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Experimental Study on the Performance and Emission Characteristics of Corn Seed Oil Methyl Ester Along with Decanol as an Additive in Diesel Engine

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ABSTRACT: Bio fuels and with additives are used decreasing the environmental pollution. The present aim focused, to protect the depletion of natural petroleum products, and also to producing energy in the safe manner with the use of alternative fuels. The corn oil is one of the major vegetable oil, this oil utilise as biodiesel for to control the emissions released from the diesel engines. Decanol (DEC) is a cetane improver its used as a fuel additive to investigate the performance and exhaust emissions in diesel engine. Corn Seed Oil Methyl Ester (COME100), D50+COME50, D50+COME40+DEC10, D50+COME30+DEC20, D50+COME20+DEC30, diesel were used as a test fuels. DEC is added 10, 20 30% by volume to biodiesel. This research work was executed in 4stroke, single cylinder diesel engine. In this study we observed that the blend D50+COME20+DEC30 will give the best BTE when compared with the other COME blends and also it will give less BSFC compared with the COME blends. And the emissions CO, HC, NO_X for the blend D50+COME20+DEC30 were observed and concluded that the blend D50+COME20+DEC30 will give lesser emissions when compared with the other COME blends. Hence the adding percentage level of Decanol with the COME bio fuel will give better performance and lower emissions this is due to the increment in the cetane number of the bio fuel.

KEYWORDS: Decanol; Corn Seed Oil Methyl Ester; Emissions; performance; Diesel Engine.

Nomenclature

BTE	- Brake Thermal Efficiency	COME	- Corn Oil Methyl Ester
BSFC	- Brake Specific Fuel Consumption	D	- Diesel
CO	- Carbon monoxide	DEC	- Decanol
HC	- Hydro Carbons	NOX	- Oxides of Nitrozen

I. INTRODUCTION

At present whole world mostly run on the energy consumption. And also growth of population increasing day by day uncountable. For the need of human being the consumption of natural resources more rapidly in the last two decades of years. In the natural resources petroleum is one of the major products. For every industrial and automotives consumption of fuels at very high rate. Already we reach max peak point of utilization of natural petroleum products at present and the petroleum products going to be disappear stage. That why whole universe looking for alternative for the fuels. In that way mostly concentrated on biofuels or biodiesels.

Biofuels production growth averaged 9.72% in 2018, the highest growth since 2010 and slightly above the 10-year average. Brazil (3.10 MT) and Indonesia (2.20 MT) together accounted for almost two thirds of global growth (8.52MT).By fuel, Ethanol production in 2018 totalled 60.5 MT with North America accounting for 56%. Biodiesel production in 2018 amounted to 34.92 MT with Europe representing 37%.

In this paper we choose the corn oil as a alternative biodiesel, because the production also high and Corn is also used to make ethanol (as a fuel source for motor vehicles), and the saturated fatty acids contains 12.9% only. Corn (corn oil) is one of the most abundant crops in the world with annual production of approximately 102 MT. Corn is the third most important cultivated citrus species with a world production of 4,20,000 MT. Corn oil is much more valuable than its juice; therefore extensive research efforts have been expended to determine its natural with the effort of the basic Composition as a way to detect adulteration as well as quality factors. Thus one of the prominent alternative fuels is the biodiesel obtained from corn and it is widely available. It is estimated that every year a surplus amount of waste is discarded the complete recycling of these discarded parts is a priority concern.

Balamurugan et al (2018).[1] Investigation aimed for to set up a biodiesel from corn oil and the assessment of performance of the diesel engine with the mix of corn oil biodiesel with extents 10%, 20% and 30% by volume is feasible. From the experimentation brake thermal efficiency decreased with increasing of biodiesel in the diesel fuel. Compare with pure diesel the brake thermal efficiency decrease the biodiesels and brake specific fuel consumption is lower in the diesel and more in the bio diesel blends. The CO & HC emission for all blended fuels was greater than that of diesel at max load. NOx present in the exhaust was less for all blended fuels when compared with that of diesel.

Nanthagopal et al (2019).[2] Experimental investigation single cylinder direct injection CI engine was fueled with diesel, pure CIME and ternary blended diesel-biodiesel-DEE (oxygenated additive). Performance, emission and combustion characteristics of the ternary blend samples of 5%, 7.5%, 10%, 12.5% have been studied post the results were analyzed by comparing with the neat baseline diesel fuel sample. These ternary blends have lower brake thermal efficiency compared to pure diesel. Least reduction in brake thermal efficiency of 5.3% was found for 5% of DEE of concentration at all the loads and BTE decreases as the concentration increases . The unburned hydrocarbon and carbon mo NOx ide emissions were reduced for all blend samples where maximum reductions are 84% and 4.6% respectively at maximum load for 12.5% of DEE concentration because of the enhanced combustion taking place inside the combustion chamber due to the rich oxygen content. Therefore, from the present work, it may be concluded that the ternary blends of diesel-biodiesel-DEE are the promising alternative fuels for a diesel engine for significant reductions in exhaust emissions compared to neat diesel.

Henein et al. [3] reviewed that NO_x emission was reduced in a DI CI engine through retardation of fuel injection timing with loss of fuel economy. It was stated that the solid particulate emissions increase with injection timing retardation in the DI engine but can be reduced by increasing the fuel injection pressures. It was inferred that combustion modification methods reduce the NO_x emission of the engine with significant increase in smoke intensity and decrease in thermal efficiency. Angle of retardation is restricted to decrease the side effects as cited earlier in this section. It was also inferred that there is a need for a method of NO_x emission of biodiesel with less effect on smoke emission and thermal efficiency of the engine.

Bhaskar et al.[4] investigated the performance of fish oil biodiesel and concluded that like CO, HC and smoke were reduced for fish oil biodiesel except NO_x . The test results showed that the engines operated normally in fish oil. For a diesel engine, injection timing is a major parameter that sensitivel11y affects the engine performance, emission and durability. In the efforts to achieve the reduction of engine emissions and fuel consumption while keeping engine performance at an acceptable level, the fuel injection system plays an important role. It is possible to predict to some extent the engine performance based on injection characteristics. Most of the literatures used methyl ester fish oil to evaluate and analyse the performance and emission characteristics of the engine whereas, in this study, an attempt has been made to use ethyl ester fish oil as biodiesel to evaluate performance and emission characteristics with changes in injection timing of a direct injection (DI) diesel engine, compared with those of diesel.

M.S Gad et al. [5] Is a study of palm oil and palm oil methyl ester blends up to 20% with diesel fuel gave better performance and exhaust emissions compared to other blends on a diesel engine. The paper tells that NO_x emissions were increased relative to conventional diesel. There are increases in fuel consumption of biodiesel and oil blends proportional to the amount of biodiesel or oil blended to the diesel fuel. Specific fuel consumption values for diesel, B20, B100 and PO20 are 0.28, 0.316, 0.346 and 0.325kg/kW.hr, respectively at full load. Thermal efficiency is slightly lower for biodiesel blends B20 and B100 compared to diesel fuel at all engine loads. Thermal efficiencies for diesel, biodiesel blend B20, B100 and PO20 fuels are 28.7, 27.7 and 24.7 and 26.8%, respectively at full load. Exhaust gas

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temperature values for diesel, B20, B100 and PO20 are 302, 312, 371 and 322 C, respectively at full load. The increase in NO_x emission for B20, B100 and PO20 was due to increase in oxygen content compared to diesel fuel. The values of NO_x emission for diesel, B20, B100 and PO20 are 174, 190, 285 and 301 ppm respectively, at full load operation.

Mohamed Shameer et al. [6] studied on advancement and retarding of injection pressure and timing to know how the combustion characteristics and performance parameters are going to be changed, tests are conducted on biodiesel fuel engine.HRR increases due to advancement of injection timing for waste cooking palm oil , we get the maximum HRR of 28.5 J/°CA at 25.5 CAD BTDC. Maximum HRR of 53.3 J/°CA is observed at advanced IT of 26 CAD BTDC, when the engine is fuelled with (jatropha in addition to tyre pyrolysis) bio diesel. They also observed that combustion duration decreases with advanced IT, lower CD Obtained at advanced IT of 25.5 CAD BTDC for biodiesel obtained from the waste cooking palm oil. Proper mixing of fuel and low volatility of biodiesel leads to rapid combustion during premixed state and yield in shorter combustion duration minimum CD of 40.1CAD prevailed at advanced IT of 25.5 CAD BTDC for (jatropha+tyrepyrolysis) biodiesel. At advanced injection timing, longer ignition delay period leads to fall in temperature and pressure during rapid combustion phase inside the combustion chamber and also accompanied with faster burning rate leading to shorter combustion duration. Combustion duration shows increment with advanced injection timing. For rapeseed biodiesel and Karajan biodiesel longer duration of combustion and shorter combustion duration were recorded for advanced IT and retarded IT respectively for fish oil methyl Easter.

Srinivasa Rao et al. [7] analyzed the performance and emission characteristics of diesel and diesel–biodiesel blends on single cylinder four stroke compression ignition diesel engine using cerium oxide nanoparticles. The cerium oxide nanoparticles were added to the pure diesel and B20 (20% biodiesel by volume). The nanoparticles were mixed in the proportion of 20, 40 and 60 ppm to the B20. The biodiesel was prepared by transesterification process from eucalyptus oil. Using high speed ultrasonication stability was improved. Results were plotted against the load. It was observed that BTE was shown improving trend with all the nanofuels from B20. The least BSFC was reported 0.268 kg/kW-hr for B20 with 60 ppm addition of nanoparticles at full load. Results showed that cerium oxide was acted as oxygen buffer and results reduced the both CO and NO_x. Results revealed that the activation energy of cerium oxide nanoparticles helped to reduce the HC emissions.

Arul Mozhi Selvan et al. [8] investigated the performance and emission characteristics of neat diesel and diesel-biodiesel-ethanol blends with 25 PPM and 32 nm size cerium oxide as fuel borne additive on a single cylinder four stroke variable compression water cooled engine at the compression ratio of 19. The phase separation between diesel and ethanol was prevented by adding biodiesel. The turbidity procedure was used to assess the stability of the resulting suspension. All the results were plotted against brake mean effective pressure (BMEP). The lower BSFC was observed for Cerium oxide blend of neat diesel. The higher brake thermal efficiency was observed for neat diesel. The highest peak pressure 10.2Mpa was found for neat diesel blends with cerium oxide. The addition of cerium oxide further decreased the CO, HC emission when compared to neat diesel. The NO_x emission was lower for the neat diesel as compared to all the fuel blends. The least smoke absorption coefficient was observed as 1.273 for cerium oxide blended diesel-biodieselethanol blends at BMEP of 0.44MPa.

Sajith et al. [9] had studied the influence of dosing level ranging from 20 to 80PPM of cerium oxide nano particles in biodiesel derived from jatropha, on a single cylinder water-cooled direct injection diesel engine operating at 1500 RPM. The physiochemical properties, performance and emission characteristics were measured. The size of nano particle was 10 to 20 nm and density was 7.13g/ml. The results so obtained were plotted against the load on test engine. Increasing trend was seen in the physiochemical properties of fuel like flash point, viscosity and volatility with addition of nano particle. The results concluded that an average reduction of 25% to 40% in the hydrocarbon emission was obtained for the additive dosing level ranging from 40 to 80 PPM of the additive. The NO_x emission was found to be generally reduced by 30% on the addition of cerium oxide nano particle to biodiesel with dosing level of 80 PPM. The reduction influence of the fuel additive on carbon monoxide NOx ide emission was not so prominent.

II. MATERIALS AND METHODS

Preparation of corn seed oil biodiesel

Preparation of bio fuel is one of the difficult processes. Most generally every seed and vegetable producing oils having free fatty acids content. Corn seed oil also had nearly 12.9% free fatty acids and these crude oil when the extraction from crusher its having high viscosity and density. To decrease this viscosity and fatty acids make a transesterification process. In the transesterification process, the crude oil is added with methyl alcohol in the presence of alkali and an

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acid catalyst to convert the vegetable oil into a methyl ester. During this process, the methyl alcohol reacts with FFA of crude oil to form as methyl ester and glycerol as a by-product. Glycerol by-product separate from the methyl ester through the separator unit, these by product used in cosmetics and soaps. Pure methyl ester called as corn oil methyl ester (COME). The transited oil having low viscosity nearer to diesel and low d

Preparation of biodiesel blends

In generally the methyl ester corn oil having low calorific value, when adding the COME directly in to the diesel its produces less efficiency. For to improve the efficiency to add Decanol as an additive. Decanol having high calorific value and low density high cetane number, when to adding additive automatically the blends give better performance. Preparation of blends at various proportions and also add additive at various concentrations. The samples are pure diesel, Corn Seed Oil Methyl Ester (COME100), D50+COME50, D50+COME40+DEC10, D50+COME30+DEC20, D50+COME20+DEC30ensity it's directly blended in the diesel. For the preparation of biodiesel blends.

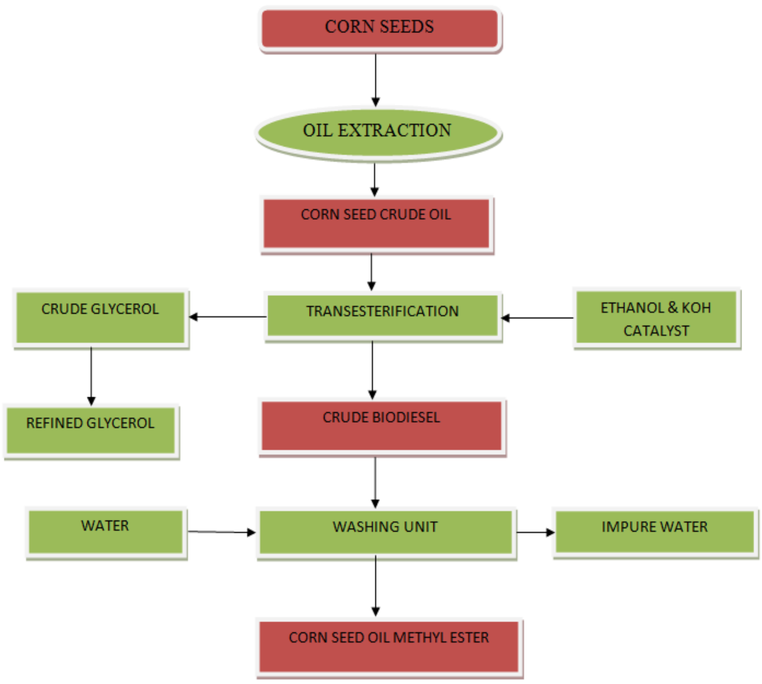

Fig.1 Biodiesel production flow chart

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Blends	DIESEL %	COME %	DECANOL %
COME 100	-	100	-
D50+COME50	50	50	-
D50+COME40+DEC10	50	40	10
D50+COME30+DEC20	50	30	20
D50+COME20+DEC30	50	20	30

TABLE.1 Blends preparation

III. EXPERIMENTAL SETUP

The experiments were conducted on single cylinder 4-stroke diesel engine. A four stroke, single cylinder variable compression ratio diesel engine was used for the present study. The performance and emission were evaluated on the variable compression ratio diesel engine using various blends of diesel and biodiesel as a fuel. The flow of cooling water and calorimeter was controlled with rotameter. Load cell sensor was used to vary the load on eddy current

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dynamometer which is coupled to the engine. Lab view based Engine Performance Analysis software package "**Enginesoft**" is provided for on line performance evaluation. A variable compression ignition engine is described in fig.2

fig. 2 single cylinder 4-stroke diesel engine

IV. RESULTS AND DISCUSSION

The experiments are conducted on the four stroke single cylinder water cooled diesel engine at constant speed (1500 rpm) with varying 0 to 100% loads with diesel and different blends of corn oil at standard injection timing as well as at advanced injection timing. All these values are compared with base line of diesel.

The performance parameters such as brake thermal efficiency and brake specific fuel consumption were calculated from the observed parameters and shown in the graphs. The variation of performance parameters are discussed with respect to the brake power for diesel fuel, diesel- biodiesel blends are discussed in below.
Brake thermal efficiency

Fig.3 indicates BTE vs Load. From the graph we observed that the diesel will give higher BTE when compare with the COME blends. For improve the BTE to the blends we add Decanol as an additive. When adding the Decanol the BTE of the blends give better performance compare with the pure COME blends. The blend D50+COME20+DEC30 will give BTE nearer to the diesel. Diesel gives 0.86% BTE more than the D50+COME20+DEC30. COME100 gives 12.5% less BTE than the pure diesel.

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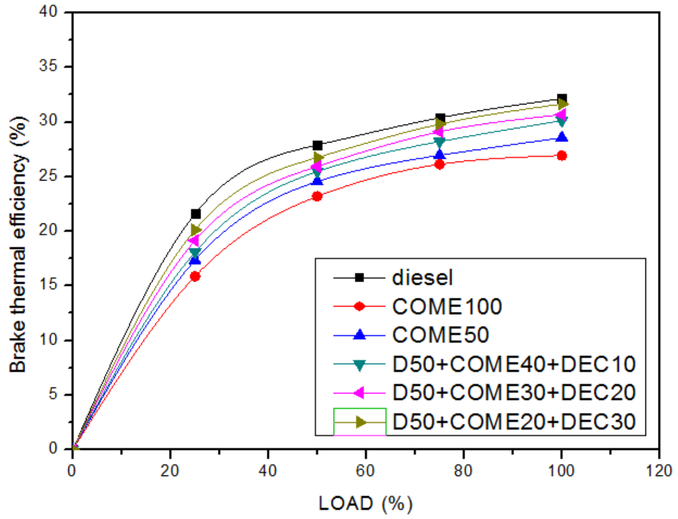

FIG.3 BTE vs Load

Brake specific fuel consumption Fig.4 indicates BSFC vs Load. From the graph we observed that the COME blends will give higher BSFC when compare with the Diesel. For to decrease the BSFC of the blends we add Decanol as an additive. When adding the Decanol the BSFC of the blends give lower BSFC compare with the pure COME. The blend D50+COME20+DEC30 will give lower BSFC. Diesel, C0ME 100 gives BSFC are 0.27kg/kw-hr and 0.34kg/kw-hr. pure diesel give 20.5% lower efficiency than COME100.

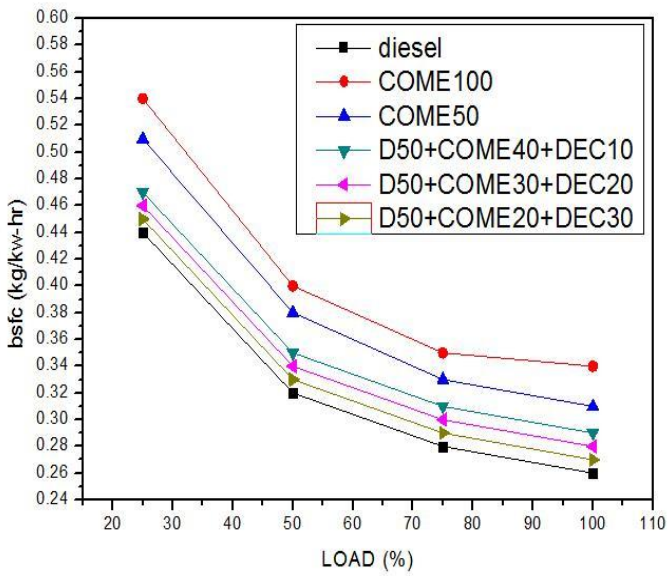

FIG.4 BSFC vs Load

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Emission parameters

CO emissions

Fig.5 shows carbon monoxide (CO) vs Load. From the graph we observed that the diesel will give higher CO emissions compared with pure COME. This is because COME having high oxygen content which leads complete combustion and also we observed that decreasing CO emissions because of the adding Decanol as an additive in the COME. The blend D50+COME20+DEC30 give lower CO emissions at all loading conditions. At full load condition diesel give 0.15% and COME100% gives 0.12%. D50+COME20+DEC30 blend produce 18.5% less CO emission than pure diesel.

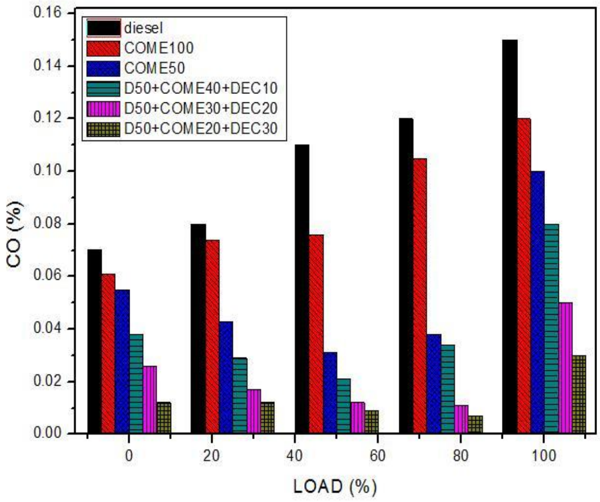

FIG.5 CO vs Load

HC emissions

FIG.6 shows Hydrocarbons (HC) vs Load. From the graph we observed that the diesel will give higher HC emissions compared with pure COME. This is because COME having high oxygen content which leads complete combustion and also we observed that decreasing HC emissions because of the adding Decanol as an additive in the COME. The blend D50+COME20+DEC30 give 44 ppm and diesel gives 60 ppm , comparison of these two D50+COME20+DEC30 gives 26.66% lower HC emissions at full load conditions. Pure diesel gives 8.33% higher than COME100.

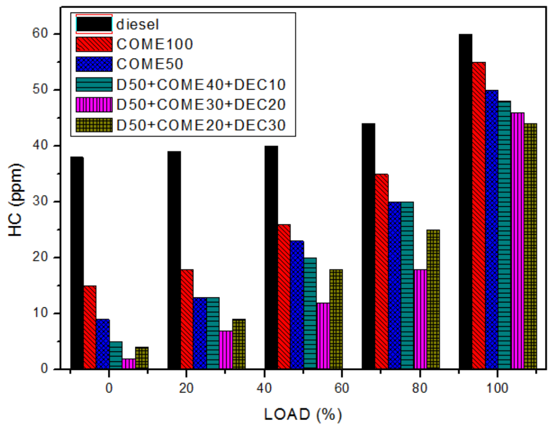

FIG.6 HC vs Load

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NOX emission

Fig.7 shows NOX vs Load. From the graph we observed that the NOX emissions are very high in pure COME and its blends also compare with diesel. We noticed that because of the more NOX in the pure COME its viscosity having very high compare with diesel and addition of additive its decrease the viscosity and increase the combustion rate for more to reduce the NOX when adding additive compare with pure COME. D50+COME20+DEC30 produce 17.08% less NOX than the COME100.

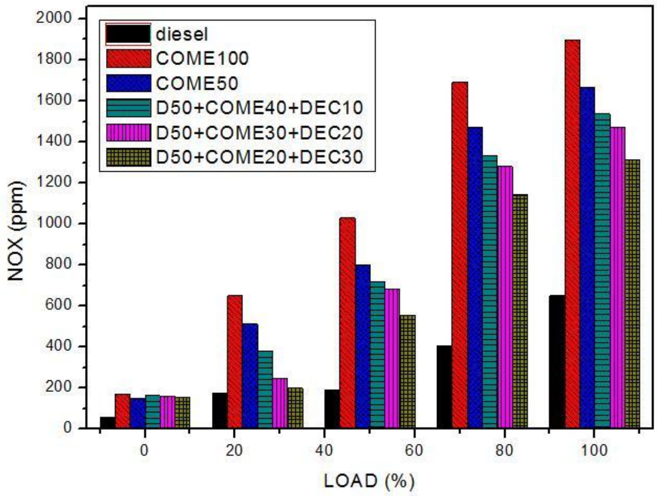

FIG.7 NO_X vs Load

V. CONCLUSION

In this present study the effect of Decanol adding with the diesel-biodiesel blends in the performance and emission characteristics. When adding the Decanol as an additive in the COME then drastically changes in the chemical and combustion properties. We observed that change in the given conclusion below.

1. The BTE for the blend D50+COME20+DEC30 was observed to be higher when compared with the other COME blends. The blend D50+COME20+DEC30 will give BTE nearer to the diesel. Diesel gives 0.86% BTE more than the D50+COME20+DEC30. COME100 gives 12.5% less BTE than the pure diesel.
2. The BSFC for the blend D50+COME20+DEC30 was observed to be lower when compared with the other COME blends. Diesel, C0ME 100 gives BSFC are 0.27kg/kw-hr and 0.34kg/kw-hr. pure diesel give 20.5% lower efficiency than COME100.
3. The CO emissions for the blend D50+COME20+DEC30 were observed to be lower when compared with the other COME blends. At full load condition diesel give 0.15% and COME100% gives 0.12%. D50+COME20+DEC30 blend produce 18.5% less CO emission than pure diesel.
4. The HC emissions for the blend D50+COME20+DEC30 were observed to be lower when compared with the other COME blends. D50+COME20+DEC30 gives 26.66% lower HC emissions than diesel at full load conditions. Pure diesel gives 8.33% higher than COME100.
5. The NOX emissions for the blend D50+COME20+DEC30 were observed to be lower when compared with the other COME blends. D50+COME20+DEC30 produce 17.08% less NOX than the COME100.
6. Hence the blend D50+COME20+DEC30 will give better performance and lower emissions.

So finally we concluded D50+COME20+DEC30 is the better blend in the biodiesel scenario. So in the diesel engine the ternary blend directly used as diesel fuel without any modifications in the diesel engine hardware.

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