Study on Effect of Injection Pressure Fuel Spray Characteristics on The Performance And Emissions of C.I Engine Running on Neem Methyl Ester Blend As A Fuel

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Abstract- *The present day internal combustion engines are operating essentially on petroleum based fuels, which are non-renewable in nature and lead to depletion in short period due to its indiscriminate use in different fuels. Renewable agriculture based, non- edible oils like pongamia, mahua, neem, Jatropha oils etc can be used as an alternative fuel in CI engines. In this investigation, neem oil methyl ester was prepared by transesterification using NaOH as catalyst and tested in 4 stroke Direct Injection natural aspirated Diesel engine. Tests are carried out at constant speed of 1500 rpm at different brake power. and at three different injection pressure. Results showed that Methyl ester Blend (B-20) performs well in running a Diesel engine at 200 bar injection pressure, which is higher than the rated injection pressure of diesel operation 180 bar. Than emissions of UBHC, and smoke level are reduced and NOx is increased case Neem methyl ester blend with diesel (B20) compared to diesel mode of operation the results reveals that brake thermal efficiency and fuel properties of methyl esters are comparable with diesel. Based on this study, methyl esters of Neem oil can be used as a substitute for diesel in compression ignition engine.*

Keywords- Neem oil, Transesterification, Methyl esters, Emissions, Performance, Injection pressure.

I. INTRODUCTION

Vegetable oils are easily available in rural areas are renewable, have a reasonably high cetane number to be used in C.I engines with simple modifications and can be used easily blended with diesel in the neat and esterified (bio diesel) forms. Jatropha, Karanja, Mahua, Neem, Coconut oil, Rape seed oil etc. are some of the vegetable oils that have been tried as fuels in internal combustion engines. As mentioned above, several vegetable oils have been tested in engines.

Among these Neem oil is also one of promising oil as substitute fuel diesel. It is non- edible and has a calorific value and cetane number is close to diesel fuel. Viscosity and density are higher compared to diesel fuel. Agriculture of Neem oil is not a monoculture and it has well established collection and storage techniques. Neem (azadircachata Indica juss) grows wild in dry forest adopting all kinds of soil the tree starts producing seed from 5-6 years old. The flowering spreads over January to April in various parts of the country depending on climatic conditions. The seed contain 35- 50% oil with dark color. The variation of injection pressure has a significant effect on the performance and emissions of diesel engines, an increase of injection pressure is formed to enhance the atomization at the nozzle outlet, resulting in a more distributed vapour, hence better mixing. A very high injection pressure will lead to fine droplets and this can adversely affect fuel distribution in air [1, 2,3]

II. TRANSESTERIFICATION

In transesterification one ester is converted into another ester the reaction is catalyzed by either acid or basic involving reaction with an alcohol, typically methanol if Bio-diesel is the desired product. As typically practiced a basic catalyst such as sodium hydroxide is used to convert the glycerol based tri- esters which make up fats and oils to methanol based mono-ester (methyl esters) yielding free glycerol as a by product. A stoichiometric material balance yields the following simplified equation [5,6]. The chemical reaction involved in this process is as shown in Figure 1.

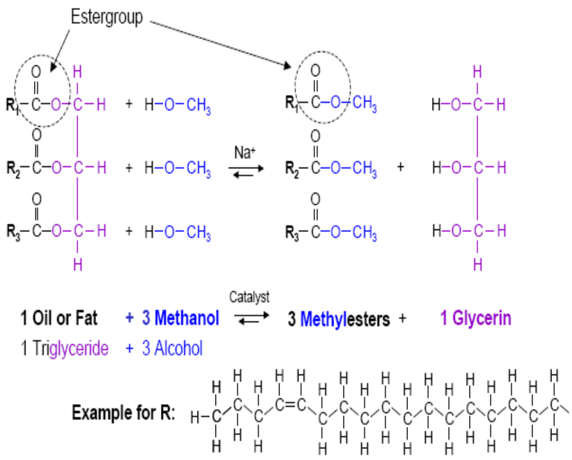


Fig.1 Basic Scheme for Bio diesel production

III. ENGINE TEST

The engine used for the study is Kirloskar make single cylinder four stroke constant speed, vertical, water cooled, direct injection , 5HP diesel engine. The computer assisted experimental set up of engine shown in Figure2. The eddy current dynamometer was used for load measurement the engine speed was sensed and indicated by an inductive pick up sensor with digital meter output. Figure3 shows AVL make smoke meter used for smoke measurement the carbon-di-oxide (CO_2), carbon monoxide (CO), hydro carbons, nitrous oxide and oxygen content was measured by MRU air fair emission monitoring systems shown in Figure 4.the experiments were conducted at three different injection pressures (180,200,220 N/m^2) for studying effect of injection pressure on the performance and emission of diesel engine with conventional diesel and neem methyl ester – diesel blends (B-20) as fuels. Tests were repeated for three times and average value has taken for analysis. The performed date was analyzed from graph regarding Brake thermal efficiency, Smoke density, UBHC and CO for all fuels. The results obtained with diesel fuel as baseline data for comparison.

Figure 2: Experimental Set up

Figure 3: AVL Smoke Meter

Figure 4: MRU Emission Monitoring System

IV. RESULTS AND DISCUSSIONS

Fuel properties: Chemical analysis of Neem oil is summarized in Table1. The conventional diesel has flash point of 50°C and that of methyl esters 80°C has a considerable higher flash point than diesel, there by the fire hazard associated with transportation, Storage utilization of esters is much less. The specific gravity of crude neem oil is 0.934 which is higher than the diesel fuel. The kinematic viscosity of neem oil is 37.42 centistokes and transesterified oil of 6.3 centi stokes, which is closer to diesel value. The fuel properties of Neem oil are presented in Table2. The iodine number, safonification value are well within the ASTM standard. Methyl ester has a cetane No and Calorific value almost equal to diesel values. From this the properties of Methyl Esters of Neem oil are compatible and acceptable as fuel oil. Table 3 represents the Comparison of important fuel properties of Diesel and Methyl ester of Neem oil.

V. ENGINE PERFORMANCE

Variation of BTE with load at three injection pressure for B-20 oil shown in figure 5 and compared with diesel mode of operation. It is observed from figure that maximum efficiency (28.34%) for B-20 oil obtained at 200 bar. High injection pressure means that the injection always takes place at high pressure and hence atomization better and mixing with oil is good.

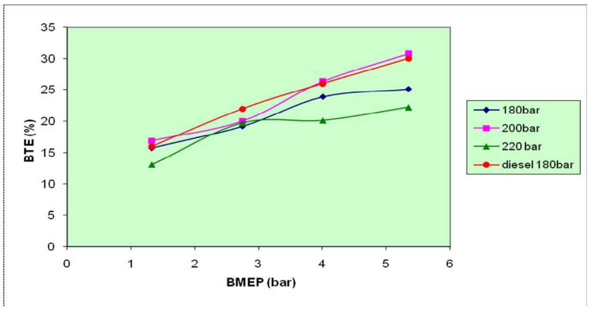


Fig 5 : Variation of BTE with BMEP

VI. ENGINE EMISSIONS

Figure 6 shows the hydrocarbon emissions with load at three different injection pressure considered. From the figure it is clear that significant drop in hydro carbon emissions levels as injection pressure increases because of better combustion. Enhanced atomization also led to lower ignition delay which in turn enhances performance with vegetable oils, which have high ignition delay to account of their high viscosity.

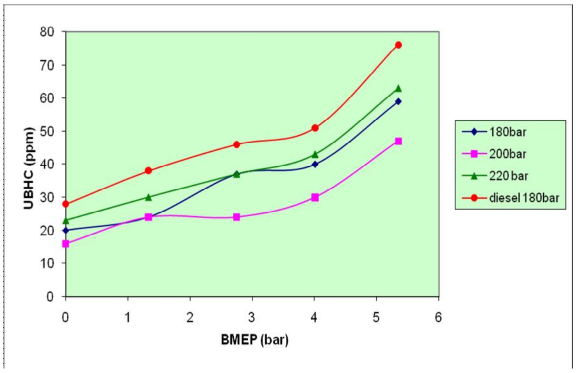


Fig 6: Variation of UBHC with BMEP

The variation of NOx emission with load shows in the figure. The NOx level increases with incoming injection opening pressure due to faster combustion and higher temperature reached in the cycle.[2,3,4,7]

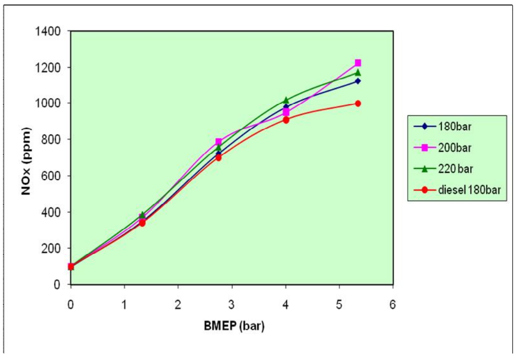


Fig 7: Variation of NOx with BMEP

Figure indicates the smoke level variation with load smoke levels decrease with increase in the Injection opening pressure due to improved mixture formation due to a well atomized spray.

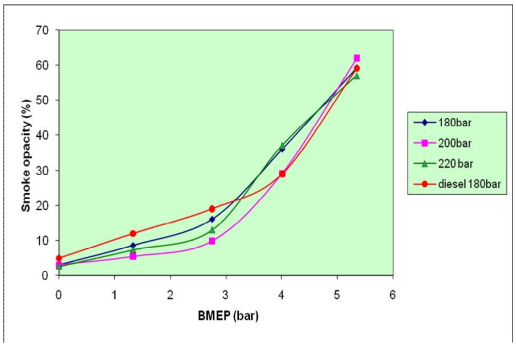
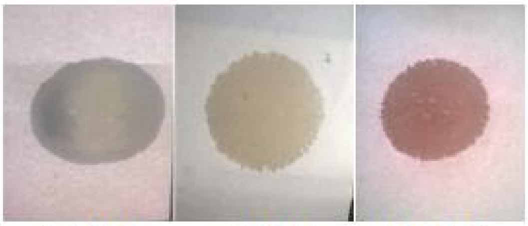


Fig 8: Smoke opacity with BMEP

VII. SPRAY PATTERN ANALYSIS

Figure 9 shows the spray tester.Initially diesel was poured into the test-oil container. Now, fuel injector of 180 bar pressure was fixed to the pressure pipe and using the hand lever the diesel was sprayed onto an OHP sheet to obtain its spray pattern. Then, the same procedure was followed for injectors of 200 bar and 220 bar pressures and their respective spray patterns were obtained. These spray patterns are shown below.



220 BAR 200 BAR 180 BAR

Fig 10: Spray Pattern Of diesel For Different Nozzle Pressures

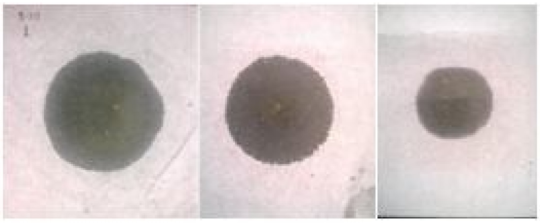


Fig 10: Spray Pattern Of B20 Biodiesel For Different Nozzle Pressures

220 BAR 200 BAR 180 BAR

Fig 11: Spray Pattern Of B30 Biodiesel For Different Nozzle Pressures

VIII. CONCLUSIONS

Neem oil is a renewable source of energy; it can be used in conventional compression Ignition engine as a substitute fuel.

After transesterification of neem oil, Kinematic Viscosity, Specific gravity has reduced and calorific Value is increased.

The injection of 200 bar is formed to optimum injection pressure for better results.

The emission such as hydro Carbon, NOx and Smoke density are reduced and Comparable BTE with B 20 fuel when compared to diesel fuel

The spray diameter of B20 and B30 blends of biodiesel containing neem is almost similar to the spray diameter of diesel at a nozzle pressure of 220 bar. Due to similar spray patterns proper combustion takes place resulting in higher efficiency. Hence instead of diesel, these blends can be used as fuel in CI engines having single nozzle fuel injectors of 220 bar nozzle pressure

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