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Performance & emission characteristics of Two Cylinder Diesel Engine Using Diesel & Pine oil

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Abstract: *With modernization and increase in the number of automobiles worldwide, the consumption of diesel and gasoline has enormously increased. As petroleum is non renewable source of energy and the petroleum reserves are scarce nowadays, there is a need to search for alternative fuels for automobiles. Work has been done in using a lot of bio-fuels, the fuels obtained from plant to be used in IC engines which have an even added advantage of lower emissions compared to that of diesel and gasoline. In the present investigation Pine has been experimented in a direct injection diesel engine under homogeneous charge compression ignition compression combustion mode*

The engine chosen to experiment is a single cylinder Direct ignition diesel engine and modified in such a way to, ignite Pine in a diesel engine under HCCI mode As the Pine has a higher self ignition temperature the ignition of Pine in regular diesel engines with auto-ignition is not possible. Hence, suitable modification is made in the engine to ignite Pine in a diesel engine like diesel fuel. The modified engine has Engine control module controlled fuel spray and an air pre-heater in the suction side of the engine. The combined effort of adiabatic compression and supply of preheated air ignites pine by auto-ignition and its timing of ignition is precisely controlled by changing intake air temperature .Pine oil has been used in direct injection Compression ignition engine as an alternate fuel has similar properties as that of diesel. This investigation revealed that the engine operated with pine performed well with little loss of brake thermal efficiency. Thereafter, the properties of the pine oil obtained are studied and represented in a graphical form.

Keywords: *Diesel, Pine oil, Performance, Emissions.*

I. INTRODUCTION

Since the inception of industrial revolution in eighteenth century, the search for portable prime movers to run machines for both industrial and transportation purpose became intense. Steam engines took a lead role in the beginning, but could not pass the test of time as they were bulky, less efficient and required huge quantity of low energy density solid fuels like coal. In the later part of nineteenth century, diesel engine was invented. Since then these engines have become an integral part of modern human civilization and mostly replaced the steam engines which became obsolete. These engines are extensively used worldwide for transportation, decentralized power generation, agricultural applications and industrial sectors because of their high fuel conversion efficiency, ruggedness and relatively easy operation [1,2].

These wide fields of global usage of diesel engines lead to ever increasing demand of petroleum derived fuels. Petroleum fuels are exhaustible sources of energy and hence an over reliability on these fuels is not sustainable in long run. Besides, the rising crude oil prices and increasing pollution due to excessive use of these engines is another grey area. The exhaust emissions of diesel engines, particularly soot, oxides of nitrogen and carbon monoxide are extremely harmful to natural environment and living beings [3].Projections for the 30-year period from 1990 to 2020 indicate that vehicle travel, and consequently fossil-fuel demand, will almost triple worldwide and the resulting emissions will pose a serious problem [4].

The engine chosen to experiment is a single cylinder DI (Direct ignition) diesel engine and modified in such a way to, ignite pine oil in a diesel engine under HCCI mode As the pine oil has a higher self ignition temperature the ignition of pine oil in regular diesel engines with auto-ignition is not possible. Hence, suitable modification is made in the engine to ignite pine oil in a diesel engine like diesel fuel. The modified engine has ECM (Engine control module) controlled fuel spray and an air pre-heater in the suction side of the engine. The combined effort of adiabatic compression and supply of preheated air ignites pine oil by auto-ignition and its timing of ignition is precisely controlled by changing intake air temperature. pine oil has been used in direct injection CI (Compression ignition) engine as an alternate fuel has similar properties as that of diesel. This investigation revealed that the engine operated with pine oil performed well with little loss of brake thermal efficiency. Thereafter, the properties of the pine oil obtained are studied and represented in a graphical form

Pine oil was used in early engines without any modification. The abundant availability of petro-fuels had stopped the usage of pine oil in I.C. engines. But the increasing cost of petro-fuel prevailing today reopens the utility of pine oil in I.C. engine. pine oil can be used in diesel engine as pine oil and diesel blend or duel fuel mode. Using pine oil in duel fuel mode in diesel engine the CO and UHBC emissions are slightly higher than diesel base line and NOx emission is found to be almost same. The gaseous fuels are used in duel fuel mode in IC engines. Since gaseous fuels have high auto-ignition temperature, they can't be used directly in CI engines easily. Hence they are normally used in DF mode. The dual fuel engine us the modified diesel engine in which usually a gaseous fuel called the primary fuel is inducted with air. The gaseous fuel-air mixture is then compressed but doesn't auto-ignite as it has a high self-ignition temperature.

A small amount of diesel usually called the pilot, is injected as in a normal diesel engine, near the end of the compression stroke. The pilot diesel fuel auto ignites and acts as a spark or source for the ignition of the primary fuel-air mixture. The combustion of gaseous fuel occurs due to the flame that propagates through. Thus the dual fuel mode combines the feature of CI and SI engine. Fuel injection is the part of CI engine and the compression of charge and propagation of flame is the part of SI engine.In the present work we are designing an apparatus for pine oil which can be inducted into the direct injection CI engine. After that, the properties of the pine oil obtained are represented on graph.

II. LITERATURE SURVEY

Jalpit B. Prajapati et al [16K] conducted the experiment on single cylinder four-stroke compression ignition engine to evaluate the engine performance and emission characteristics of
Diesel-biodiesel (palm) blends i.e. B0, B10, B20, B30, with load variation from no load to full load and compared with diesel as a fuel with fixed compression ratio i.e. 18. They concluded that B20 is best in performance compare to other blends but NOx formation is also little higher in B20.

S.N. Harikrishnan et al [17K] paper presents performance and emission characteristics on single cylinder, four stroke, constant speed, water cooled, direct injection diesel engine using rubber seed oil (RSO) as a fuel. The experimental data for various parameters such as thermal efficiency, brake specific fuel consumptions are analyzed and acceptable thermal efficiencies of the engine were obtained with blends containing up to 75% of rubber seed oil biodiesel blend compared to 25%, 50% and 100%.

M.Prabhahar et al [18K] This paper present the performance and emission characteristics of a single cylinder constant speed direct injection diesel engine using neat Pine methyl ester and its diesel blends (PME) such as B20 and B100 at different load conditions. The results showed that the brake thermal efficiency decreased and BSFC increased slightly for Pine methyl ester blends as compared with diesel fuel and also seen that CO and smoke emissions were reduced by about 34% and 25% respectively for B20 at full load but NOx emission was increased about 8.5% for B20 blend. Finally to be Concluding 20% of Pine methyl ester can be used as diesel fuel without any engine modifications.

Table-1Properties			
Sl. No	**Properties**	**Diesel**	**Pine oil ($C_{11}H_{10}BrN_5$)**
1	Density(kg/m^3)	850	950
2	Calorific value (kJ/kg)	46,500	43404.03
3	Kinematic viscosity @ 40^{0}C (cst)	3.05	1.04
4	Cetane number	55	4
5	Flash point ºC	52	65
6	Fire point ºC	56	97.6
7	Specific gravity	0.86	0.91
8	Sulphur content (%)	<0.035	-

III. Objective Of The Project

- To study the performance and emissions characteristics of a diesel engine with Pine oil as fuel and it is compared with the base engine.
- To study the performance and emissions characteristics of modified piston diesel engine with Pine oil as fuel and it is compared with the base engine.
- To measure the level of CO, HC and smoke in the exhaust emissions in the above said engine.
- To reduce the CO, HC and smoke level in the exhaust emissions by modifying the piston.
  To analyze the exhaust emission.

IV. Methodology

- The engine used for the experiment is started using diesel fuel and then its performance and emission readings are observed under various load condition.
- Selecting suitable Pine oil for double cylinder diesel engine and development of an experimental set-up with necessary instruments to study the performance and emission characteristics.
- The admission of Pine oil along with diesel fuel makes the engine run under dual fuel Mode.
- Conducting same trail for Pine oil and diesel fuel from zero to full load condition for modified piston diesel engine.
- Compare the performance and emission parameters for diesel and Pine oil for both base engine and modified piston diesel engine.

V. Experimental Setup and Engine Specification

The experimental test set up as shown in fig 1 and 2 consists of four stroke, constant speed and multi cylinder diesel engine. The engine is oil cooled. The injection timing given by the manufacturer is 27º BTDC, the operating pressure of the fuel injector was set at 1800 bar and the engine speed is 1500rpm.There are number of sensor are used in the engine to measure the fuel and engine parameter and the engine is loaded with water loading as shown in fig 3. Engine specifications as shown in table 2 and table 3 show load bank specification.

Fig- 1: Schematic arrangement of Experimental Set-up

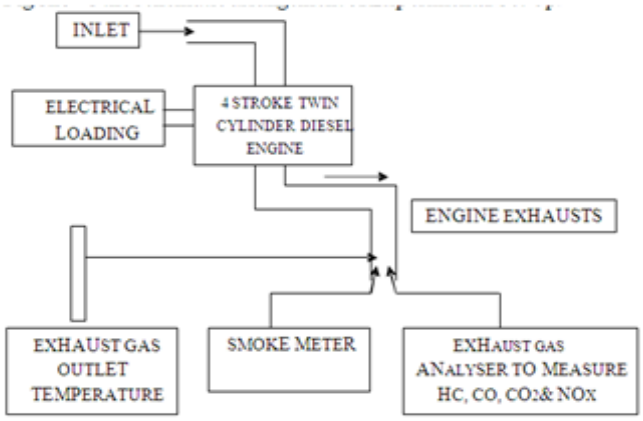

Fig -2: Test engine

Fig- 3: Water loading

Engine type	Four stroke Two cylinder diesel engine
No. of cylinders	02
Stroke	100 mm
Bore Diameter	87 mm
Engine power	15 KV
Compression ratio	17.5:1
NRPM	1500
Type of starting	Crank starting
Load type	Water loading

Table-2 Test Engine specification

Max. Output	15 KV
Generator type	1 Phase
Amps	63
RPM	1500
PF	0.8
Volts	240

Table-3 Load bank specification

VI. Experimental Procedure

- Experiments were initially carried out on the engine using diesel as fuel in order to provide base line data.
- Initially the engine was started using diesel fuel and allowed to run for few minutes until to reach steady state; the base line data were taken. Load was varied from zero loads to full load conditionusing the water loading and Emissions, smoke and fuel consumption reading were recorded.
- The engine was started on duel fuel mode, when engine became sufficiently heated; the supply of diesel was slowly substituted by 100 % Pine oil for which a two way valve was used. Once the engine reaches steady state, the emission, fuel consumption and smoke reading were taken. The same procedure is carried from zero to full load condition. Similarly same procedures were carried for modified piston diesel engine

VII. Results and Discussion

a) Carbon Monoxide

Figures 4, shows the variation CO level with respect to diesel and Pine oil at different loads. From the graph it is clear that the CO level decreases for conventional pine oil engine and keep on increases for modified engine

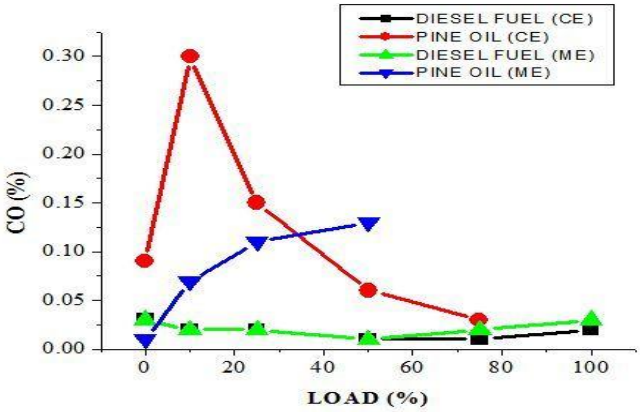

Figure- 4: Comparison of Carbon monoxide vs Load

b) Brake thermal efficiency

Figure 5, shows the variation of brake thermal efficiency with respect to Pine oil & diesel at different loads. From the graph it is observed that as load increases brake thermal efficiency increases for conventional pine oil and diesel oil engine up to 50% of load and decreases for modified Pine oil engine.

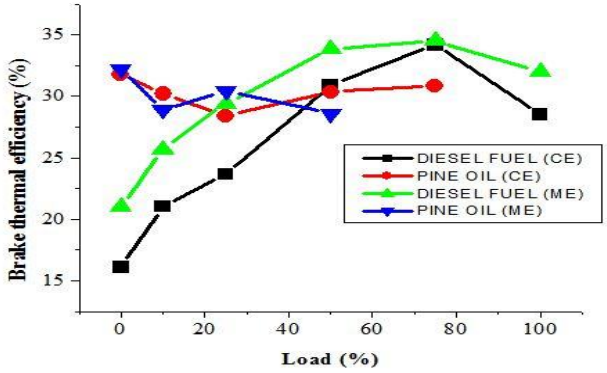

Figure- 5: Comparison of Brake thermal efficiency vs Load

c) Specific fuel consumption

From figure-6 it is clear that as the load increases specific fuel consumption decreases up to 50% load and the SFC of Pine oil is less than the diesel for both conventional and modified upto 50% engine load.

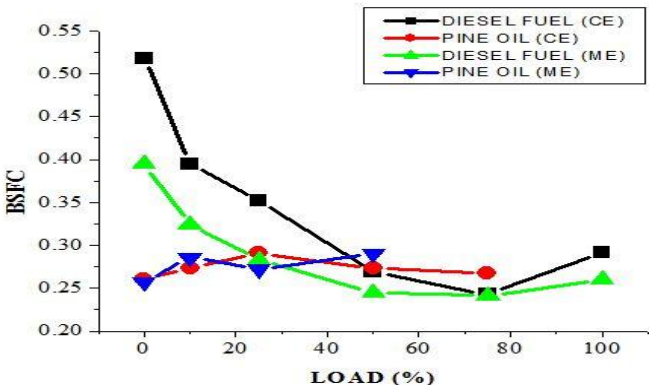

Figure- 6: Comparison of Brake specific fuel consumption vs Load

d) Hydrocarbon

The variation of Hydrocarbon of the engine with diesel & Pine oil is shown in figure 7. It can be seen that there is a higher Hydrocarbon emissions for conventional and modified Pine oil engine at lower loads and emissions keep on decreasing as the engine load increases.

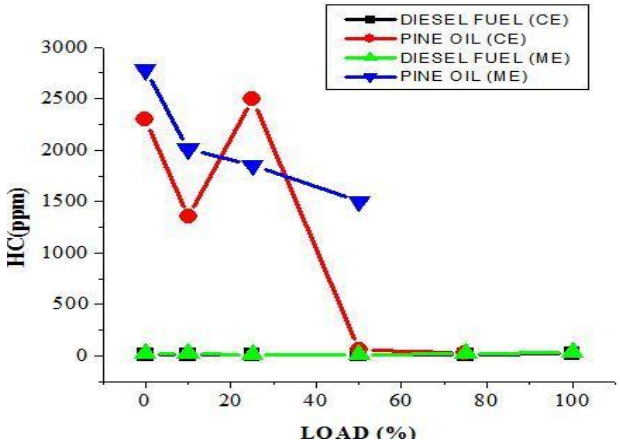

Figure- 7: Comparison of HC vs Load

VIII. Conclusion and Future Scope

Based on the performance and emissions characteristics of Pine oil, it is concluded that the Pine oil shows a good alternative fuel with closer performance and better emission characteristics to that of a diesel. From the above results it is concluded that the Pine oil shows better performance characteristics like Brake thermal efficiency, and decrease in the emission parameters like CO, HC. Hence the 100% Pine oil can be substitute for diesel. The future research directions for scientists or researcher can be done with different engine modification.

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