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Effect of Polysorbate-20 on Performance and Emission Characteristics of A C.I Engine Fueled with Mustard Oil and Linseed Oil

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***Abstract* - Depletion of fossil fuel resources and continuous release of harmful emissions to the environment forces the researchers to develop alternative fuel technologies. Therefore, it is necessary to find different ways to reduce emissions and to improve the performance of a C.I engine. In this context, biodiesel has been prepared with mustard oil, linseed oil and 2, 3, 5 percentages of polysorbate-20 surfactant. Hence performance and emission characteristics are analyzed for M85L15, M83L15T2, M82L15T3 and M80L15T5 biodiesel blends to replace diesel fuel.**

Keywords – Bio Diesel, Diesel Engine, Linseed oil, Mustard oil, Polysorbate-20, Transesterification.

I. INTRODUCTION

The growing industrialization and mechanization of the world has triggered a sharp increase in the interest for oil based marchandise. India is one of the fastest growing nations with a steady economic development, which increases the awareness for transportation in several fields. In general diesel engines are preferred over petrol engines in the case of heavy duty applications due to their high efficiency and low cost. As we dependant more on diesel for transportation but this causes the major issue in the supply as there is a scarcity of petroleum products. This will rise to find an alternate for the diesel fuel. After several investigations, it is recommended to use sustainable energy resources like vegetable oils and alcohols.

Thus biofuels are considered as the sustainable sources of energy. And the properties of vegetable oils like cetane number, calorific value and density are nearly equal to the diesel. So, we should take vegetable oils into consideration in the point of usage in the IC engines. In this regard, edible oils such as mustard oil and linseed oil may be the possible source for production of biodiesel.

Rekam Manikumar, et.al [1] has conducted experiment on Performance and Emission Characteristics of a CI Engine Fueled With Biodiesel Extracted from Wco-Mustard Oil and from that B10 blend is found to have optimum efficiency and economy when the use of waste cooking oil and mustard oil in 1:1 ratio along with diesel in different proportions such as B10, B20, B30 biodiesel blends has taken place in the diesel engine. P.Srinivasa Rao, et.al [2] has conducted study on Performance and Emission Characteristics of Diesel Engine Fuelled by Biodiesel Derived from Linseed Oil which clearly reveals L30 blend selected as the optimum blend when diesel engine is fueled with blends of diesel and linseed oil in different proportions such as L10, L20, L30 respectively. Prof. C.S. Koli, et.al [3] has conducted performance test on a single cylinder 4 stroke diesel engine with dual vegetable oil blended with diesel and has taken two vegetable oils mustard oil ,palm oil into consideration and are blended in equal proportions by volume. The blends of BB 10 (Diesel 90%, Mustard oil 5% and Palm oil 5% by volume) and BB 20 (Diesel 80%, Mustard oil 10% and Palm oil 10% by volume) shown better brake thermal efficiency and lower brake specific fuel consumption than other blends. Syarifah Yunus, et.al [4] has conducted emission test on 4 stroke single cylinder diesel engine fueled with Jatropha-Palm blended biodiesel and it revealed that there is higher CO, NOx and CO_2 produced from all biodiesel blends when compared to conventional diesel due to higher oxygen content in the biodiesel and also due to higher temperatures attained in the engine. Seyed Saeed Hoseini, et.al [5] has conducted performance and emission characteristics of a diesel engine operating on different surfactant ratios which results in decrease of emissions.

According to literature survey, very less number of investigations had conducted on vegetable oils using surfactant. In order to replace diesel fuel with vegetable oil, polysorbate 20 surfactant is added in 2, 3, 5 percentages to mustard linseed biodiesel blends to get better performance and emission characteristics.

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II. Materials and Methods of Production

2.1. EXTRACTION OF LINSEED OIL FROM LINSEEDS

Linseed oil is also known as flaxseed oil .And is generally extracted from seeds of the flax plant. Flax is a member of the genus Linum in the family Linaceae. These seeds are widely found in some parts of India, china, New Zealand Fig .2.1(a). These flax seeds are available in two colors mainly brown and gold. Among these we use gold flax seeds due to high availability. These seeds are dried without having any moisture content and then by pressing in the grinders, sometimes followed by solvent extraction, linseed oil is produced. After the crude linseed oil is collected, it is undergone through trans esterification process to convert into esters which are having less viscosity.

Fig .2.1(a) Linseeds

2.2. EXTRACTION OF MUSTARD OIL FROM MUSTARD SEEDS

Mustard oil is one of the most important sources of cooking oil in India. It accounts almost 40 percent of total edible oil output in the country. Mustard oil is also known as canola oil and widely produced in northern India majorly Rajasthan, Haryana, MP and Gujarat. Mustard oil is extracted from mustard seeds of mustard plants Fig 2.2(a). Initially these seeds are cleaned to remove dust, dirt and foreign particles. These are cured to bring the moisture level of 10 to 12 percent and passed through the oil expeller. The oil cake is conveyed automatically and pressed to achieve maximum oil recovery, which is about 35 percent depending on the variety and quality of the seed. And once the crude mustard oil is collected, it is undergone through trans-esterification process so that esters are formed which have less viscosity.

Fig 2.2(a) Mustard Seeds

2.3. PREPARATION OF POLYSORBATE-20

Polysorbate-20 is a nonionic surfactant formed by the addition of lauric acid after the ethoxylation of sorbitan. This surfactant is going to decrease the surface tension between the two liquids to improve the properties of the resulting mixture. Due to its stability and relative non toxicity, it can be used as surfactant and emulsifier. It is insoluble in water but relatively neutral molecule.

Fig. 2.3(a) Polysorbate-20

III. Characteristics of Linseed Oil, Mustard Oil and Its Blends

After the trans-esterification process, the properties of both the Linseed oil and Mustard oil are found using standard ASTM techniques and these are compared with the conventional diesel properties. Experiments are conducted on mustard oil and linseed oil blends such as M100, M95L5, M90L10, M85L15, M80L20, M75L25 in different proportions from no load to full load condition and the performance is analyzed. Among them M85L15 has shown better performance characteristics. Then 2, 3 and 5 percentages of Polysorbate 20 surfactant is added to M85L15 blend and the effect of surfactant is analyzed on performance and emission characteristics. The properties of mustard oil, linseed oil and biodiesel blends are shown in table 3.1.

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FUEL SPECIFICATIONS:

Table: 3.1. Properties of Mustard oil, Linseed oil, diesel and biodiesel blends

Property	Mustard oil	Linseed oil	Diesel	M85L15	M83L15T2	M82L15T3	M80L15T5
Density (kg/m^3)	885	912	830	890	893	897	906
Kinematic Viscosity (Cst)	13.8	41.2	3.8	21.32	23.41	25.67	28.12
Flash point(°C)	218	240	70	44	43	43	42
Calorific Value (KJ/Kg)	39830	37830	42700	39750	39800	39820	39850

Where M85L15 - 85% Mustard Oil + 15% Linseed Oil
M83L15T2 – 83% Mustard Oil + 15% Linseed Oil + 2% Polysorbate-20
M82L15T3 - 82% Mustard Oil + 15% Linseed Oil + 3% Polysorbate-20
M80L15T5 - 80% Mustard Oil + 15% Linseed Oil + 5% Polysorbate-20

IV. EXPERIMENTAL SETUP

The experimental setup consists of an engine, a Dynamometer, air filter, fuel tank and manometer .The engine used is a four stroke, single cylinder, water cooled, compression ignition engine whose specifications are tabulated below in Table 4.1. Experiments are conducted by applying electrical loads on engine by using dynamo from no load to full load condition and the readings are noted. AVL-DIGAS 444 five gas analyzer is being used to measure the emissions.

ENGINE SPECIFICATIONS:

Table 4.1. Technical Specifications of Engine

Make	Anil
Engine details	Single cylinder, compression ignition, four stroke, water cooled vertical diesel engine
Compression ratio	17.5:1
Rated power	3.7 KW
Cylinder Bore and stroke	80mm and 110mm
Speed	1500 rpm

Fig 4.1(a) Diesel Engine

Fig 4.1(b) AVL-DIGAS 444 five gas analyzer

V. RESULTS AND DISCUSSION

5.1. BRAKE THERMAL EFFICIENCY (BTE)

The Fig.5.1 shows the variation of brake thermal efficiency with respect to brake power with different percentages of surfactant polysorbate-20 for mustard linseed blend. From the graph it is evident that M82L15T3 has higher thermal efficiency compared to diesel and other blends and it is increased by 0.9% when compared with conventional diesel. And it is due to increase in calorific value with surfactant percentage.

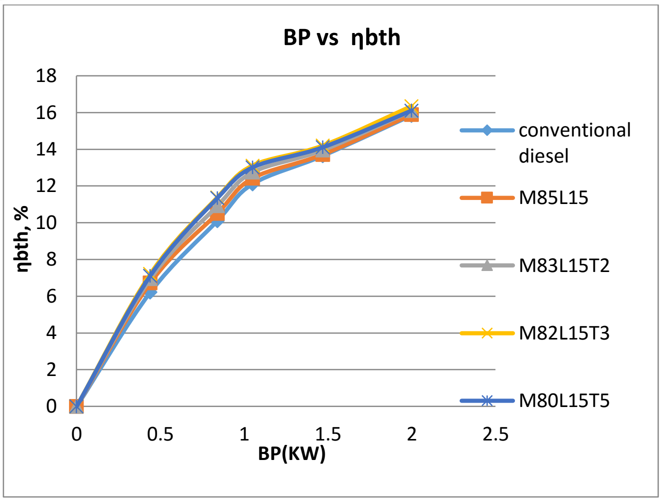

Fig.5.1 Comparison of Brake Thermal Efficiency with conventional diesel and biodiesel blends

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5.2. BRAKE SPECIFIC FUEL CONSUMPTION (BSFC)

The Fig.5.2 shows the variation of brake specific fuel consumption with respect to brake power with different percentages of surfactant polysorbate-20 for mustard linseed blend. From the graph it is evident that diesel has the lowest value of BSFC when compared with all other blends. And the brake specific fuel consumption of the blends M80L15T5 and M82L15T3 are high at high loads due to increase in viscosity.

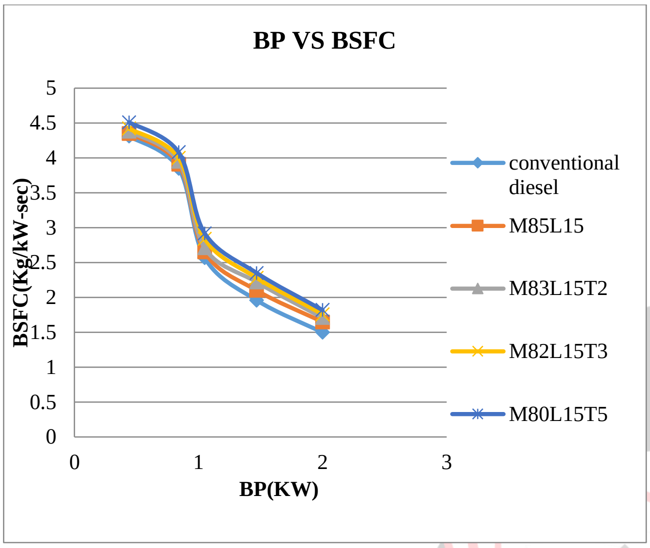

Fig.5.2. Comparison of BSFC with conventional diesel and biodiesel blends

5.3. MECHANICAL EFFICIENCY

The Fig.5.3 shows the variation of mechanical efficiency with respect to brake power with different percentages of surfactant polysorbate-20 for mustard linseed blend. And it is evident from the graph that the mechanical efficiency of diesel is high and also biodiesel blends have less mechanical efficiency due to increase of carbon chains.

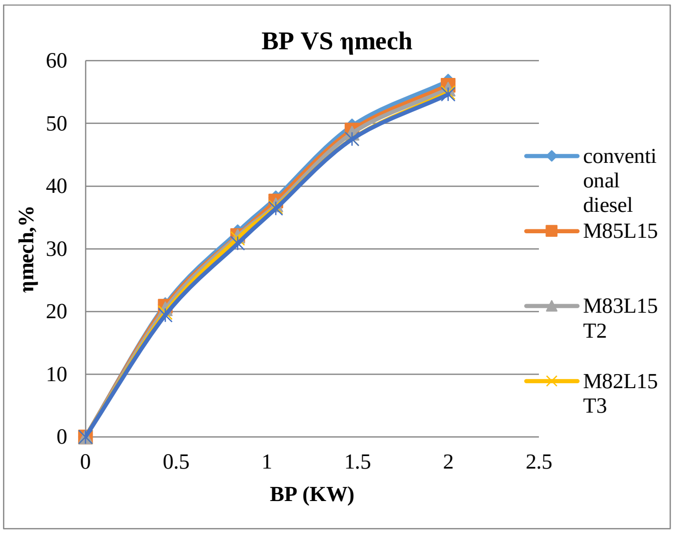

Fig.5.3. Comparison of Mechanical Efficiency with conventional diesel and biodiesel blends

5.4. EXHAUST GAS TEMPERATURE (EGT)

The Fig.5.4 shows the exhaust gas temperatures of the CI engine with conventional diesel and different biodiesel blends. The exhaust gas temperatures for the bio diesel blends M85L15, M83L15T2, M82L15T3 and M80L15T5 are very high when compared to conventional diesel which is due to excess availability of oxygen in the combustion chamber and complete combustion.

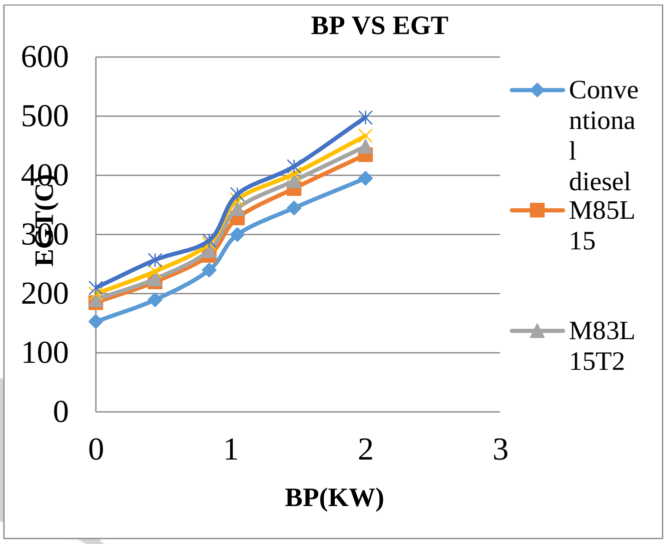

Fig.5.4. Comparison of EGT of CI Engine with conventional diesel and biodiesel blends

5.5. CARBON DIOXIDE EMISSIONS (CO_2)

The Fig.5.5 shows the CO_2 Emissions with conventional diesel and different biodiesel blends. The value of CO_2 Emissions for the biodiesel blends M85L15,M82L15T3,M80L15T5 are 8.4%,8.6%,8.7% respectively where as its value for diesel is 8.2%.The increase in CO_2 Emissions is due to complete combustion of biodiesel.

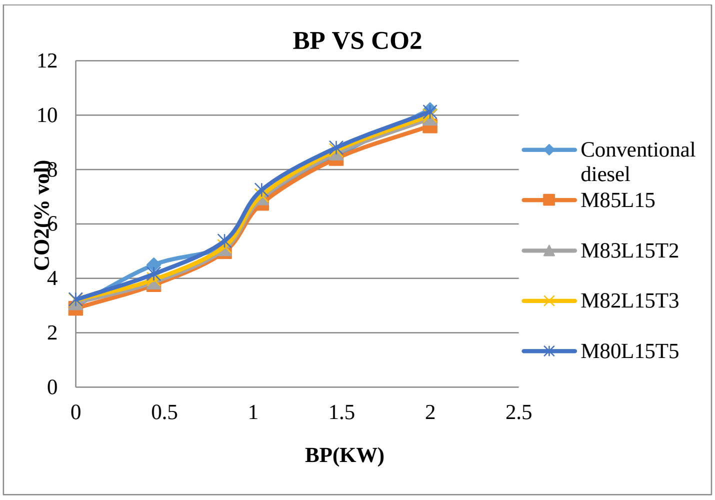

Fig.5.5. Comparison of CO_2 Emissions with conventional diesel and biodiesel blends

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5.6. CARBON MONOXIDE EMISSIONS (CO)

The Fig.5.6 shows the CO Emissions with conventional diesel and biodiesel blends. The value of CO emissions for M85L15 blend is 0.21% where as its value has been decreased as 0.19, 0.18 for M83L15T2, M82L15T3 biodiesel blends. And this decrease in value of CO emissions is due to poor atomization and higher carbon chains of surfactant.

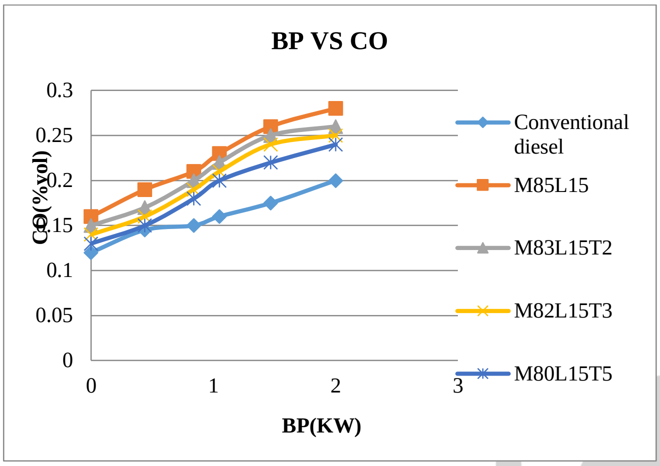

Fig.5.6. Comparison of CO Emissions with conventional diesel and biodiesel blends

5.7. HYDROCARBON EMISSIONS (HC)

The Fig.5.7 shows the HC Emissions with conventional diesel and biodiesel blends. It is clear from the graph that HC emission diesel was 25ppm where as its value has increased as 27ppm, 28ppm for M83L15T32, M82L15T3 biodiesel blends and is due to poor atomization and high viscosity of the biodiesel blends.

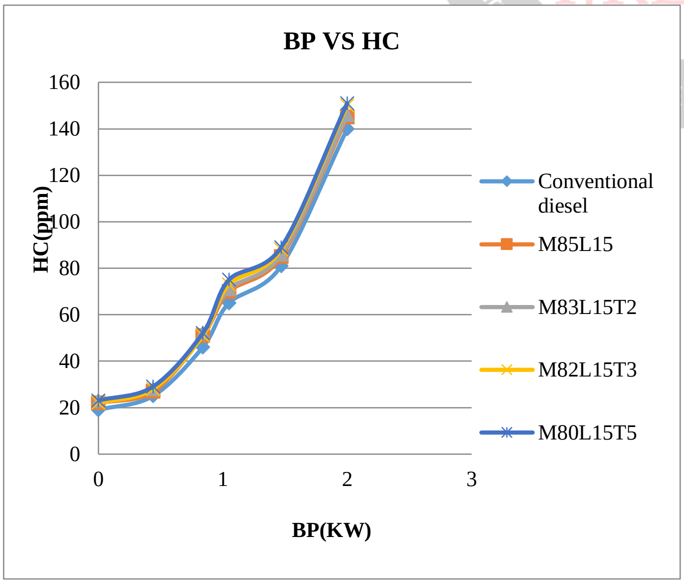

Fig.5.7. Comparison of HC Emissions with conventional diesel and biodiesel blends

5.8. OXIDES OF NITROGEN EMISSIONS (Nox)

TheFig.5.8 shows the comparison of NOx Emissions with conventional diesel and biodiesel blends. The NOx Emissions are very high as 410ppm, 420ppm, 425ppm for biodiesel blends M85L15, M82L15T3, M80L15T5 but for diesel as 385ppm.This increase in NOx Emissions are due to higher temperatures attained in the engine and also due to poor atomization.

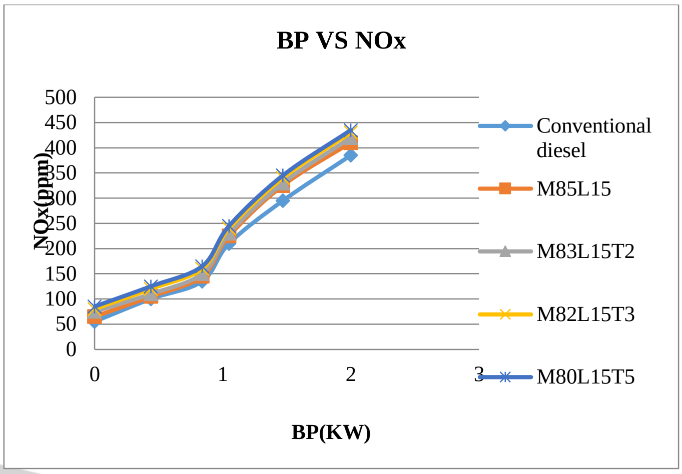

Fig.5.8. Comparison of NOx Emissions with conventional diesel and biodiesel blends

VI. CONCLUSION

In this study, performance and emission characteristics of a CI engine fuelled with mustard oil and linseed oil blends were carried out at different percentages of Polysorbate-20 surfactant. The brake thermal efficiency of the M82L15T3 blend is 16.35 % and is increased by 0.9% when compared with conventional diesel fuel. And the emission values of M82L15T3 blend are less when compared with all other blends. From all the graphs it is concluded that M82L15T3 blend has better performance and emission characteristics among all other blends and it could be better replacement of diesel fuel.

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