International Journal of Research in Engineering and Science (IJRES)
ISSN (Online): 2320-9364, ISSN (Print): 2320-9356
www.ijres.org Volume 9 Issue 2 ǁ 2021 ǁ PP. 14-19

An Experimental Investigation on performance Characteristics of a Diesel Engine with Decanol as an Additive using corn Biodiesel

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Abstract
Diminution of natural resources combined with the disturbing increment of contamination level is the main threat to utilize diesel in a naturally beneficent way. Research done till now focused upon the usage of lower alcohols and fewer data is available on higher alcohol mix in corn oil biodiesel. The present examination explores the impact of utilizing a ternary blend of diesel, biodiesel, and decanol as an additive in DI diesel engine. Tests were performed using decanol blended with biodiesel and diesel. The concentration of decanol mixing were 10%, 20%, 30% by volume while the diesel concentration was kept 50% all through. The research revealed brake thermal efficiency increases and brake specific fuel consumption decreases with increase in the concentration of decanol. BTE values for pure diesel, COME100, D50COME50, D50COME40DC10, D50COME30DC20, D50COME20DC30 was observed as 32.16%, 26.94%, 28.55%, 30.54%, 30.68%, and 31.65% at full load. BSFC of ternary blend D50COME20D30 was 20.58% and 12.90% less than COME100 and D50COME50.

Keywords: *Diesel, COME (Corn oil methyl ester), Decanol, Performance, CI Engine.*

Date of Submission: 25-01-2021 Date of acceptance: 10-02-2021

I. INTRODUCTION

World population was growing faster and simultaneously need of vehicles requirement also increased. Hence the utilization of fossil fuels was very high. Availability of petroleum products was also at insufficient position after some period of time and anticipated to reach the end in the near future. Hence an immediate requirement exists to replace fossil fuels with renewable and natural sources like vegetable oil and fats. Moreover unsafe discharges from the CI engines can also be restricted using biodiesels. Be that as it may, the diesel fuel discharges contain destructive toxins, for example, nitrogen oxides (NO_X), carbon monoxide (CO), unburned hydrocarbon (UHC), particulate issue (PM), just as ozone harming substances (CO_2,CH_4,N_{2O}) . These discharges straightforwardly and in a roundabout way sway on ozone layer. These reasons quicken the push to direct research in the territory of vegetable oil-based fuel choices. A few vegetable oils such as corn oil, corn oil, soybean oil, rice bran oil, tamarind seed oil which are inexhaustible assets can be used as favourable options for diesel engines, because of their comparable physical and chemical properties similar to diesel fuel. **Ramalingam** et al. (2018) proposed that the utilization of vegetable oils offers a potential decrease in destructive contamination produced from CI engines. **Balamurugan** et al. (2018) prepared bio diesel from corn oil and also done the performance and emission tests on pure diesel and corn oil methyl ester (COME), B10, B20, B30 blends. In the performance test, brake thermal efficiency (BTE) of the blends decreased with increase the percentage of blend in the diesel. When the compared with diesel, all blends are having low BTE. The brake specific fuel consumption (BSFC) increased with increase in the percentage of blend, compare with diesel all blends are giving high value of BSFC. At emission point of view, hydro carbons (HC), carbon monoxide (CO) are increased and NOX are decreased with increase in the blend percentage. On the other hand vegetable oils which have enormous potential to replace diesel have certain limitations such as high thickness, low calorific value, and high specific gravity. To counter act these limitations, transesterification method was employed. Transesterification is a procedure wherein triglycerides are changed over into a blend of methyl esters and glycerol. Biodiesel has higher oxygen content than diesel, which upgrades its ignition productivity, and decreases CO, UHC, and PM yet creates more prominent NOx emanations (around 10% more than diesel). Also, numerous analysts attempted to improve the fuel economy and lessen emanation attributes of different kinds of biodiesel by employing different additives. Nanthagopal et al. (2019) assessed the effects of 1-pentanol and 1-butanol as additives with Calophyllum Inophyllum biodiesel. **JinlinXue** et al. (2011) studied the impact of biodiesel in CI engine. The impact of biodiesel on engine power, economy, and discharges including managed and non-directed outflows are studied in detail. The use of biodiesel prompts the substantial decrease in PM, HC and CO emissions and the increase in fuel utilization and NOx discharges. The engine power dropped because of the loss of calorific value and high thickness of biodiesel. The substance of unsaturated mixes in biodiesel could greatly affect NOx emanations. But yielded higher NOx emissions, ranging from an increase of 5.58% to an increase of 25.97%, when compared to pure diesel. **Ramalingam S** et al. (2018) carried out experiments by varying the operating parameters and using antioxidant additives with biodiesel to improve the performance and reducing the emissions. The use of biodiesel in diesel engine caused slight decrease in performance and reduced the exhaust emissions compare with pure diesel. Engine operating parameters such as compression ratio (CR), injection pressure (IP) and injection timing (IT) was varied to improve the performance.BTE for diesel, biodiesel blends such as B10, B20, B30, and P50 was observed as 18.39%, 27.48%, 18.5%, and 19.82% respectively. The HC and CO emissions were reduced by 52% and 37.5% and NOx emission was increased by 36.84% when CR was increased from 14 to 18. They also found that advanced IT by 5^0CA showed reduction in BSFC, CO, HC and smoke emissions and increase in BTE and NOx emission. Further HC, CO and smoke emissions were reduced but increase of NOx emission was observed with increase of CR, IP and advancing the IT. Finally it was concluded that, the combination of CR 18:1, IP 240 bar and IT 26 °CA compared to that of diesel with standard values of CR, IP and IT. Antioxidant additives are viable as an alternative fuel in diesel engines with minor modifications to engine. For environmental and economic reasons, their popularity may grow.

II. MATERIALS AND METHODS

The crude corn oil extracted from the pulp of corn fruit is a bit thicker and denser. When it is used in the engine directly, it causes bad atomization of fuel, chocking of injectors, sticking on piston rings, increases the ignition delay. Poor atomization of fuel leads to increase in BSFC in order to develop same power output as diesel but it also results in unpredictable increase of HC and soot emissions. Increase in ignition delay may cause detonation which leads to engine vibration. Hence the thickness of crude corn oil should be reduced before introducing it into the engine combustion chamber. Crude corn oil contains free fatty acids (FFA) similar to other vegetable oils. These free fatty acids may or may not be saturated in nature. The acids which are present in vegetable oils are cornitic acid, oleic acid, steric acid, linoleic acid. Crude corn oil contains equitable amount of cornitic acid in saturated condition. There are several techniques to reduce the thickness of vegetable oils like blending with diesel, preheating, creating micro emulsions and transesterification. Out of the above indicated techniques transesterification is most widely used technique to reduce the thickness of vegetable oils. Transesterification is the process of converting triglycerides of vegetable oils into fatty acid methyl or ethyl esters. This process depends on various factors like quantities of methanol or ethanol, type of catalyst, free fatty acid content, reaction temperature and water content. As the selected crude corn oil contains FFA more than 0.5% by weight, base catalyzed transesterification will yield required biodiesel. Increase in FFA in the crude oil results in soap formation during esterification process which may prevent the separation of biodiesel from glycerol. Consequently both acid catalyzed and base catalyzed transesterification must be carried out to yield an appreciable amount of oil. Base catalyzed esterification is used to remove unsaturated fatty acids while Acid esterification process removes saturated fatty acids.

Table.1.Physical and chemical properties of COME, Diesel and additive Decanol

Properties	Test Method ASTM D 6751	COME	DIESEL	Decanol
Calculated cetane Index	ASTM D 613	51	48	50
Net Calorific value kJ/kg	ASTM D 4809	39650	42500	41818
Flash point (^{0}c)	ASTM D 93	169	54	108
Density @15^{0}c in gm/cc	ASTM D 1298	0.890	0.830	0.8297
Kinematic Viscosity @40^{0}C in CST	ASTM D 445	6.40	3.08	4.6

Table.2. Properties of different samples chosen for the current experimentations

Properties	Test Method ASTM D 6751	COME100	D50COME50	D50COME40DC10	D50COME30DC20	P50COME40DC10
Calculated cetane Index	ASTM D 613	51	50.05	49.84	49.63	49.42
Net Calorific value kJ/kg	ASTM D 4809	39650	40765	41043.8	41322.6	41601.4
Flash point (^{0}c)	ASTM D 93	169	110	104.6	98.7	92.8
Density @15^{0}c in gm/cc	ASTM D 1298	0.890	0.8619	0.85549	0.84908	0.84267
Kinematic Viscosity @40^{0}C in CST	ASTM D 445	6.40	4.825	4.818	4.811	4.804

III. EXPERIMENTAL PROCEDURE AND TEST SET-UP

The present Study was led on a 4-stroke, single chamber, C.I. motor (Kirloskar Engines). Performance, emission and combustion characteristics was analysed from no load to full load. Each fuel blend mentioned in various plots was tested for performance and emission parameters thrice and average values are taken for final graphical representation. The experimental set-up used for the present research work was presented in Fig.1. A eddy current dynamo meter was coupled to the engine to apply the load on the engine. The fuel stream rate was estimated by timing the utilization for known amount of fuel (10cc) from a glass burette. Various emission parameters such as HC, CO and NOx and performance parameters such as BSFC, BTE were evaluated. The fundamental reason for smoke estimation was to evaluate the dark smoke discharging from the diesel engine. Perceivability was the fundamental standard in assessing the power of smoke. Bosch meter was utilized for estimating the diesel motor smoke. It comprises of a testing siphon and assessing unit. The examining siphon was utilized to move almost 300cc of exhaust gas by methods for a spring worked siphon and discharged by pneumatic activity of middle abdomen. The gas test was additionally drawn through the separating paper obscuring it. The spot made on the filter paper was evaluated by means of a recalibrated photocell reflect meter to give precise assessment of the intensity of the spot. The intensity of the spot was measured on a scale of 10 in arbitrary units, called Bosch smoke units for white to black. Flow rate of air can be measured using Air-box method. Air was initially sucked into the orifice present at the entry of air-box. The difference in pressures at the orifice and before orifice was taken using U-tube differential manometer in terms of water column. The water column is converted in to equivalent air-column. This obtained head of air can be used to calculate volumetric efficiency. However, there are certain external factors which affect the performance, emission and combustion parameters of the engine.

Fig.1.Experimental Test Set-up

IV. RESULTS AND DISCUSSIONS

4.1 Performance characteristics

The following sections describe various performance parameters such as brake specific fuel consumption and brake thermal efficiency at different loading conditions.

4.1.1 Brake thermal efficiency

Fig.2 shows the variation of brake thermal efficiency for different tested fuels and ternary blends with respect to brake mean effective pressure. It was noticed that brake thermal efficiency increased with an increase in the brake mean effective pressure. BTE for diesel fuel is higher because of its lower viscosity than that of other tested fuels. BTE values for pure diesel, COME100, D50COME50, D50COME40DC10, D50COME30DC20, D50COME20DC30 was observed as 32.16%, 26.94%, 28.55%, 30.54%, 30.68%, and 31.65% at full load respectively. Higher calorific value of D50COME50 was the dominant reason behind the decrease in efficiency when compared to D100. But BTE of D50COME50 was higher than COME100 on account of more calorific value. BTE of ternary blends was higher compared to COME100 and D50COME50. This was due to increase in calorific value and oxygen content in the ternary blends influencing the combustion rate and atomization of the fuel. Finally, it was observed that BTE of D50COME20D30 was nearly equal to D100. BTE of D50COME20D30 was 0.51% less than diesel and it was 4.71% and 3.1% higher than COME100 and D50COME50.

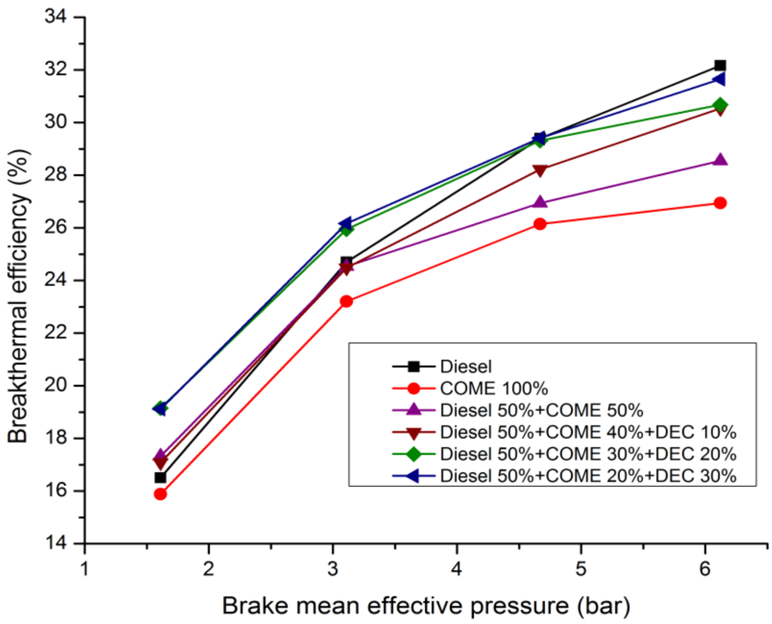

Fig.2.Biodiesel and additive concentration effect on Brake Thermal Efficiency

4.1.2. Brake specific fuel consumption

Variations of brake specific fuel consumption across brake mean effective pressure was represented in Fig.3.The brake specific fuel consumption (BSFC) was characterized as the amount of the fuel per unit of created brake power. Brake specific fuel consumption indicates the efficiency with which, an engine converts the supplied energy to useful work output and for any engine, the lower value for BSFC was always desirable where lower brake specific fuel consumption can be achieved by higher heat content (calorific value) of the fuel. All the fuel samples reduce the BSFC with increase in brake mean effective pressure and it is a general trend for all constant speed diesel engines. It was observed that the BSFC of COME100 was 0.34 kg/kWh and it is20.58% and 8.82% higher than diesel fuel and D50P50. The inherent oxygen content in the biodiesel reduces the heat content which in turn increases the fuel consumption for achieving same power output. Interestingly BSFC has been reduced substantially during ternary blend operation. BSFC for D50COME50, D50COME40DC10, D50COME30DC20 and D50COME20DC30 was noted as 0.31kg/kWh,0.2kg/kWh,0.28kg/kWh,0.27kg/kWh. However when compared to pure biodiesel, the fuel reformulation by decanol has decreases the BSFC value at all engine loads. More heat released on account of increased calorific value is the primary reason for the decrement in fuel consumption for the ternary blends when compared to D50COME50. Moreover, BSFC of ternary blend D50COME20D30 was 20.58% and 12.90% less than COME100 and D50COME50.

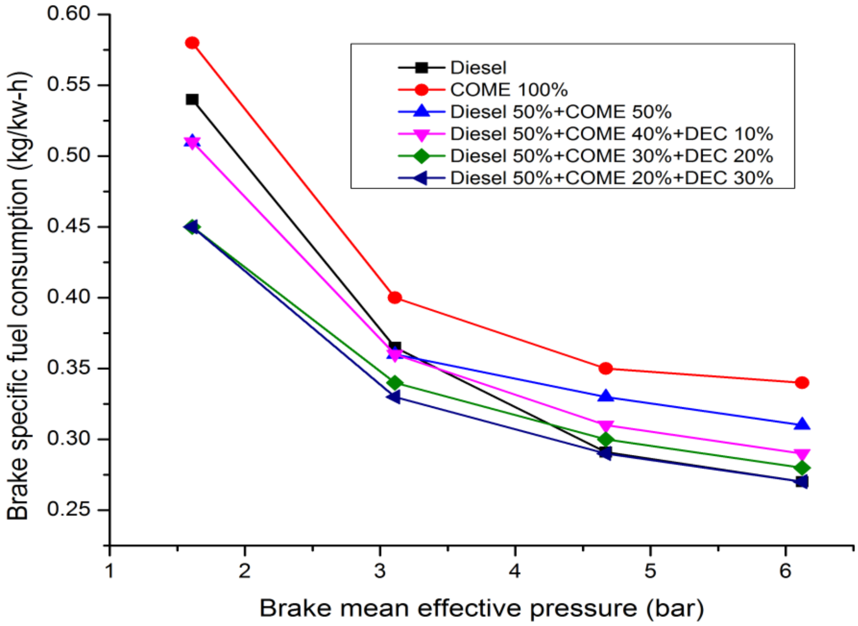

Fig.3.Biodiesel and additive concentration effect on Brake Specific Fuel Consumption

V. CONCLUSION

The present work was done on the decanol added as an additive to the diesel and biodiesel at the proportion of 10%, 20%, 30% concentration by volume. Initially pure biodiesel and 50% biodiesel was compared with pure diesel (D100). Further decanol as an additive was added in the range of 10%, 20% and 30% by volume while maintaining the diesel concentration at 50%. The biodiesel concentrations were 40%, 30% and 20% for decanol additions of 10%, 20% and 30%.

1. The BTE in the test performed for pure diesel gave more percentage compared with biodiesel and the BTE value was in the increasing trend with increase in the concentration of decanol in the biodiesel. At higher percentage of decanol added to the biodiesel, the value of BTE reached nearest to the diesel value.BTE of D50COME20D30 was 0.51% less than diesel and it was 4.71% and 3.1% higher than COME100 and D50COME50.
2. BSFC of the decanol blends were slightly higher than diesel and lower than the COME biodiesel. High oxygen content in the ternary blends resulted in lower BSFC compared with biodiesel. BSFC of ternary blend D50COME20D30 was 20.58% and 12.90% less than COME100 and D50COME50.

REFERENCES

[1]. Nanthagopal k , Ashok B, Saravanan B, Patel D, B. Sudarshan, Ramasamy RA (2018) An assessment on the effects of 1-pentanol and 1-butanol as additives with Calophyllum Inophyllum biodiesel. Energy Conversion and Management 158, 70-80.
[2]. Fattah IMR, Masjuki HH, Kalam MA, Mofijur M, Abedin MJ (2014) Effect of antioxidant on the performance and emission characteristics of a diesel engine fuelled with corn biodiesel blends. Energy Conversion and Management 79, 265–272.
[3]. Ramalingam S, Rajendran S, Ganesan P, Govindasamy M (2018) Effect of operating parameters and antioxidant additives with biodiesels to improve the performance and reducing the emissions in a compression ignition engine. Renewable and Sustainable Energy Reviews 81, 775–788.
[4]. Alagu K, Beemkumar N (2018) Impact of antioxidant additives on the performance and emission characteristics of C.I engine fuelled with B20 blend of rice bran biodiesel. Environmental Science and Pollution Research.
[5]. El-Arab R, Amin A (2017) Study on the characteristics of corn oil–biodiesel–diesel fuel blend, Egyptian Journal of Petroleum.
[6]. Vijay raj K, Sathiyagnanam AP (2016) Experimental investigation of a diesel engine with methyl ester of mango seed oil and diesel blends. Alexandria Engineering Journal 55, 215–221.
[7]. Velmurugan K, Sathiyagnanam AP (2015) Impact of antioxidants on NOx emissions from a mango seed biodiesel powered DI diesel engine. Alexandria Engineering Journal.
[8]. K. Nanthagopal, B. Ashok (2019) Study on decanol and Calophyllum Inophyllum biodiesel as ternary blends in CI engine. Fuel 239, 862–873.
[9]. Venu H, Subramani L, Raju VD (2019) Emission reduction in a DI diesel engine using exhaust gas recirculation (EGR) of corn biodiesel blended with TiO2 nano additives. Renewable Energy 140, 245-263.
[10]. Anbumani K and Pal Singh A (2010) performance of mustard and neem oil blends with diesel fuel in CI engine. Journal of Engineering and Applied Sciences, VOL. 5, NO. 4.

[11]. Prabu SS, Asokan MA, Prathiba S, Ahmed S, Puthean G (2018) Effect of additives on performance, combustion and emission behaviour of preheated palm oil/diesel blends in DI diesel engine. Renewable Energy 122, 196-205.

[12]. Srinivas, Abhimanyu, Posangiri R (2018) Emission Characteristics of Totapuri Mango Methyl Ester Biodiesel Fuelled Single Cylinder Four Stroke Diesel Engine. International Journal of Research in Advent Technology, Vol.6, No.11.

[13]. Imtenan S, Masjuki HH, Varman M, Kalam MA, Arbab MI, Sajjad H, Rahman SMA (2014) Impact of oxygenated additives to palm and jatropha biodiesel blends in the context of performance and emissions characteristics of a light-duty diesel engine. Energy Conversion and Management 83, 149–158.

[14]. Pugazhvadivu M (2009) Studies on the effect of ethanol addition to biodiesel: Performance and emissions of a diesel engine, Indian Journal of Science and Technology. Vol.2 No. 11, ISSN: 0974- 6846.

[15]. Narkpakdee J, Permsuwan A, Deethayat T, Kiatsiriroat T (2012) Performance and Emission of Small Diesel Engine Using Diesel-Crude Palm Oil-Water Emulsion as Fuel. Energy Science and Technology, Vol. 3, No. 2, pp. 38-45, ISSN 1923-8479.

[16]. Hasan Ali MD, M Mashud (2013) Biodiesel from Neem oil as an alternative fuel for Diesel engine. 5th BSME International Conference on Thermal Engineering, Procedia Engineering 56, 625 – 630.

[17]. Ashok B, Nanthagopal K, Perumal LA, Babu JM, Tiwari LA, Akhil Sharma (2019) An investigation on CRDI engine characteristic using renewable orange-peel oil. Energy Conversion and Management 180, 1026–1038.

[18]. Sreeja C, Prasanthi G (2015) Experimental investigations of performance and emission characteristics of a compression ignition engine fuelled with diesel pine oil blends and by adding 2-ethoxy ethyl acetate as an additive. International Journal of Applied Research 1(12): 158-164.

[19]. Anand BP, Yadav SPR, Aasthiya B, Akshya G, Arulmozhi K (2018) Effect of Fuel Injection strategies on performance of common rail diesel injection (CRDI) engine powered by Biofuel. International journal of ambient energy, DOI: 10.1080/01430750, 1517690.

[20]. Ashok B, Raj RTK, Nanthagopal K, Krishnan R, Subbarao R (2017) Lemon-peel oil- A novel renewable alternative energy source for diesel engine. Energy Conversion and Management 139:110-121.