EFFECT OF INJECTION PRESSURE ON THE PERFORMANCE AND EMISSION CHARACTERISTICS OF C I ENGINE USING JATROPHA CURCUS AS BIO-DIESEL WITH SC5D ADDITIVE.

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Abstract

The depletion of world petroleum reserves and the increased environmental concerns have stimulated the search for alternative sources for petroleum-based fuel, including diesel fuels. Because of the closer properties, biodiesel fuel from non-edible oil is considered as the best candidate for diesel fuel substitute in diesel engines. With increasing demand on the use of fossil fuels, stronger threat to clean environment is being posed as burning of fossil fuels is associated with emissions like CO_2, CO, HC, NOx and particulate matter and are currently the dominant global source of emissions. The harmful exhaust emissions from the engines, rapid increase in the prices of petroleum products and uncertainties of their supply have jointly created renewed interest among the researchers to search for suitable alternative fuels. Transesterified non-edible oils (biodiesel) are promising alternative fuel for diesel engines. Experimental investigation has been carried out on the effect of injection pressure on the performance and emission characteristics of C I Engine using Jatropha Curcus as bio-diesel with SC5D Additive. The properties of JME thus obtained are comparable with ASTM biodiesel standards. Tests are conducted on single cylinder four stroke water cooled compression ignition engine to evaluate the feasibility of blends of JME with SC5D Additive. Our studies indicate that J20 with SC5D Additice is the best blend among all other blends. The performance of J20 with SC5D Additive shows less specific energy consumption and highest break thermal efficiency. As the amount of JME blend with SC5D Additive increases the HC, CO, smoke density in exhaust decreases.

Key Words: diesel engine, biodiesel, performance, emissions, Jatropha Methyl Ester, S C5D Additive.

I. INTRODUCTION

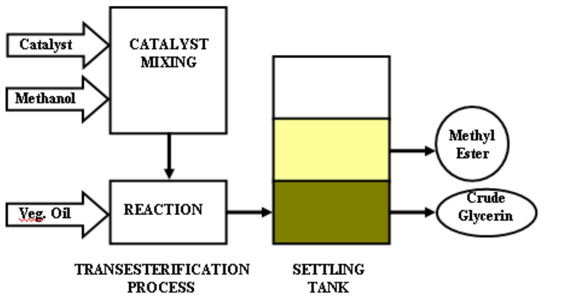
As the fossil fuels are depleting day by day, there is a need to find out an alternative fuel to fulfill the energy demand of the world. Bio-diesel is one of the best available sources to fulfill the energy demand of the world. The petroleum fuels play a very important role in the development of industrial growth, transportation, agricultural sector and to meet many other basic human needs. However, these fuels are limited and depleting day by day as the consumption is increasing very rapidly. Moreover, their use is alarming the environmental problems to society. Hence, the scientists are looking for alternative fuels. India is importing more than 80% of its fuel demand and spending a huge amount of foreign currency on fuel. Bio-diesel is gaining more and more importance as an attractive fuel due to the depleting nature of fossil fuel resources. By adding SC5D Additive to the bio-diesel the performance will improved and emission will be reduced more than plain bio-diesel.

1. Biodiesel can be used in the existing engine without any modification.
2. The use of biodiesel in conventional diesel engines results in substantial reduction of unburnt hydro carbon, carbon monoxide and particulate matters (but NO_X about 2% higher).
3. Biodiesel has almost no sulphur (0.05%), no aromatics and has about 10% built in oxygen which helps in better combustion.
4. Its higher flash point (>100 as against 35 in diesel) is good from safety point of view.
5. Unlike fossil fuels the use of biodiesel does not contribute to global warming as CO_2 emitted is once again absorbed by the plants grown for non-edible oil production. Thus CO_2 balance is maintained.
6. Biodiesel is produced from renewable non-edible oil and hence improves the fuel or energy security and economy independence.

A lot of research work has been carried out to use vegetable oil both in its neat form and modified form. Studies have revealed that the usage of non-edible oil in neat form is possible but not preferable [3]. The high viscosity of non-edible oils and low volatility affects the atomization and spry patterns of fuel, leading to incomplete combustion and severe carbon deposits, injector choking and piston ring sticking. The methods used to reduce the viscosity are.

- Emulsification.
- Pyrolysis.
- Transesterification.

Among these, the transesterification is commonly used commercial process to produce clean and environment friendly method to reduce the viscosity of Bio-diesel



PROCESS FLOW CHART FOR TRANSESTERIFICATION

In the present investigation, the oil obtained from the seeds of Jatropha Curcus has been considered as a potential alternative fuel for C.I. Engines. *Iman K. Reksowardojo et.al. [12]* reported that the biodiesel fuel from Jatropha oil and its blend with petro-diesel can comparable engine performance parameters such as Torque(T) Fuel Volumetric Consumption (FVC), Break Specific Energy Consumption (BSEC), engine exhaust gas emissions of total hydro carbon (THC), carbon monoxide (CO) & smoke emissions reduce significantly when engine run with biodiesel fuel. *Y.V.Hanumantha Rao et al [4] studied* the Additives act like catalyst so that they aid combustion, control emission, control fuel quality during distribution and storage and reduce refiners operating cost. In this work the performance & emission characteristics of JME with SC5D Additive is studied & reported. More over this paper presents comprehensive analysis of blends of JME and SC5D Additive with diesel.

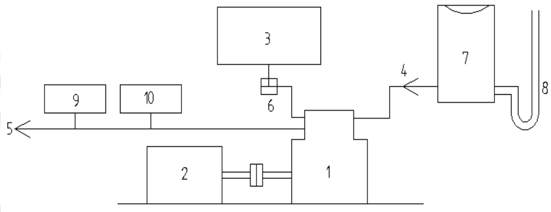
II. EXPERIMENTAL PROCEDURE

A. Preparation of Jatropha Methyl Ester (JME)

As a diesel fuel substitute, Jatropha falls under the category of bio-diesel. Extraction requires passing the seeds through a screw crusher, generally called expellers. The oil is then filtered to make it clean enough for processing. The filtered oil is treated with alcohol, i.e. ethanol or methanol using KOH or NAOH as catalyst in a process known as transesterification ([1],[4]).

B. Engine Tests

The engine used for this experimental investigation was a single cylinder 4 stroke naturally aspirated water cooled diesel engine having 5 BHP as rated power at 1500 rev/min. The engine was coupled to a brake drum dynamometer to measure the output. Fuel flow rates were timed with calibrated burette. Exhaust gas analysis was performed using a multi gas exhaust analyzer.



1. Engine
2. Eddy Current Dynamometer
3. Fuel Tank (Biodiesel)
4. Air Flow Direction.
5. Exhaust Flow
6. Three Way Valve
7. Air Box.
8. Manometer.
9. Smoke Meter.
10. Exhaust Gas Analyzer

SCHEMATIC DIAGRAM OF THE EXPERIMENTAL SETUP

Table-1: PROPERTIES OF DIESEL & JME

Sl.No	Properties	Diesel	JME
1	Density kg/m^3	820	916
2	Kinematic Viscosity at 40^{o}C CSt	4.86	5.37
3	Flash Point ^{o}C	49	230
4	Calorific Value MJ/kg	44.42	39.1

III. RESULTS AND ANALYSIS

This paper compares specific fuel consumption, brake thermal efficiency and exhaust emissions of blends of JME and SC5D Additive with those of diesel.

A. Performance characteristics:

Engine performance characteristics are the major criterion that governs the suitability of a fuel. This study is concerned with the evaluation of Brake Specific Energy Consumption (BSEC) and Brake Thermal Efficiency (BTE) of the blends of JME and SC5D Additive with diesel.

1. Brake Specific Energy Consumption (BSEC)

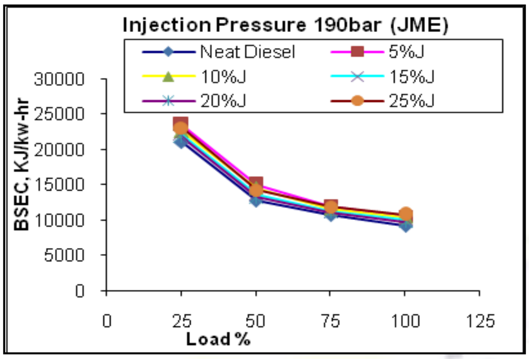


Fig 1.Variation of BSEC with for different percentage of JME

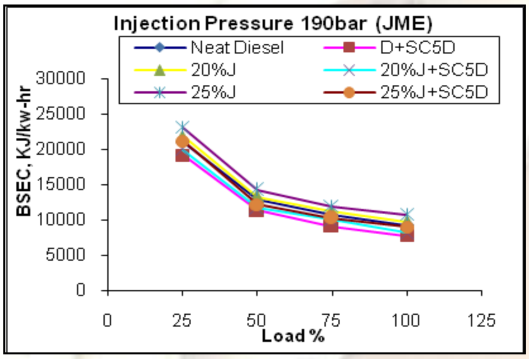


Fig 2.Variation of BSEC with load for different percentage of JME and JME with SC5D Additive in Diesel

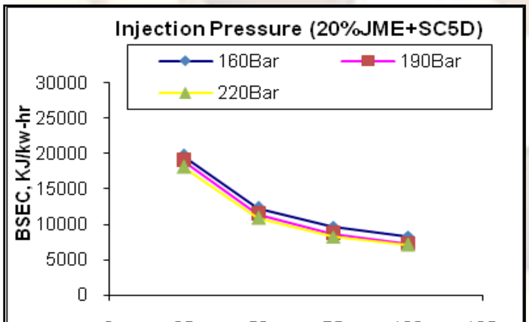


Fig 3.Variation of BSEC with load for 20%JME and SC5D Additive at different Injection Pressures

JME has lower calorific value than that of diesel. Hence Brake Specific Energy Consumption is slightly higher than that of the diesel. From fig 1. It is seen that the BSEC decreases with load for JME blends, fig 2. Shows BSEC still more decreases by adding SC5D Additive to JME blends. And also from fig 3. It is also seen that as the injection pressure increases BSEC decreases.

2. Brake Thermal Efficiency (BTE)

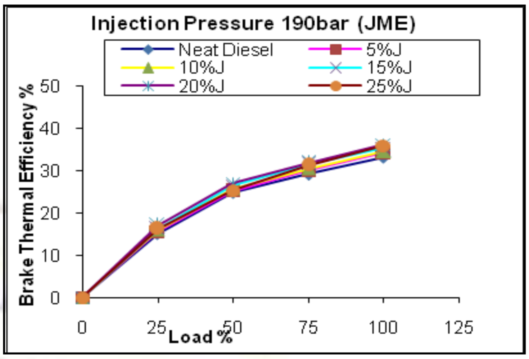


Fig 4. Variation of BTE with load for different percentages of JME in Diesel

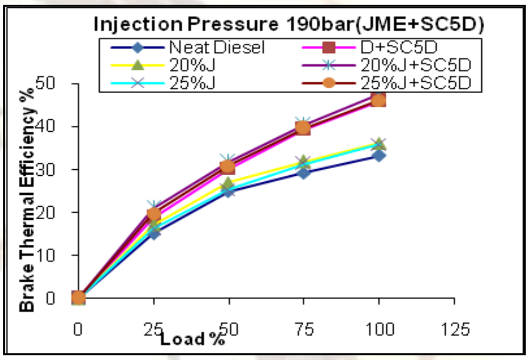


Fig 5. Variation of BTE with load for different percentages of JME and JME with SC5D Additive in Diesel

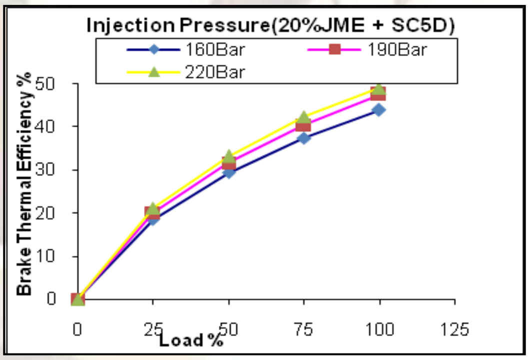


Fig 6. Variation of BTE with load for 20%JME and SC5D Additive at different Injection Pressures

Fig4.Shows that Brake Thermal Efficiency is slightly higher than that of diesel and BTE increases with load for JME blends and fig 5. Shows again it increases by adding SC5D Additive to JME blends. And from fig6. It is seen that as the injection pressure increases BTE also increases.

B. Emission Characteristics:

With problem like global warming ozone layer deletion and photochemical smog in addition to widespread air pollution automotive emission are placed under the microscope and every possible method is attempted to reduce emission. Hence this study compares the emission of pollutants nitrogen oxides, carbon monoxide, unburned hydrocarbon emissions and smoke density of JME blends and SC5D Additive with diesel.

1. Exhaust Gas Temperature (EGT):

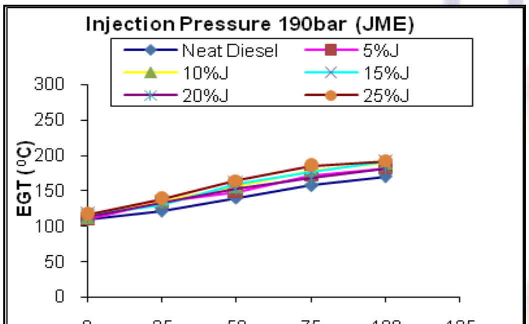


Fig 7.Variation of Exhaust Gas Temperature with load for different percentages of JME in diesel

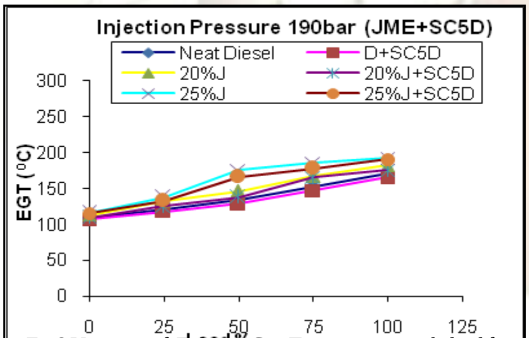


Fig 8.Variation of Exhaust Gas Temperature with load for different percentages of JME and JME with SC5D Additive in Diesel

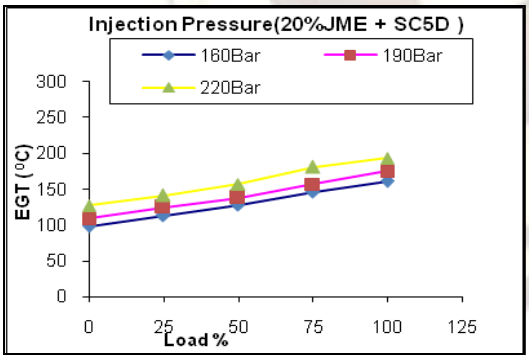


Fig 9. Variation of EGT with load for 20%JME and SC5D Additive at different Injection Pressures

Fig7, 8 and 9 shows EGT variation for test fuels with load. It is observed that from fig 7. EGT increases with load because more fuel is burnt at higher loads to meet the power requirement and also observed that EGT increases with percentage of JME blends and fig 8. Shows again it increases by adding SC5D Additive in the test fuel for all loads. This may be due to the oxygen content of the JME and SC5D Additive, which improves combustion and thus may increase the EGT. From fig 9. It is seen that as injection pressure increases Exhaust Gas Temperature also increases.

2. Smoke Density (HSU):

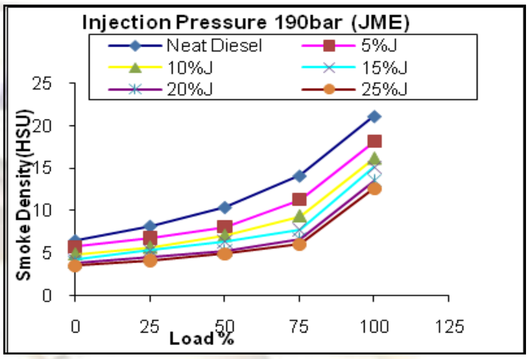


Fig 10.Variation of Smoke Density with load for different percentages of JME in diesel

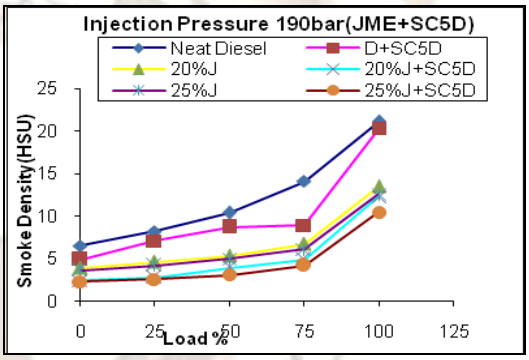


Fig11. Variation of Smoke Density with load for different percentages of JME and JME with SC5D Additive in Diesel

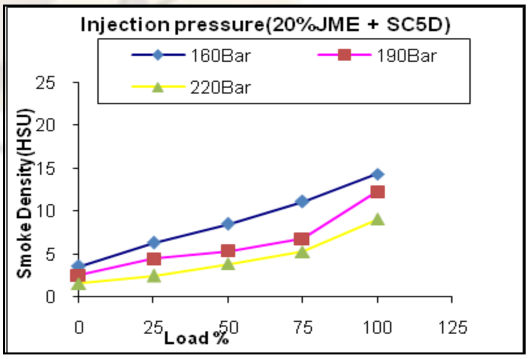


Fig 12. Variation of Smoke Density with load for 20%JME and SC5D Additive at different Injection Pressures

From fig 10. It is observed that smoke density increases with load and a vast reduction in the smoke intensity is observed with increase in the percentage of JME blends and fig 11. Shows that again smoke density decreases by adding SC5D Additive to JME blends. And from fig 12.it is seen that as the injection pressure increases smoke density reduces.

From fig 13. it is observed that hydrocarbon emission increases with load and as the percentage of JME blends increases hyrocarbon emission is reduced and again from fig 14 it is seen that by adding SC5D Additive to JME blends the emission is reduced more. And fig 15. Shows that as the injection pressure increases hydrocarbon emission is reduced.

3. Unburnt Hydrocarbon:

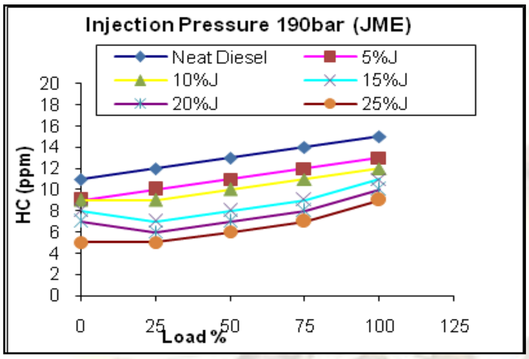


Fig 13. Variation of HC with load for different percentages of JME in diesel

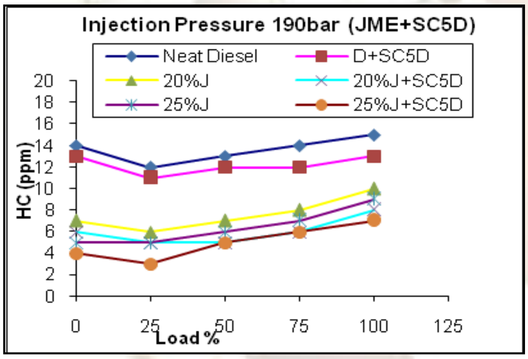


Fig 14. Variation of HC with load for different percentages of JME and JME with SC5D Additive in Diesel

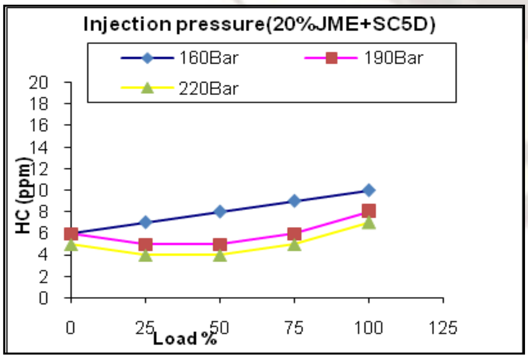


Fig 15. Variation of HC with load for 20%JME and SC5D Additive at different injection pressures

4. Oxides of nitrogen (NOx):

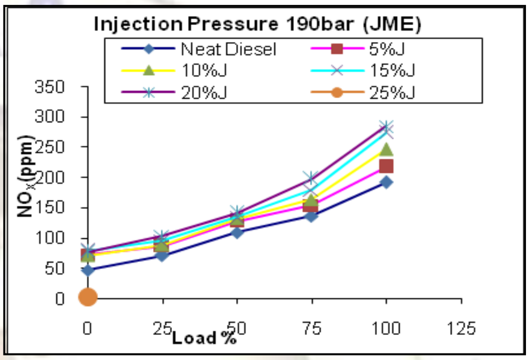


Fig 16. Variation of NOx with load for different percentages of JME in diesel

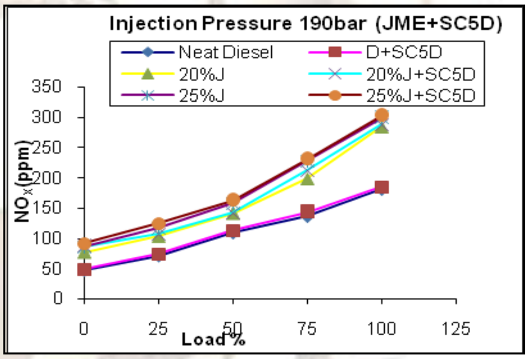


Fig 17.Variation of NOx with load for different percentages of JME and JME with SC5D Additive in Diesel

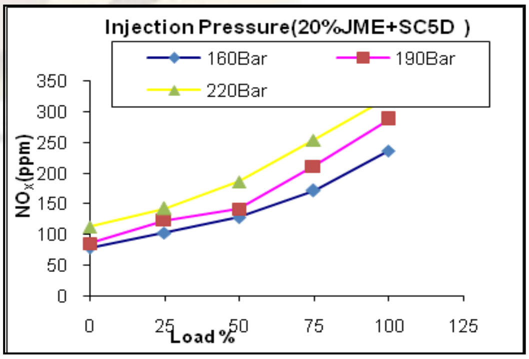


Fig 18.Variation of NOx with load for 20% JME

and SC5D Additive at different Injection Pressures

Fig 16.Shows gradual increase in the emission of nitrogen oxides (NO_X) with increase in percentage of JME blends and again fig 17.Shows it also increases by adding SC5D Additive in the fuel. The NO_X increases for JME may be associated with the oxygen content of JME, since the oxygen present in the fuel may provide additional oxygen for NO_X formation. And from fig 18.It is seen that as the injection pressure increases NO_X emission also increases.

5. Carbon monoxides

It is observed that there is no much variation in CO emission which remains almost same throughout the experimentation.

IV. CONCLUSION

The project work is carried out with the intention of exploring the possibility of increasing the efficiency and reducing exhaust emissions by adding JME and SC5D additive to the diesel fuel in C.I. Engine.

- Brake thermal efficiency increases with the increase in injection pressure and best efficiency occurs for the 20% blend of JME with diesel and SC5D Additive at full load. As the injection pressure increases BTE also increases.
- It is also observed that the exhaust gas temperature increases with percentage of JME and SC5D Additive in the test fuel for all the loads and also as the injection pressure increases exhaust gas temperature also increases
- There is a reduction in smoke density for blends of JME and SC5D Additive and as the injection pressure increases smoke density reduces.
- Interestingly HC emission of JME and SC5D Additive were lower than neat diesel and as the injection pressure increases hydrocarbon emission is reduced.
- CO emissions are not much significantly affected by the variation in blends of JME and SC5D Additive with diesel
- JME and SC5D Additive satisfies the important fuel properties as per ASTM specification of Biodiesel and improves the performance and emission characteristics of engine significantly.

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