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STUDY THE PERFORMANCE OF DIESEL ENGINE USING NERIUM BLENDS AS AN ALTERNATIVE FUEL

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***Abstract*— Among the different possible sources, fatty acid methyl esters, known as Biodiesel fuel derived from triglycerides (vegetable oil and animal fates) by trans-esterification with methanol, present the promising alternative substitute to diesel fuels and have received the most attention now a day. The main advantages of using Biodiesel are its renewability, better quality exhaust gas emission, its biodegradability and the organic carbon present in it is photosynthetic in origin. Many alternative fuels like alcohols, biodiesels, liquid petroleum gas (LPG), compressed natural gas (CNG) etc. have been already commercialized in the transport sector. In this context Nerium oil renewed interest. Nerium oil is blended with diesel and used as alternative fuels for CI engine. In the present work the performance characteristics and emissions are evaluated on single cylinder four stroke diesel engine, water cooled which is capable of developing a power output of 7.5kW at 1500rpm, fueling with NO 20%, 30% and 40% of Nerium oil blended with diesel. The performance parameters such as brake power, specific fuel consumption, indicated thermal efficiency, brake thermal efficiency, mechanical efficiency and volumetric efficiency are calculated based on experimental analysis of engine. Emissions such as carbon monoxide (CO), carbondioxide (CO_2) and unburned hydrocarbons (HC) are measured. Brake Thermal efficiency of the tested diesel engine is improved when it is fuelled with Nerium oil-diesel blends.**

***KEY WORDS*: *Nerium oil , CI Engine, Blends and Efficiency*.**

I. INTRODUCTION

Biodiesel is a renewable alternative fuel obtained from the chemical reaction between vegetable oil with an alcohol such as methanol or ethanol. The key feature of bio diesel is that, it can be used direct injection diesel engines without many modifications. Biodiesels, produced from vegetable oils, has been under research as an alternative fuel for the past few years. Biodiesel can either be used as a sole fuel, known as neat biodiesel or can be blended with petroleum diesel in various proportions for use in diesel engines. Recent researches in this field show that biodiesels can be blended with diesel up to 30 % by volume without any modifications to the engine. Further increasing the biodiesel content in the fuel blend requires minor modifications like varying the injection pressure, injection timing, compression ratio etc. In a few foreign countries, B20 (20% biodiesel + 80% diesel) fuel blend has been used widely in compression ignition engines as a partial alternative to petroleum diesel. Biodiesel is the name of a clean burning alternative fuel that can be produced from algae, vegetable oils, animal fats or recycled restaurant greases, domestic, renewable resources. It contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend and can be used in compression ignition (diesel) engines with little or no modifications. Biodiesel is simple to use, environment friendly liquid fuel similar to petro-diesel in combustion properties biodegradable, nontoxic, and essentially free of sulfur and aromatics. It is a processed fuel consisting of short chain alkyl (methyl or ethyl) esters, made by transesterification of vegetable oils or animal fats, which can be used (alone, or blended with conventional diesel fuel) in unmodified diesel-engine vehicles.

II. LITERATURE SURVEY

Vegetable oil has been considered as alternative fuels for compression ignition engines. Vegetable oils are renewable, nontoxic, biodegradable, and have low emission profiles [1–6]. However, there are some drawbacks related to the use of straight vegetable oils in diesel engines primarily due to their high viscosity, lower volatility and lower heat content [7–9]. high viscosity of vegetable oils may lead to ring sticking, formation of injector deposits, development of gumming, as well as incompatibility with lubricating oils [2, 10]. Different techniques have been developed to solve their high viscosity and low volatility problems of vegetable oils, such as preheating oils, blending or dilution with other fuels, transesterification and thermal cracking / pyrolysis [11–13]. Transesterification appears to be the most promising technique which is a chemical process of converting vegetable oil into biodiesel fuel [6, 12, 14 and 15]. Biodiesel can be used as a blend in diesel engines without modification. Detailed reviews about transesterification process are available in the literature [13].

The important compositional difference between biodiesel and the diesel fuel is concerned with oxygen content. Biodiesel contains 10–12% oxygen in weight basis and this lowers the energy content. The lower energy content causes reductions in engine torque and power [16–18]. Biodiesel containing oxygen reduces exhaust emissions such as HC, smoke and CO mainly due to the effect of complete combustion [19–24].

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In the present investigation, Nerium oil, that is non-edible oil, was considered as a potential alternative fuel for compression ignition engines. Specifications of the Nerium oil investigated and compared these specifications with other vegetable oils and this was the basic motivation behind the research in this paper. The engine tests were carried out on a direct injection diesel engine fuelled with diesel fuel and 20%, 30% and 40% Nerium oil-diesel blends by volume. The results were summarized.

III. MATERIALS AND METHODS

Trans-esterification is a chemical reaction in which vegetable oils and animal fats are reacted with alcohol in the presence of a catalyst. The products of reaction are fatty acid alkyl ester and glycerin, and were the fatty acid alkyl esters known as biodiesel.

A. Transesterification of Nerium Oil:

To reduce the viscosity of the Nerium oil, trans-esterification method is adopted for the preparation of biodiesel.

B. Methyester of Nerium oil:

The procedure involved in this method is as follows: 1000 ml of Nerium oil is taken in a three way flask. 12 grams of sodium hydroxide (NaOH) and 200 ml of methanol (CH3OH) are taken in a beaker. The sodium hydroxide (NaOH) and the alcohol are thoroughly mixed until it is properly dissolved. The solution obtained is mixed with Nerium oil in three way flask and it is stirred properly. The methoxide solution with Nerium oil is heated to 60 ^{0}C and it is continuously stirred at constant rate for 1 hour by stirrer. The solution is poured down to the separating beaker and is allowed to settle for 4 hours. The glycerin settles at the bottom and the methyl ester floats at the top (coarse biodiesel). Methyl ester is separated from the glycerin. This coarse biodiesel is heated above 100°C and maintained for 10-15 minutes to remove the untreated methanol. Certain impurities like sodium hydroxide (NaOH) etc are still dissolved in the obtained coarse biodiesel. These impurities are cleaned up by washing with 350 ml of water for 1000 ml of coarse biodiesel. This cleaned biodiesel is the methyl ester of Nerium oil.

C. Ethyl ester of Nerium oil:

The procedure involved in this method is as follows: 1000 ml of Nerium oil is taken in a three way flask. 12 grams of sodium hydroxide (NaOH) and 200 ml of Ethanol (C2H5OH) are taken in a beaker. The sodium hydroxide (NaOH) and the alcohol are thoroughly mixed until it is properly dissolved. The solution obtained is mixed with Nerium oil in three way flask and it is stirred properly. The ethoxide solution with Nerium oil is heated to 60°C and it is continuously stirred at constant rate for 1 hour by stirrer. The solution is poured down to the separating beaker and is allowed to settle for 4 hours. The glycerin settles at the bottom and the ethyl ester floats at the top (coarse biodiesel). Ethyl ester is separated from the glycerin. This coarse biodiesel is heated above 100°C and maintained for 10-15 minutes to remove the untreated ethanol. Certain impurities like sodium hydroxide (NaOH) etc are still dissolved in the obtained coarse biodiesel. These impurities are cleaned up by washing with 350 ml of water for 1000 ml of coarse biodiesel. This cleaned biodiesel is the Ethylester of Nerium oil. This bio-diesel of methyl ester of Nerium oil and ethyl ester of Nerium oil was then blended with mineral diesel in various concentrations for preparing biodiesel blends to be used in CI engine for conducting various engine tests[1].

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TABLE 1: PROPERTIES OF NERIUM OIL

Properties	Diesel	NERIUM oil
Kinematic viscosity at 40 ^{0}C (cSt)	3.52	4.88
Density at 15 ^{0}C (kg/m^3)	830	910
Flash point (^{0}C)	49	148
Calorific value (kJ/kg)	42000	36570
Sp.gravity	0.83	0.91

IV. SPECIFICATION OF THE PROBLEM

In the present work the performance characteristics and emissions are evaluated on single cylinder four stroke diesel engine, water cooled which is capable of developing a power output of 7.5kW at 1500rpm, fueling with TPO 20%, 30% and 40% of Nerium oil blended with diesel. The performance parameters such as brake power, specific fuel consumption, indicated thermal efficiency, brake thermal efficiency, mechanical efficiency and volumetric efficiency are calculated based on experimental analysis of engine. Emissions such as carbon monoxide (CO), carbon dioxide (CO_2) and unburned hydrocarbons (HC) are measured.

V. EXPERIMENTAL SETUP

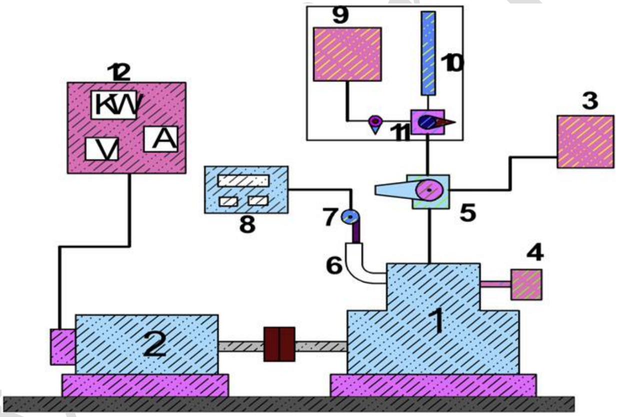

Fig 1. Experimental Setup

The experimental setup is fabricated to fulfill the objective of the present work. The various components of the experimental set up including modification are shown in fig no.1.
Various Parts of Experimental Setup

1. Alamgair Engine,
2. Alternator,
3. Diesel Tank,
4. Air Filter,
5. Three Way Valve,
6. Exhaust Pipe,
7. Probe,
8. Exhaust Gas Analyser,
9. Alternative Fuel Tank,
10. Burette,
11. Three Way Valve,
12. Control Panel

A. EXPERIMENTAL PROCEDURE

Before starting the engine, the lubricating oil level in the engine is checked and it is also ensured that all moving and rotating parts are lubricated.

The various steps involved in the setting of the experiments are

1. The Experiments were carried out after installation of the engine
2. The injection pressure is set at 200 bar for the entire test.
3. Precautions were taken, before starting the experiment.
4. Always the engine was started with no load condition
5. The engine was started at no load condition and allowed to work for at least 10 minutes to stabilize.
6. The readings such as fuel consumption, spring balance reading, cooling water flow rate, manometer reading etc., were taken as per the observation table.
7. The load on the engine was increased by 20% of FULL Load using the engine controls and the readings were taken as shown in the tables.
8. Step 3 was repeated for different loads from no load to full load.
9. After completion of test, the load on the engine was completely relieved and then the engine was stopped.
10. The results were calculated theoretically and tabulated.

Finally, the engine is run by blend at various loads and the corresponding observations are noted.

The test is carried on the Alamgir Engine for the following fuel blends:

1. 100% Diesel
2. 20% Nerium Oil + 80% Diesel
3. 30% Nerium Oil + 70% Diesel
4. 40% Nerium Oil + 60% Diesel

VI. RESULTS AND DISCUSSIONS

Experiments were conducted when the engine was fuelled with Nerium oil and their blends with diesel in proportions of 20:80, 30:70 and 40:60 (by volume) which are generally called as NO-20, NO-30 and NO-40 respectively. The experiment covered a range of loads.

The performance of the engine was evaluated in terms of brake specific fuel consumption, brake thermal efficiency and volumetric efficiency shown in corresponding graphs and figures. The emission characteristics of the engine were studied in terms exhaust gas temperature, concentration of HC, CO and CO_2. The results obtained for Nerium oil and their blends with diesel were compared with the results of diesel.

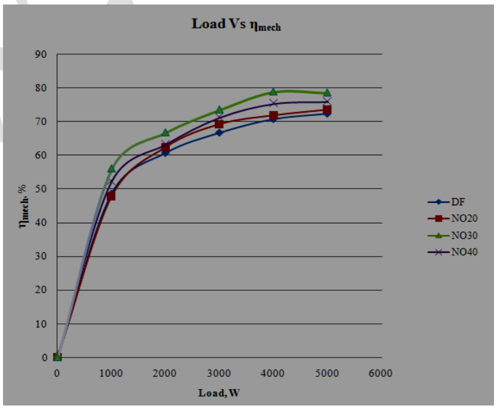

Fig .2 Load Vs B.S.F.C

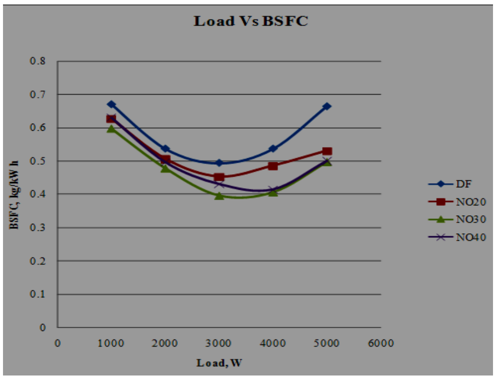

Fig 3 Load Vs Mechanical efficiency

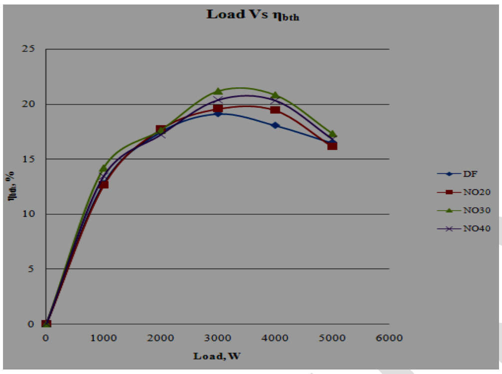

Fig 4 Load Vs Brake Thermal Efficiency

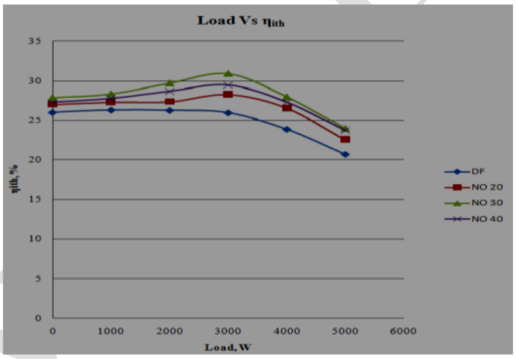

Fig 5 Load Vs Indicated Thermal Efficiency

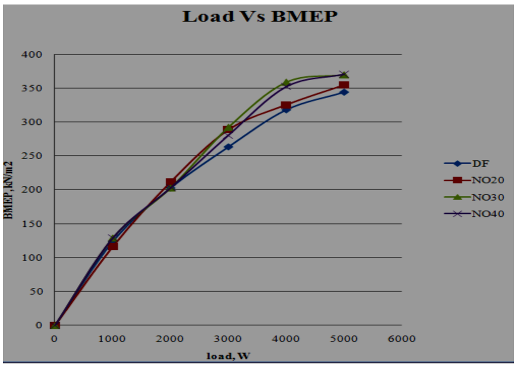

Fig 6 Load Vs Brake Mean Effective Pressure

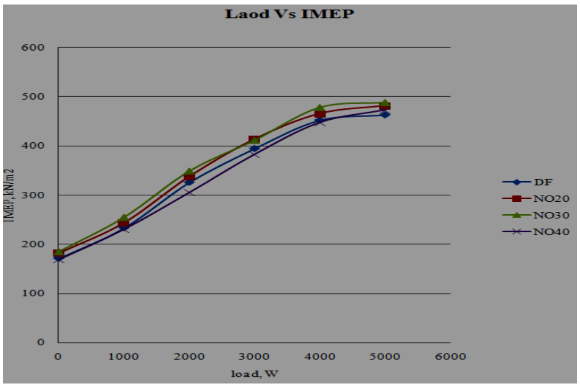

Fig .7 Load Vs Indicated Mean Effective Pressure

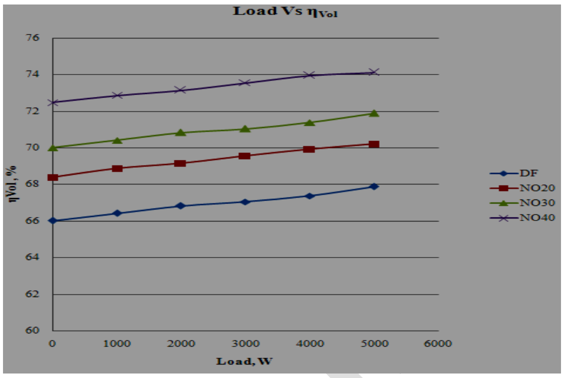

Fig 8 Load Vs Volumetric Efficiency

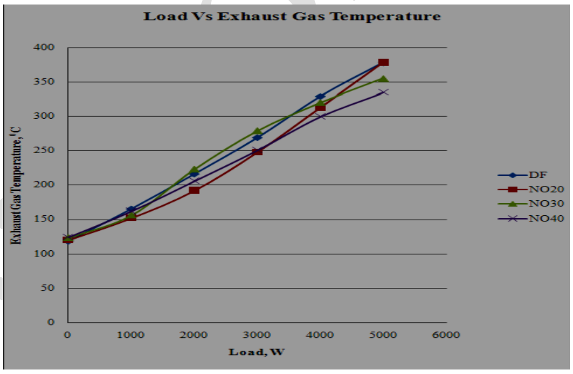

Fig .9 Load Vs Exhaust Gas Temperature

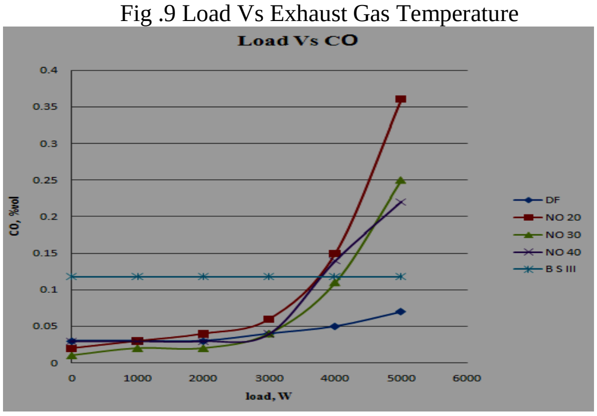

Fig 10 Load Vs Carbon monoxide

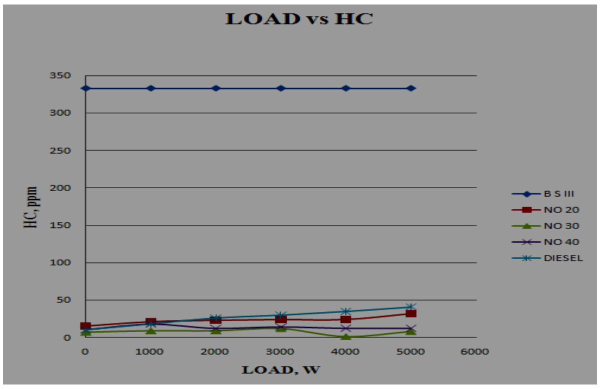

Fig 11 Load Vs Hydrocarbons

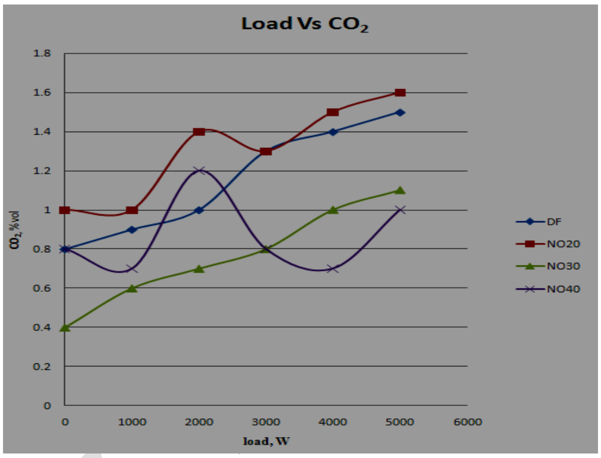

Fig 12 Load Vs Carbon dioxide

VII. CONCLUSIONS

- Following are the conclusions based on the experimental results obtained while operating single cylinder air cooled diesel engine fuelled with Nerium Oil and its diesel blends.
- The blends of Nerium oil show lowest specific fuel consumption than the diesel at part loads. B.S.F.C is decreased the blend NO
- Brake Thermal efficiency of the tested diesel engine is improved when it is fuelled with Nerium oil-diesel blends.
- Mechanical efficiency for NO 30 is higher compared to Diesel fuel operation is observed. * Brake mean effective pressure is also increased as the percentage of the Nerium oil increases with the diesel. But this increment in Brake mean effective power is insignificant.
- Actual Breathing capacity of the engine also slightly increased which leads to increase in volumetric efficiency. It is noted that the volumetric efficiency is raised as the blend of the Nerium oil increases in the diesel.
- CO emission decrease with increase in percentage of Nerium oil in the fuel up to 3000W.
- CO_2 emissions of Nerium oil and its diesel blends are slightly lower than that of diesel.
- HC emissions of Nerium oil and its diesel blends are lower than that of diesel.

- From the above analysis the main conclusion is Nerium oil and its diesel blends are suitable substitute for diesel as they produce lesser emissions than diesel upto a load of 3000W and have satisfactory combustion and performance characteristics.

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