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Discharge and Performance Investigation of Unconventional Diesel Combination in Compressed Ignition Engine

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Abstract:- The world is confronted with the twin emergencies of fossil fuel consumption and natural corruption. The erratic extraction and utilization of fossil fills have driven to a lessening in petroleum saves. The expanding moment charge has required the seek forfluid powers as an elective to diesel, which is being utilized in expansive amounts in transport, farming, mechanical, commercial and household segments. In this paper, an endeavor has been made to examine foursorts of ~lls are considered (100% unadulterated diesel-D100 ; 30% of crude corn oil mixed with 70% immaculate diesel; 25% Methyl Ester of corn oil with 5% of Diethyl Ether mixed with 70% unadulterated diesel; 25% Methyl Ester of corn oil blended with 5% of Hydrogen Peroxide is mixed with 70% unadulterateddiesel,. 25% Methyl Ester of corn oil blended with 5% of Butane 1-ol is mixed with 70% unadulterated diesel, 25% Methyl Ester of corn oil blended with 5% of Propane 2-ol is mixed with 70% unadulterated diesel, Out which the ~nal ~ve sorts have been considered as an elective ~lls are tried in compressed start 4 stroke diesel motor, The different execution and emanation parameters like., brake warm effectiveness, particular fuel utilization, smoke, CO, HC, NOx, CO2, O2 and the deplete gas temperatures were measured and analyzed.The tests appeared noteworthy change in motor execution compared to unadulterated diesel conjointly an increment within the brake warm efficiencies and particular fuel utilization were taken note in biodiesel combinations compared to immaculate diesel. The smoke, CO, NOx, CO2 and HC out flows of the motor were found to be viably diminished with this combination.

I. INTRODUCTION

The world is in need of an alternative fuel, because of the depletion of crude oil. To satisfy the need, great search of alternative fuel is going on. Vegetable oil is considered as one of the alternate fuel because of its easily availability and renewable. Therefore, during recent years a systematic approach has been made by several researchers to use vegetable oils as a fuel in IC engines. Corn oil is having tremendous potential as alternate fuels. Corn oil has some disadvantages like high viscosity and density. The high viscosity is due to the large molecular mass and complex chemical structure of vegetable oils that in turn leads to problems related to pumping, combustion and atomization in the injector systemsof a diesel engine. Due to the high viscosity, the long term operation of the engine with vegetable oils normally introduce the development of gumming, the formation of injector deposits, ring sticking and problems related to the lubricating oils. Therefore, the reduction of viscosity of vegetable oils isof prime importance to make it a suitable alternative fuel for diesel engines. The problem of high viscosity ofvegetable oils can be reduced in several ways, such as transesterification, micro emulsification, preheating the oils and blending with other fuels such as diesel, oxygenated organic compounds, and methanol. Emission levels of the blends of diesel and vegetable oils were found to be reduced. Several research and studies on vegetable oil has evidently proved out that 20% blending with Diesel gives a suitable alternate fuel for compression ignition Engine. In this direction, an attempt has been made to investigate five types of fuels are considered.

- 100% pure diesel-D100.
- 30% of raw corn oil blended with 70% pure diesel (Sample1)
- 25% Methyl Ester of corn oil with 5% of DiethylEther blended with 70% pure diesel(Sample2)
- 25% Methyl Ester of corn oil mixed with 5% of Hydrogen Peroxide is blended with 70% pure diesel(Sample3)
- 25% Methyl Ester of corn oil mixed with 5% of Butane 1-ol is blended with 70% pure diesel (Sample4)
- 25% Methyl Ester of corn oil mixed with 5% of Propane 2-ol is blended with 70% pure diesel (Sample5)

Out which the last five types have been consideredas an alternative fuels are tested in a computerized fourstroke direct injection single cylinder C.I engine with acompression ratio of 16.5. The various performance and emission parameters like., brake thermal efficiency, specific fuel consumption, smoke, CO, HC, NOx, CO_2, O_2 and the exhaust gas temperatures were measured and analyzed.

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II. TRANSESTERIFICATION

Fig 1: Laboratory Setup of Transesterification Process

III. TRANSESTERIFICATION PROCESS SETUP

➢ *Biodiesel Production:*

Corn oil was used as the raw oilto react with methanol in a molar proportion of 1:6 to produce biodiesel. Sodium hydroxide (NaOH) of 1% ona mass base of the corn oil was used as the catalyst and pre-mixed with methanol by a mechanical stirrer to form sodium methoxide and water This mixture was thereafter added into a reacting tank to be mixed with the Corn oil using a mechanical homogenizer in order to undergo transesterification reaction. Because, the boiling point of methanol is 63 ^{0}C, the reacting temperature of the transesterification process was set at 60 ^{0}C in order to prevent the vaporization of the methanol from the reacting mixture during the biodiesel production process. It took 50 min to complete the transesterification reaction. After this process, the mixture was separated into two layers, coarse biodiesel and glycerol, by centrifuging or keeping it motionless by virtue of the difference in density between these two compounds. The unreacted methanol was distilled away from the coarse biodiesel at a temperature of 70^{0}C. The 50 wt% of petroleum ether and 0.5 wt% of water of the coarse biodiesel were then added into the biodiesel in turn to wash away the other impurities in the coarse biodiesel. The biodiesel was termed as methyl ester of Corn oil (MECO) after undergoing theseprocesses.

IV. EXPERIMENTAL SETUP

The experimental setup used for this work consists of a single cylinder, four strokes, Kirloskar, direct injection diesel engine. The engine is operated atfixed compression ratio of 16.5 and it is loaded with Power MAG Eddy current Dynamometer. The engine is fueled with D100, Sample1,Sample2, Sample3, Sample4, Sample5.The brake thermal efficiency, indicated thermal efficiency, specific fuel consumption were measured. The received data were compared, analyzed and converted into the graphical form for better presentation.

Fig 2: Experimental Setup of the Transesterification Process

V. DATA AQUISITION SYSTEM

Table 1: Engine Specification

Engine specification	
Make	Kirloskar
BHP & Speed	5 Hp & 1500-1580 rpm
Type of Engine	Single cylinder C.I. ,DI & 4S
Compression ratio	16.5:1
Bore & stroke	80 mm & 110 mm
Method of Loading	Eddy current Dynamometer
Method of starting	Manual cranking
Method of cooling	Water
Lube oil	SAE40

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Table 2: Smoke Meter Specifications

Technical specifications:

AVL smoke meter specifications	
Type	AVL 437
Measuring range	0-100 capacity in 1%
Absorption Coefficient	0-99.99 absorption m^{-1} /400…6000 min^{-1}
Operating temperature	0…..150°C
Accuracy and repeatability	±1% full scale reading
Maximum smoke Temperature at entrance	250°C

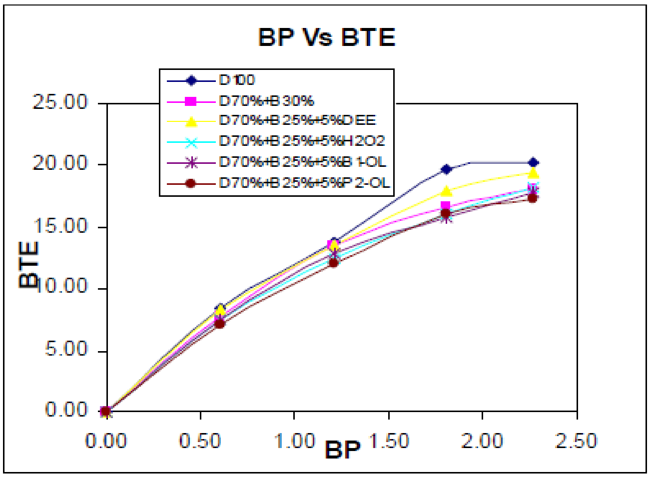
AVL DiGas 444

Measured Quality	Measuring Range
CO	0… 10 % vol
CO_2	0… 20 % vol
HC	0… 20000 ppm vol
O_2	0… 22 % vol
NO	0… 5000 ppm vol

Load was changed in five levels (0%, 20%, 40%,60% and 75%). The engine was operated at the rated speed @1500 rpm for all the tests. Concentration of CO, CO2, NOX, O2 and HC were measured with an AVL-444 exhaust gas analyzer. Smoke density was also measured for every blend at each load by means of an AVL-437 Diesel smoke meter.

VI. RESULTS AND DISCUSSION

A. Brake Thermal Efficiency:

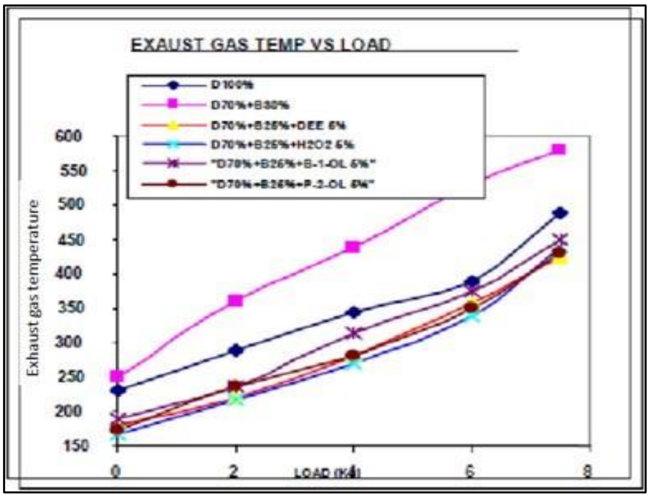


Graph 1: Brake Power vs Brake Thermal Efficiency

At high load D100 has an efficiency of 8% higher than sample1, sample2 and 3% higher than sample3 and sample4. Also sample5 has efficiency, 1%lesser than D100.At medium loads, D100 hasefficiency 3% higher than sample3 whereas sample 2 and sample5 has 6% lesser than efficiency of D100.This is due to poor spray character and no effective utilization of air resulting incompletecombustion.

B. Exhaust Gas Temperature:

The results show that the exhaust gas temperature increase with load in all case. The exhaustgas temperature was higher for sample1 based fuel maybe due to better combustion. At higher load, exhaust temperature of sample2 and sample5 is 11% lower thanD100, sample3 and sample4 is 8% lower than D100 whereas sample1 is 16.4% higher than D100.At medium loads, D100 has 9.4% and 35.3% higher than sample4 and sample2, sample3, sample5 respectively whereas D100 has 20% lower than sample1.



Graph 2: Exhaust Temperature vs Load

C. Oxygen:

Sample1, sample2, sample3, sample4 has almost same oxygen content which is 52.5% higher than D100, and sample4 has 48% higher than D100.Sample1, sample2, sample3, sample4 has almostsame oxygen content which is 30.5% higher than D100,and sample4 has 26% higher than D100.sample1, sample2, sample3, sample4 and sample5 have almost same oxygen content which is 16% higher than D100.

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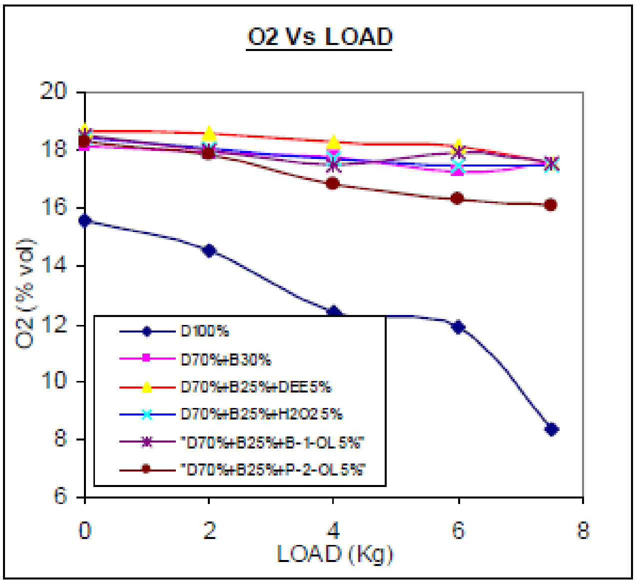
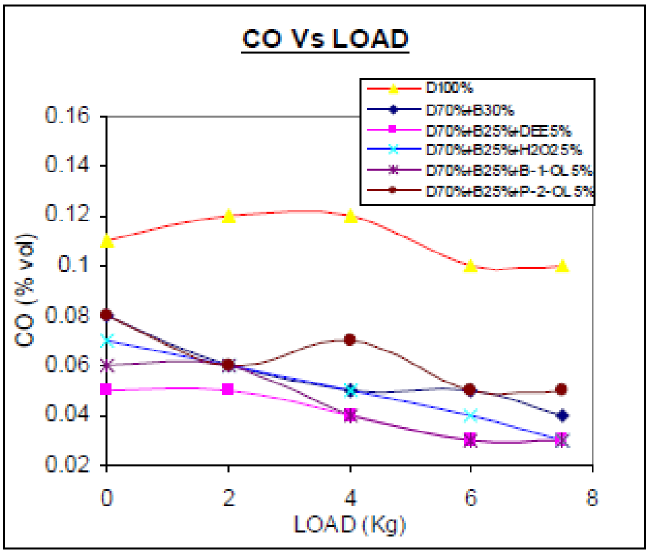


Graph 3: Oxygen vs Load

D. Carbon Monooxide:

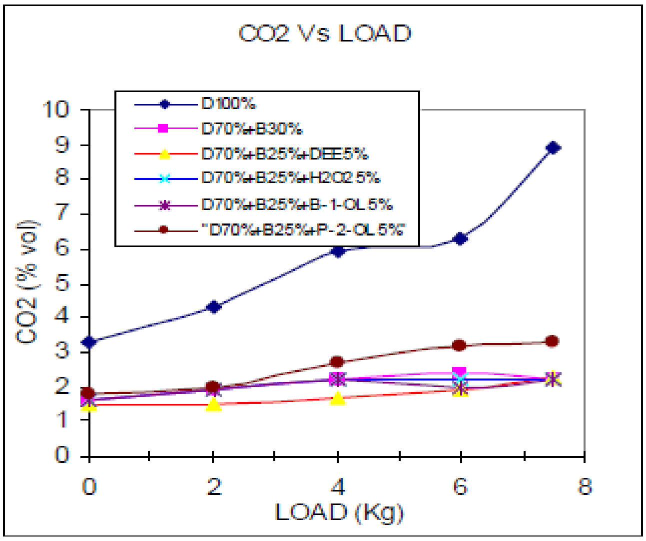


Graph 4: Carbon Monoxide vs Load

Emissions of CO from a diesel engine mainly due to the physical and chemical properties. The main difference in ester based fuel compares to diesel is the O2 content and Cetane number. As ester based fuel contain some O2 which acts as a combustion parameterinside the cylinder result better combustion than diesel fuel. Hence carbon monoxide which present in the exhaust due to incomplete combustion drastically. At higher load CO content of D100 has 60% and 50% higher than sample1 and sample5 respectively. Sample2, sample3, sample4 has same CO content which has 70.5 lower than D100.At medium loads sample2, sample4 has almost same CO content which is66% lower than D100 and also sample 1 and sample3 has same CO content which is 58% lower than D100.Atno load, CO content of sample1and sample5 is same which 27% is lower than D100 and CO content of D100has 55%, 36% and 45% higher than sample2, sample3,and sample4 respectively.

E. Carbondioxide:

The CO2 emissions from a diesel engine indicate that how efficiently the fuel burnt inside the combustion chamber.sample1, sample2, sample3 and sample4 has almost same cabon-di-oxide content whichis 73.8% lower than D100 respectively at higher load. At medium load, CO2 content of D100 has 53.8% and 69.2% higher than sample5 and sample2 respectively and the sample1, sample3, sample4 has same CO2content which is 60.6% lower than D100.At no load all samples has same CO2 content which is 51.5% lower than D100.



Graph 5 Carbon Di Oxide vs Load

F. Nitrogen Oxides:

In a DI naturally aspirated four stroke diesel engine NOx emissions are sensitive to O2 content, adiabatic flame temperature and spray characteristics. Itis well known that vegetable based fuel doesn't containsulphur, aromatics and nitrogen content is very small. The spray characteristics depend upon droplet size, droplet momentum, degree of mixing with air, penetration rate, evaporation rate and radiant heat transfer rate. A change in any of those properties may change NOx production. The trend depicts here clearlysays that the reduction in NOx incase of esters graduallydecreases from no load condition to maximum load. Sample1, Sample2, Sample3, Sample4 has same NOx content and are 72.6% lower than D100 and Sample5 has 65.3% lower than D100 at higher load. At mediumload, Sample1, Sample4, Sample5 has same NOx content and are 66.1% lower than D100 and D100 has 74.5%,71.2% higher than Sample2, Sample3 respectively. At no load, all samples have same NOx content which is 50%lower than D100.

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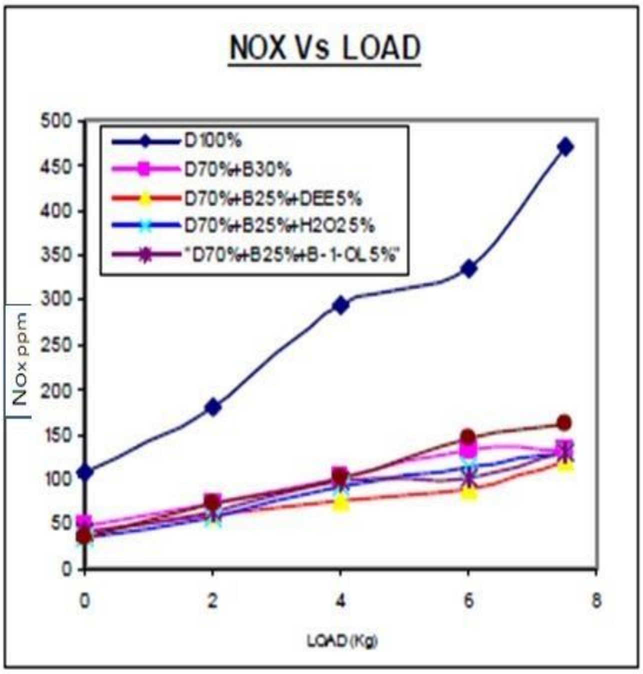
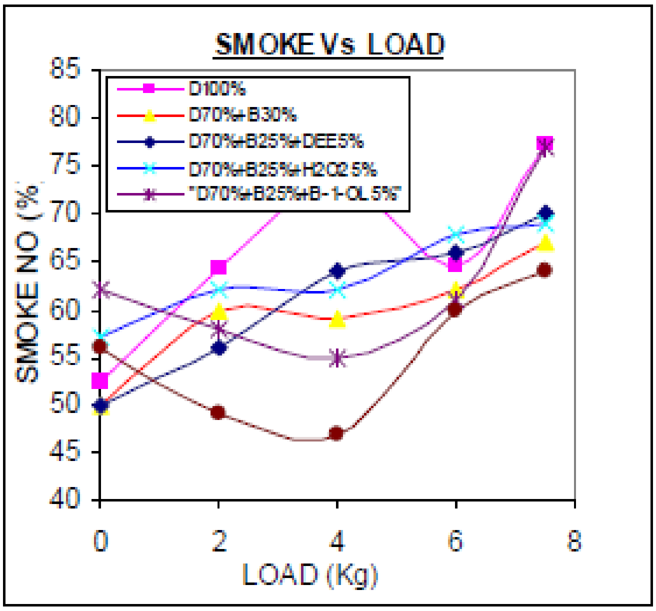


Graph 6: Nitrogen Oxide vs Load

G. Smoke Number:

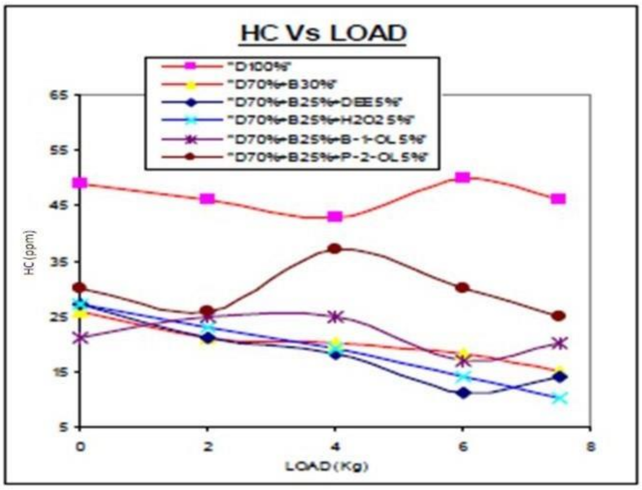
The smoke that formed due to incomplete combustion is much lower for esters compared to diesel. This is because of better combustion of ethers. Since bio diesel contains O2, there is an increased efficiency of combustion. It is found that the smoke capacity increased with increase in load. S2 and S3 hasalmost same smoke number 10% lower than D100 at higher loads, where as S1, S5 has almost same smoke number 15% lower than D100 and S3 has smoke number of D100. At mean load S2, S3 has almost samesmoke number 15% less than D100 and 20%, 26% and30% higher than S1, S4 & S5 respectively. At no load, D100 has 4%, 7%, & 19% higher than S1, S3 & S4.



Graph 7: Smoke vs Load

H. Hydrocarbon:

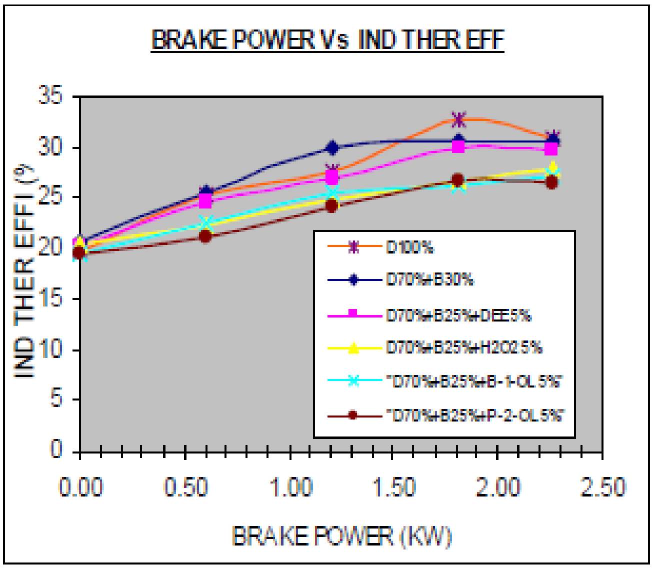
The variations of unburned hydrocarbon with load for base diesel and diesel blends of bio diesel and its blends are lower than the neat-diesel operation. At higher loads, HC content of D100 has 68.8%, 70.6%, 78.2%, 57.7%, and 46.6% higher than S1, S2, S3, and S4 & S5 respectively.



Graph 8: Hydrocarbon vs Load

I. Indicated Thermal Efficiency:

It can be observed that at high load, D100 has efficiency 8% higher than S1 and S2. S3 and S4 have efficiency 5% lower than D100 due incomplete combustion. At medium loads, S1, S3 have anefficiency that of D100 where as RV20 and B20 (P) is respectively 5.2% and 3.2% lower than D100 and B20.



Graph 9: Brake Power vs Indicated Thermal Efficiency

J. Specific Fuel Consumption:

At high loads the specific fuel consumption of S1 and S2, S3 S4 are 25% higher than efficiency of D100. S1 has 20% higher than D100. At mean loads, S1has 3.3% higher than D100. S3 and S4 have 20% higherthan D100 where as S5 has 26% higher than D100.

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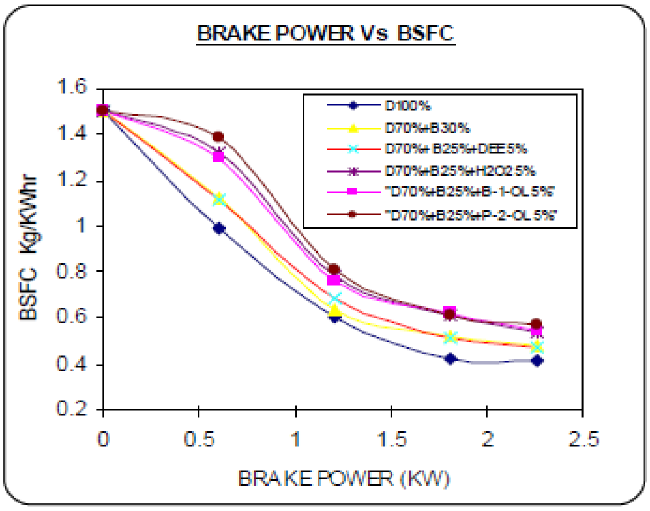

Graph 10 Brake Power vs Specific Fuel Consumption

VII. CONCLUSION

A computerized four-stroke direct injection single cylinder C.I engine was operated successfully using different combination of Corn oil with diesel as fuel. The following conclusions are made based on the experimental results:

- In case of Corn oil brake thermal efficiency issimilar to that of pure diesel.
- Indicated thermal efficiency is greater forsample1.
- At medium load, specific fuel consumption of Sample3,4,5 are same.
- Availability of oxygen in Sample3,4,5 is higher, easier combustion and gives higher efficiencyand performance.
- Smoke emission for Sample 4,5 is very low comparing to other fuel combinations. Carbondioxide, Nitrous oxide, Hydrocarbon and carbon mono oxide contents in exhaust gasis low in all samples when compared to pure diesel.
- Oxygen content in exhaust gases is much higher in all combinations when compared to pure diesel.

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