability. Here we will contrast the original fuel with the blends of biodiesel obtained by two stage trans-esterification method from neem oil to evaluate the performance and emission characteristics of diesel engine. The obtained bio diesel is mixed with original fuel in a variety of ratios, including B25 percent, B50 percent, B75 percent, and B100 percent. The reason for choosing different mixes is that they gives different readings from which the engine performance and other operational parameters can be evaluated. Metal-based nano additives have an impact on diesel engine performance and emissions. Iron oxide nanoparticles have been chosen as a biodiesel addition. The experiment was carried out in a single cylinder water cooled diesel engine with neem oil as the sole fuel, and the engine performance and emissions were measured and analysed. The CO, $NO_x$ emission are found to decreases for all the biodiesel blend with decrease in smoke emission when compared to that of diesel fuel.*

***Keywords—*** *Natural Rubber, Synthetic Polymer, Carbon Black*

## 1. Introduction

Rapid urbanization, growing populations, and high living standards necessitate the use of alternate energy sources. Scarcity in fossil fuel resources and global warming drives the look for to develop a renewable, efficiently and more ecologically acceptable fuel source [1]. Biodiesel is derived from renewable resources such as vegetable oils and animal fats [2-3]. The environmental benefits of vegetable oils, as well as the fact that they are made from renewable resources, have made them more appealing. Vegetable oils are a sustainable, possibly infinite source of energy with a similar energetic content to diesel fuel. Biodiesel is conceived to contribute even less to global warming than fossil fuels because the carbon in the oil or fat comes mainly from carbon dioxide in the air. When diesel engines run on biodiesel instead of petroleum-based diesel fuel, they emit less carbon monoxide, unburned hydrocarbons, particulate matter, and air toxics. Vijayakumar Chandrasekaran [4] studied the performance of mahua oil with its blends in a single cylinder diesel engine with diesel at different loads at constant rated speed. From the investigation it is found that 20MEOM is the better fuel blend in comparison with other blends. The obtained result indicates that the brake thermal efficiency was 2.19% improved compared than 20MEOM blend without additive at rated loading condition. The present analysis reveals that the bio-fuel from mahua oil with nano additives is quite suitable as an alternate fuel for diesel engine. Yadav and Singh [5] investigated engine efficiency with preheated jatropha, karanja, and neem oil. They indicated that using these vegetable oils reduced engine power as compared to mineral diesel, which they attribute to the higher viscosity of vegetable oil. Preheated oils have a slightly lower thermal performance (at 800C), but it is equivalent to mineral diesel. Haldar [60] investigated the engine efficiency and emission parameters of three vegetable oils, putranjiva, karanj, and jatropha, after removing impurities with phosphoric acid (degumming). They mixed 10 %, 20 %, 30 %, and 40 % vegetable oils with mineral diesel and tested engine output in a Ricardo variable compression engine, reporting that degumme performed well. The viscosity and cetane number of the blended fuel are unfavourable above 20%, resulting in a decrease in the engine's thermal performance. CO, HC, and NOx emissions are higher in lower loads and decrease in higher loads, according to the emission results. Shehata [7] investigated the engine output of blended jojoba oil (20% jojoba oil+80% mineral diesel) in a single cylinder, constant speed, water cooled diesel engine and found that increasing BSFC decreased thermal efficiency and brake strength. Darunden and Rathod [8] investigated the engine performance of kusum biodiesel with its blends (20%,40%,60% and 80%) in a single cylinder, constant speed diesel engine. They found that both blended and pure biodiesels outperform mineral diesel in terms of brake thermal performance. From the literature review it has been found that the various research work has been done on various bio diesels. Neem oil is extracted by crushing the fruits of the Azadirachta indica popularly known as Neem. This tree is commonly found in south Asian countries and has a life cycle of around 150 to 200 years. 30-50 kg of fruits can be produced by a mature neem tree [9]. Though some researchers carried out the engine performance of neem bio diesel, but no work is done regarding the effect of additives with biodiesel and its blends on the engine performance. The present work mainly focuses on determining the relationship between diesel engine performance and emission characteristics of biodiesel in fuel blends.

## 2. Bio Diesel Preparation

The neem biodiesel is to be prepared by the Trans-esterification process because of high free fatty acid content .The neem oil was heated at 60-65℃ for the purpose of adding catalyst. The catalyst potassium hydroxide of 19grams and 200ml of methanol is well mixed together and then add to the neem oil. Neem oil and added catalyst react to form a product as biodiesel and glycerol. The glycerol waste is removed and biodiesel is washed with water to remove impurities and biodiesel is heat at 100℃ to remove water particles and then iron oxide nano particle are added. The cooled biodiesel is used for test purpose in diesel engine.

## 3. Experimental Setup

The experimental setup consists of a single cylinder, four strokes, direct injection, water cooled CI engine have been utilized to perform experimental investigations. The engine was coupled to Eddy current dynamometer for loading of the engine and AVL smoke meter is used for measuring the smoke density. Experiments are conducted with pure diesel and blends of Neem oil biodiesel and diesel by adding Nano additives. Nano additives is used as catalyst with the biodiesel blends to enhance the performance parameters. In this experiment we use iron oxide nano particle as a catalyst of Neem biodiesel blends of ratio of 30 ppm. The blends of Neem oil biodiesel and diesel with additives are prepared on volume basis as follows: B25: 25% Neem oil biodiesel and 75% Diesel and its combination of various blends is represented in table-1. Electronic Controller Device (data acquisition system) connected with engine which displays all different parameters at every 5 seconds related with Experimental work using different sensors. The experimental setup and various components are shown in figure -1.

Table-1 Sample preparation

| Fuel | Fuel composition |
|---|---|
| B0 | 100% Diesel |
| B25 | 75% Diesel + 25% Neem oil with 30ppm $Fe_2O_3$ |
| B50 | 50% Diesel + 50% Neem oil with 30ppm $Fe_2O_3$ |
| B75 | 25% Diesel+ 75% Neem oil with 30ppm $Fe_2O_3$ |
| B100 | 100% Neem oil with 30ppm $Fe_2O_3$ |

## Results and Discussions

The experimental investigations are carried out using the above said oils and their blends on the experimental setup. The engine performance parameters namely Brake thermal efficiency (ηB.th) and Brake specific Fuel consumption (bsfc), the emission parameters namely Carbon Monoxide (CO), and Smoke density (Smoke) carbon monoxide (CO) and Oxides of Nitrogen are evaluated and analyzed from graphs. The detailed analyses of these results are as follows

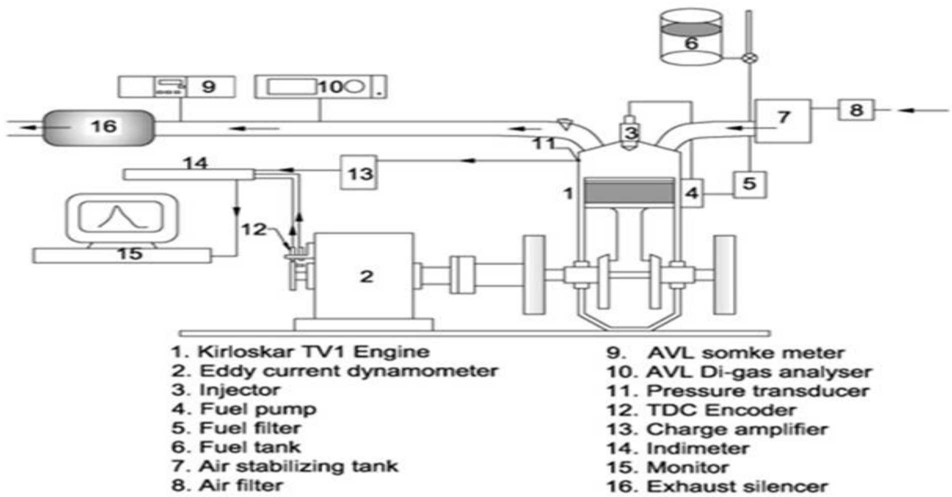


Figure: 1 Experimental Setup with Test Engine

## Brake Thermal Efficiency:

Brake thermal efficiency is the measurement to evaluate the conversion of fuel energy to useful power [10]. The variation in Brake Thermal Efficiency with Brake power output for neem oil and its blends with Diesel in the test engine is represented in Figure -2. From the graph, the brake thermal efficiency at full load of B25 with 30ppm nano additives near to the value of diesel compared to other blends.

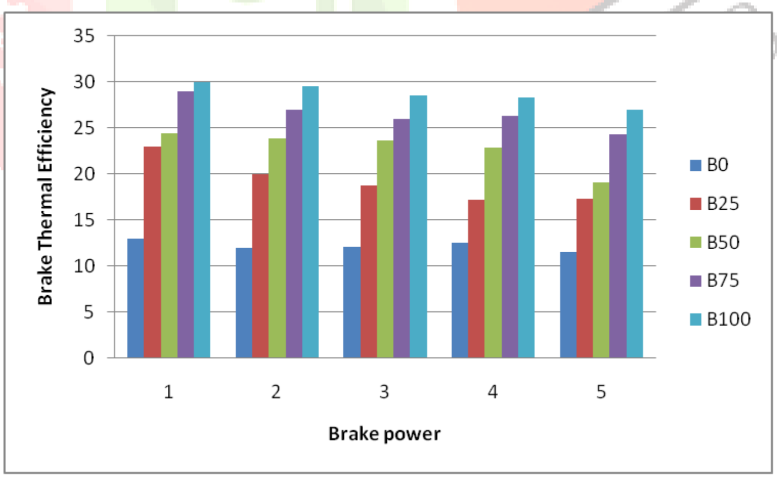


**Figure 2 Variations in Brake Thermal Efficiency with Brake Power**

## Specific fuel consumption

The variation in specific fuel consumption with Brake power output for neem oil and its blends with Diesel in the test engine is represented in Figure -3. From the graph, it is observed that when the brake power increases the specific fuel consumption decreases. At full load condition the SFC for B0, B25 and B50 are 0.291, 0.29 and 0.30 % respectively.

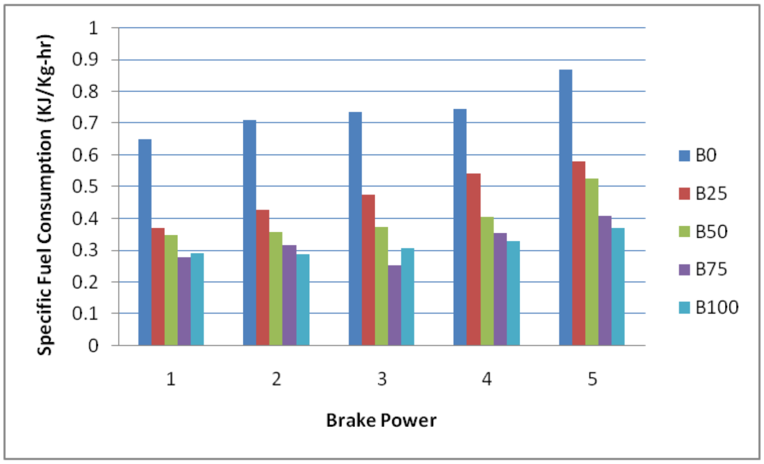


**Figure 3 Variations in specific fuel consumption with Brake Power**

## Engine Emission Parameters

### Smoke Density:

The variation in smoke density with Brake power output for neem oil and its blends with Diesel in the test engine is represented in Figure -4. From the graph, it is observed that B25 and B50 blend of neem oil with diesel has higher Smoke emission compared to pure diesel. The incomplete combustion of fuel is one of the reason for above obtained results.

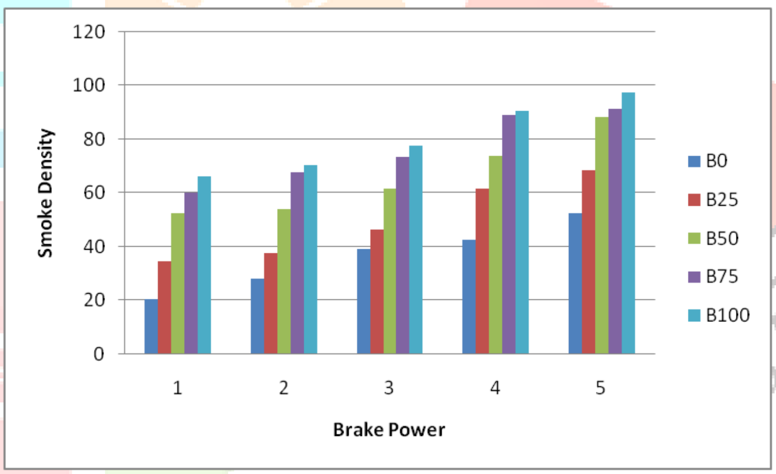


**Figure 4 Variations in Smoke density with Brake Power**

## Carbon Monoxide

The variation in Carbon Monoxide (%) with Brake power output for neem oil and its blends with Diesel in the test engine is represented in Figure -5. From the graph, it is observed that CO emission for the biodiesel blends (B25 and B50) decreases that of the value of the diesel fuel at rated load. The reason may be the additional oxygen content present in biodiesel, and because of iron oxide nano particles increases the conversion of CO into $CO_2$.

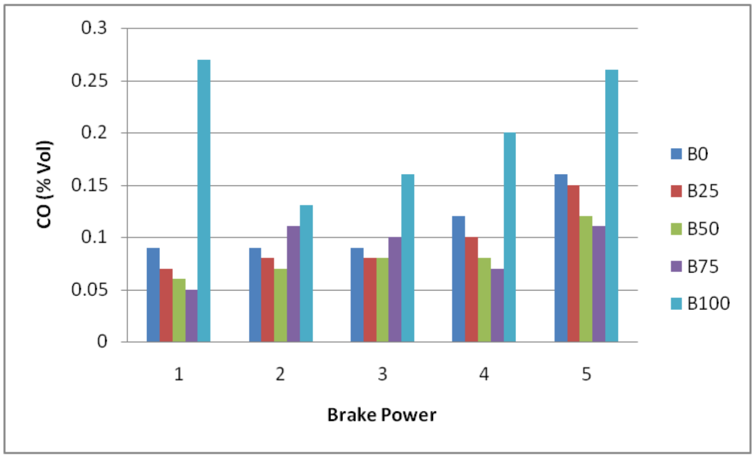


**Figure 5 Variations in Carbon Monoxide with Brake Power**

## CONCLUSION

1. Biodiesel is biodegradable, non-toxic and compatible with diesel. Biodiesel and its blends with diesel reduces the total emission and its low concentration in diesel can give similar result as that of pure diesel.
2. Using of bio-diesel and its blends with varying proportions as a fuel in diesel engine causes improvement in engine performance and engine efficiency.
3. B25 gives better performance with lower emissions compared to other blends. Hence a blend up to B25 without preheating of oil is used as alternate to diesel fuel for diesel engine.
4. The blends of biodiesel show significant reduction in CO, and increases of smoke emission when compared to that of diesel fuel.

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