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Effect of Combustion Nano Additives in CI Engine Fuel Useing Diesel-Neem Biodiesel Blends: A Review

Arjun A. Varaghane
M. Tech Heat Power Engineering
G. H. Raisoni College of Engineering, Nagpur, Maharashtra. India
V. W. Khond
Assistant Professor**,** ME Department
G. H. Raisoni College of Engineering, Nagpur, Maharashtra. India

Abstract:
This paper reports the review of effect of combustion additives on ci engine fuelled used diesel-neem biodiesel blends. Besides exploring the historical background of biodiesel production from vegetable oils, it also provides insight of different methodologies evolved for the conversion of vegetable oil in biodiesel. Properties of neem biodiesel have been compared with the properties of diesel; showing a comparable regime for satisfactory performance of a C.I. engine with neem biodiesel. Biodiesel reportedly has a number of technical advantage over diesel especially on safety and environmental considerations. Additives used in diesel and neem biodiesel the performance are improved.

Key words*: Neem-biodiesel C.I. engine, impact of homogeneous combustion catalyst, diesel-neem blends*

1. Introduction

Bio-diesel is an alternative to petroleum-based fuels derived from vegetable oils, animal fats, and used waste cooking oil including triglycerides. Since the petroleum crises in 1970s, the rapidly increasing petroleum prices and uncertainties concerning its availability, growing concern of the environment and the effect of greenhouse gases (GHGs) during the last decades, has revived more and more interests in the use of vegetable oils as a substitute of fossil fuel. [1] Diesel engines are widely used in road transportation, remote and small scale diesel-fuelled power generation system, heavy machineries and mining equipments powered by diesel fuel. [2] Due to an increase in the price of petroleum and more stringent emissions regulations, many studies have been conducted to develop cleaner and more efficient diesel engines over the past few decade.[4] Diesel engine exhausts are typically severe, which contain, depending on the engine design and operational parameters, large amounts of particulate matter (PM) or smoke emissions and varying amounts of carbon monoxide (CO), unburned hydrocarbons (UHCs), nitrogen oxides (NOx), sulphur oxides (SOx) and carbon dioxide (CO_2) Biodiesel, derived from the oils and fats of plants like sunflower, rape seeds, Canola or Jatropha Curcas, neem etc. can be used as a substitute or an additive to diesel. As an alternative fuel biodiesel can provide power similar to conventional diesel fuel and thus can be used in diesel engines. Biodiesel is a renewable liquid fuel that can be produced locally thus helping reduce the countrys dependence on imported crude. Production and utilization of locally developed biodiesel may lead to overall sustainable development in developing nation.[16] Biodiesel can make a major contribution in the future if it meets the few percent of petroleum and it can provide improved fuel properties lower emission of unburned hydrocarbons, carbon monoxide but higher level of oxides of nitrogen.

2. Effect of Combution Additives on CI Engine Performance

2.1. Brake Specific Fuel Consumption

Mingming Zhu et al.[1]studied the effect of a homogeneous combustion catalyst on the combustion characteristics and fuel efficiency in a diesel engine.

The brake specific fuel consumption can be reduced up to 4.2% with the addition of the homogeneous combustion catalyst. However, the brake specific fuel consumption reduction does not correlate linearly with the catalyst dosing ratio and, when the catalyst dosing ratio is greater than 10,000, the brake specific fuel consumption becomes less variant.

The reduction of the brake specific fuel consumption is greater at light loads. With the catalyst dosing ratio of 1:10,000, the brake specific fuel consumption is reduced by 3.3–4.2% at light engine load of 0.12 MPa and only 2.0–2.4% at higher engine load of 0.4 MPa.

Mingming Zhu et al.[2] studied homogeneous combustion catalyst on fuel consumption and smoke emission in diesel engine. Effect of a homogeneous combustion catalyst on the combustion characteristics and fuel efficiency in a diesel engine. The brake specific fuel consumption are reduced with the use of the homogeneous combustion catalyst with respect to that of the pure diesel fuel but the level of fuel saving was not linearly proportional to the catalyst dosing ratio. When the catalyst dosing ratio was greater than 1:3200, increasing catalyst dosing ratio did not change the brake specific fuel consumption. With the catalyst dosing ratio of 1:3200 in the fuel, the brake specific fuel consumption was reduced by 2.1% to 2.7% under controlled engine conditions and the maximum fuel saving was achieved when the engine was run at speed of 2600 rpm under load of 0.4 MPa.

Mingming Zhu et al.[3]studied the effect of a homogeneous combustion catalyst on exhaust emissions from a single cylinder diesel engine. he experimental investigated into the effect of an Fe-based homogeneous combustion catalyst on the emission characteristics from a four-stroke single cylinder diesel engine. He experiments were conducted with the three fuels under conditions of two engine speeds at 2800 rpm (low) and 3200 rpm (medium), respectively, and four engine loads at each engine speed, corresponding to 0.14 MPa, 0.21 MPa, 0.33 MPa and 0.42 MPa of the brake mean effective pressure (BMEP). Under each of the test conditions, the engine was allowed to operate at the specified speed and load for about 30 min until the characteristic temperatures (exhaust, lube oil and coolant) of the engine stabilized. Fuel consumption was measured by the weighing scale at 5 min intervals for each engine condition and automatically recorded by the computer.

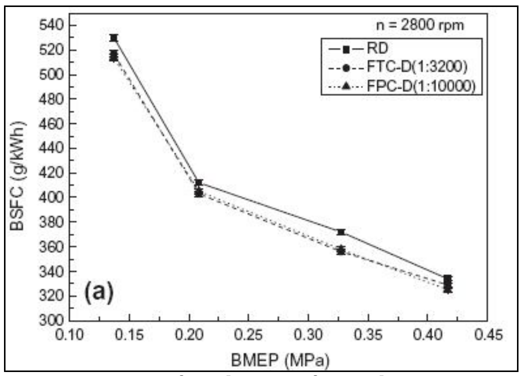

Figure 1: Variation of Brake Specific Fuel Consumptions[3]

T.Pushparaj et al.[4] Studied on karanja biodiesel fuelled diesel engine with ethanol as additive. the exhaust gas temperature increases when the percentages of ethanol increases, this is due to increasing concentration of oxygen in the bio fuel mixture, and leads to increase of NO in the exhaust. The engine efficiency variation with load for the studied fuel. As it was expected, the engine efficiency decreases at full load for fuel blends, the tendencies being varied for adding of ethanol. The BTE increases with 10% ethanol and it decreases when the ethanol percentage increases. The

brake-specific fuel consumption is slightly increased .The main reason for this could be that percent increase in fuel required to operate the engine is less than the percent increase in brake power due to relatively less portion of the heat losses at higher loads. But while adding ethanol the BSFC decreases and come closer to diesel.

B.Deepanraj et al.[6]studied transesterified palm oil as an alternate fuel for compression ignition engine. The comparison of result shows very clearly that the performance and emission characteristics of C.I engine using palm oil methyl ester as a fuel are almost matching with the diesel mode of operation. This justifies that the attempt made to use palm oil methyl ester as a fuel in the C.I engine is very effective and can be used as an alternative fuel without modifying the engine. However due to the lower calorific value of the palm oil methyl ester, it is found that the thermal efficiency of the engine is found to be slightly lesser and the specific fuel consumption is higher when compared to Diesel fuel.

R.Senthilkumar et al.[7]studied the emission and performance characteristics of single cylinder diesel engine fuelled with Neem biodiesel , Neem based methyl esters can be directly used in diesel engines without any engine modification. Properties of different blends of biodiesel are very close to the diesel and B30, B50 are giving good results. It is not advisable to use B 100 in CI engines unless its properties are compared with diesel. Good mixture formation and lower smoke emission are the key factors for good CI engine performance. These factors are highly influenced by viscosity, density and volatility of the fuel. For biodiesels these factors are mainly decided by the effectiveness of transesterification process. With properties close to the diesel fuel, biodiesel from Neem seed oil can provide a useful substitute for diesel thereby promoting our economy. Fig shows the difference between various blends of Neem oil and Diesel on Brake power and specific fuel consumption.

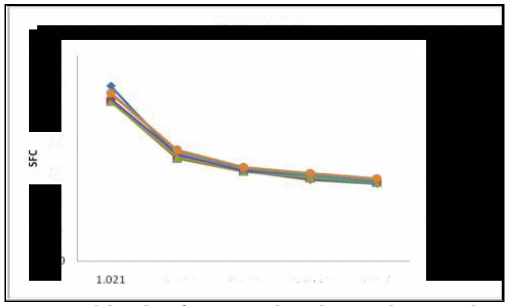

Figure 2: Shows the difference between various blends of Neem oil and Diesel on Brake power and specific fuel consumption[7].

H.M. Dharmadhikari et al [9]studied Performance and emissions of CI engine using blends of biodiesel and diesel at different injection pressures. The variation in brake specific fuel consumption with load for different fuels shows decline with increase in load. One possible explanation for this could be due to more increase in brake power with load as compared with fuel consumption. The BSFC in case of blends were higher compared to diesel in the entire load range, due to its lower heating value, greater density and hence higher bulk
modulus. The higher bulk modulus results in more discharge of fuel for same displacement of the plunger in injection pump, there by resulting increase in BSFC.

L. Prabhu et al [15] studied combustion, performance and emission characteristics of diesel engine with neem oil methyl ester and its diesel blends Figure shows the variation in brake fuel consumption for diesel and neem biodiesel. The BSFC is an important parameter to evaluate engines performance and determine the fuel efficiency of an engine. The BSFC of diesel engine decreases as the engine brake loads are increased. The brake specific fuel consumption of Neem biodiesel is increased for B20, B100 than that of diesel at full load. It is observed that the BSFC of B20 blends is lower in comparison to neat neem biodiesel. It is observed that the BSFC of B100 is higher than that of diesel fuel when the blends are B20 and B100 are used in diesel engine.

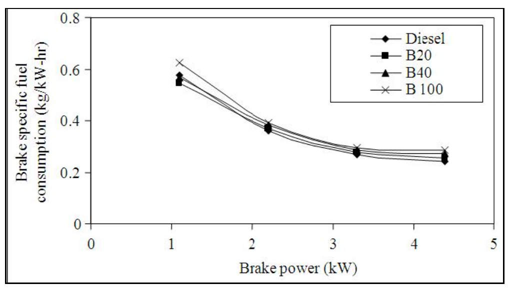

Figure 3: Variation of specific fuel consumption with BP[15]

Lovekush Prasad et al [8] studied Experimental investigation of performance of diesel engine working on diesel and neem oil blends. The BSFC decreases with increase in load; BSFC for B10 is increased by 23.38% as compared to diesel at maximum load and BSFC for B20 increased by 12.12% at minimum load and 9.53% at maximum load as compared to B10. This is caused due to effect of delay in ignition pressure, higher viscosity and lower calorific value of the fuel.

2.2. Brake Thermal Efficiency (BTE)

Mingming Zhu et al.[1]studied effect of a homogeneous combustion catalyst on the combustion characteristics and fuel efficiency in a diesel engine. The brake thermal efficiency is increased with the addition of the catalyst. The brake thermal efficiency is increased by 0.3– 0.8% at engine speeds of 2800 rpm, 320 rpm and 3600 rpm with the catalyst dosing ratio of 1:10,000.

T.Pushparaj et al.[4] Studied on karanja biodiesel fuelled diesel engine with ethanol as additive. The engine efficiency variation with load for the studied fuels is shown in. As it was expected, the engine efficiency decreases at full load for fuel blends, the tendencies being varied for adding of ethanol. The BTE increases with 10% ethanol and it decreases when the ethanol percentage increases.

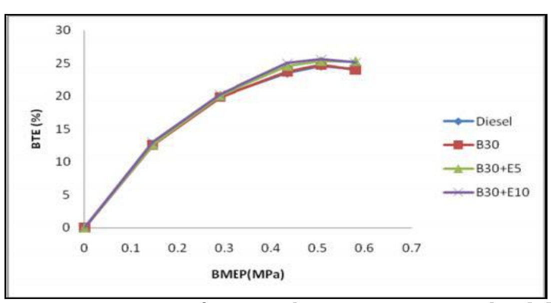

Figure 4: Variation of BTE with respect to engine loads[4]

B. Deepanraj et al.[6]studied transesterified palm oil as an alternate fuel for compression ignition engine. the variation of brake thermal efficiency with different loads for diesel and biodiesel operation. The BTE increases with increase in load due to reduction in heat loss and increase in power with increase in load. At maximum load, the palm oil methyl ester produces lower brake thermal efficiency which is 5.1% lower than standard diesel fuel. This is probably due to high density of biodiesel than Diesel and that affects mixture formation of the fuel thus leads slow combustion.

J. Isaac Joshua Ramesh Lalvani et al [5] studied Performance Characteristics and Emission Analysis of a Single Cylinder Diesel Engine Operated on Blends of Diesel and Waste Cooking Oil. the BTE of all tested fuel is lower than the diesel. Brake thermal efficiency increases with increase of loads. It is seen that the efficiency of the engine for 30 % of waste cooking oil – diesel blends is 9% lesser compare to the

diesel. The greatest brake thermal efficiency is 32.0021% for diesel, whereas in B30, it is 23.968%. B10 and B20 increases BTE by 7.75%, 11.53%respectively compared to B30. The drop of Brake thermal efficiency for 30% of waste cooking oil – diesel blends is due to higher viscosity and its reduced energy content and lower calorific value compared to diesel. This results in poor atomization, incomplete combustion and lower heat release.

H.M. Dharmadhikari et al[9]studied Performance and emissions of CI engine using blends of biodiesel and diesel at different injection pressures. The variation in brake thermal efficiency for various blends,

was less than at part load than at higher load due to the raised temperatures inside the cylinder. The brake thermal efficiencies of diesel and the blends of biodiesel with diesel

were seen increased with increase in load but tended to decrease with further increase in load. The BTE of blends were lower than with diesel throughout the entire range the poor combustion characteristics of methyl ester due to high viscosity and poor volatility. The BTE of B10, B20 of KOME / NOME are closer to that of diesel. At full load conditions BTE of B20 KOME is about 5% less than that of diesel. The BTE of B10, B20 of KOME/NOME are found better.

L. Prabhu et al [15] studied combustion, performance and emission characteristics of diesel engine with neem oil methyl ester and its diesel blends.The thermal efficiency is lower for B100 that of B20 and diesel. It may be due to larger differences in viscosity,

specific gravity and volatility between diesel and B20. Poor spray formation and reduced spray angle causes reduction in air entrainment and fuel-air mixing rates (Murayama, 1984). The B20 NOME has a lower viscosity, which results in better atomization that leads to complete combustion of the fuel as compared to 100%

Neem methyl ester.

Pooja Ghodasara et al [13]studied Experimental studies on emission and performance characteristics in diesel using io-diesel blends and EGR. It is observed that thermal efficiency improved with increasing concentration of Bio-Diesel in blend due to improved thermal efficiency observed with oxygenated fuel. All Bio-Diesel blends have higher thermal efficiency than base line data.

Nishant Tyagi et al[14] studied Experimental investigation of neem methyl esters as biodiesel on CI engine. An increase in break thermal efficiency may be attributed to the complete combustion of fuel because of oxygen present in blends perhaps also helped in complete combustion of fuel. It was observed that brake thermal efficiency of B10 is very close to brake thermal efficiency of diesel. Brake Thermal efficiency of B20 is better than B10 due to the more oxygen content. It is found that slight drop in efficiency of B30 because of improper combustion which may be attributed to higher viscosity than B10 and B20. Because of higher viscosity which may lead to poor mixture formation.

B. Jothi Thirumal et al [12] studied Performance and emission analysis of bio diesel fuelled engine with selective catalyst reduction (SCR). the internal combustion engine emission control by SCR system. It is seen that the installation of after treatment system does not affect the engine brake thermal efficiency for all loads. Therefore the engine performance will not be affected by after treatment method. Hence it can be assumed that the after treatment system does not create any appreciable increase in the engine back pressure.

Lovekush Prasad et al [8] studied Experimental investigation of performance of diesel engine working on diesel and neem oil blends. Brake thermal efficiency is plotted against the various loads for neem oil blended with diesel. The brake thermal efficiency is defined as the actual brake power per cycle divide by the amount of fuel chemical energy. Brake thermal efficiency for B10 is reduced by 21.10% as compared to diesel at maximum load and BTE for B20 is reduced by10.52% as compared to B10 at minimum load and 7.62% at maximum load. This reduction in brake thermal efficiency with biodiesel blends was due to higher viscosity, poor spray characteristics and lower calorific value. The higher viscosity leads to decreased atomization, fuel vaporization and combustion and hence the thermal efficiency of the biodiesel blends is lower than that of diesel.

S. Prabhakar et al [10] studied Analysis of Chosen Parameters of CI Engine for Nerium Oil - an Alternative Fuel. At normal injection timing of 27ºBTDC the brake thermal efficiency for neat diesel at full load is 28.75 %,where as it was 24.08% ,23.56% ,22.45% ,21.923% ,21.07% for N20,N40,N60,N80 and N100.“The best thermal efficiency was obtained for N20 blend and was 4.67% less than that of diesel for full load. From the “Fig 3” it was observed that brake thermal efficiency for the different injection timings for best efficiency blend(N20) at 24ºBTDC was 22.60%,30ºBTDC was 26.12% and 33ºBTDC was 24.61%.The efficiency of N20 at 30ºBTDC was found to be 2.04% higher than the efficiency of N20 at 27ºBTDC. This may be due to better spray characteristics and effective utilization of air resulting in complete combustion of the fuel.

3. Effect of Additives on CI Engine Emissions

3.1. Smoke Emission

Mingming Zhu et al.[1]studied the homogeneous combustion catalyst on fuel consumption and smoke emission in diesel engine. With the catalyst dosing ratio of 1:3200 in the fuel, the smoke emission was reduced by 6.7% to26.2% under the controlled engine conditions, and the maximum reduction ratio was obtained when the engine was run at speed of 2800 rpm under load of 0.4 MPa.

Mingming Zhu et al.[3]studied the effect of a homogeneous combustion catalyst on exhaust emissions from a single cylinder diesel engine. The homogeneous combustion catalysts treated fuels generated remarkably less PM, CO and UHC emissions in the engine exhausts compared with those from the reference diesel fuel. The maximum reduction ratios for PM, CO and UHC emissions were 39.5%, 21.1% and 13.1%, respectively. Slightly elevated NOx emissions were also observed with the application of the ferrous picrate-based catalyst, which was consistent with the improved fuel combustion efficiency and reduced PM, CO and UHC emissions from the test engine.

T.Pushparaj et al.[4] Studied on karanja biodiesel fuelled diesel engine with ethanol as additive The CI engine's smoke emissions were evaluated through exhaust gases opacity measurements, made obvious by the light absorbing coefficient . Exhaust gases' opacity has significantly decreased in the case of all fuel blends, especially at low and medium loads. It is obvious that the smoke emissions are evidently reduced with the addition of ethanol and decreases most with 10%, under operating conditions. Soot formation mainly takes place in the fuel-rich zone at high temperature and pressures, specifically within the core region of each fuel spray. It is commonly assumed that oxygenates blended with diesel fuel effectively deliver oxygen to the pyrolysis zone of the burning diesel spray resulting in reduced smoke emission. The oxygen weight content of ethanol is higher than that of biodiesel and diesel. Therefore, adding ethanol to biodiesel-diesel blend had a remarkable effect on the reduction of smoke emission.

J. Isaac Joshua, Ramesh Lalvani et al [5] studied Performance Characteristics and Emission Analysis of a Single Cylinder Diesel Engine Operated on Blends of Diesel and Waste Cooking Oil. The engine emission parameters (Smoke, HC, NOx, CO2, and CO) were evaluated for all test fuel. Smoke is measured for all blends at unstable loads. It is observed that smokes for all blends at every one load are high, when compared to diesel. The lowest smoke is 17.9 HSU for diesel, whereas in B30, it is 33.1 HSU.

Nishant Tyagi et al[14] studied Experimental investigation of neem methyl esters as biodiesel on CI engine. Smoke intensity was calculated by opacity test for various blends of biodiesel and diesel. Biodiesel gives less smoke density compared to pure diesel. When percentage of blend of biodiesel increases, smoke intensity decreases because oxygen present in the blend perhaps also helped in complete combustion of fuel. But we found that slight increase in smoke intensity in B30 because of incomplete combustion. This may be attributed to higher viscosity which may lead to poor mixture formation.

L. Prabhu et al [15] studied combustion, performance and emission characteristics of diesel engine with neem oil methyl ester and its diesel blends. Smoke emission with respect to brake power for diesel and biodiesel blends. The smoke emission with respect to different loads was analyzed for
various blends of fuel. The results confirm that smoke emission for biodiesel blend to be lower for NOME than that of the diesel fuel. 20% blend show low smoke number contributing to the factor that lesser amount of unburnt hydrocarbons is present in the engine exhaust emission. This may be due to the presence of oxygen molecule present in the neem oil methyl ester helps for complete combustion.

Anindita Karmakara et al.[17] studied Biodiesel production from neem towards feedstock diversification: Indian perspective.
It was found that CO, NOx,
HC and smoke emission were reduced to 18%, 3%, 18% and 12% for
NOME when compared to diesel fuel.

3.2. Nitrogen Oxides[NOx]

Mingming Zhu et al.[3]studied the studied the effect of a homogeneous combustion catalyst on exhaust emissions from a single cylinder diesel engine. NOx emissions were also observed with the application of the ferrous picrate-based catalyst, which was consistent with the improved fuel combustion efficiency.

Nishant Tyagi et al[14] studied Experimental investigation of neem methyl esters as biodiesel on CI engine. NOx was calculated by emission test for various blends of biodiesel and diesel. At higher temperature nitrogen will combined with oxygen and produce the oxides of nitrogen. Biodiesel gives more oxides of nitrogen as compared to pure diesel because of extra oxygen present in the blend which may lead to better combustion results higher temperature which is responsible for generating the oxides of nitrogen. One more reason for generating the oxides of nitrogen is after burning because in C.I. Engine combustion will continue till to the end of the expansion process. Those particles of fuel which are taking part in the combustion process at the end of the expansion process is not producing any work. This can generate higher temperature in exhaust where there is chance for generating the oxides of nitrogen. When percentage of blend of biodiesel increases, nox increases because oxygen present in the blend perhaps also helped in complete combustion of fuel. But it is found that slight decrease in Nox in B30 because of incomplete combustion. This may be attributed to higher viscosity which may lead to poor mixture formation.

L. Prabhu et al [15] studied combustion, performance and emission characteristics of diesel engine with neem oil methyl ester and its diesel blends. The variation of NOx
emission with respect to brake power for diesel and biodiesel blends is presented in . The result shows that the diesel fuel is having lower NO emission and blends of Neem oil are having higher NO emission. Compared to conventional fuel the NO emission is increased by 5% with the blend of Neem oil. The presence of oxygen in NOME helps to produce more amount of NO. The impact of fuel injection also plays a role in the higher NO emissions in the NOME.

J. Isaac Joshua,Ramesh Lalvani et al [5] studied Performance Characteristics and Emission Analysis of a Single Cylinder Diesel Engine Operated on Blends of Diesel and Waste Cooking Oil. NOx emission for all blends at every one load is high, when compared to diesel. Increasing the load the NOx emission is increasing. It is seen that the oxides ofnitrogen of the engine for diesel is 35.85% is higher than the 30% of diesel – waste cooking oil blends. This may be due to higher combustion temperature in cylinder of the engine with increasing the load, overall richness of air fuel ratio, longer duration of diffusion combustion phase and reduced oxygen concentration.

B. Deepanraj et al.[6]studied transesterified palm oil as an alternate fuel for compression ignition engine. Oxides of nitrogen (NOx) formation is highly depends on gas temperature inside cylinder and availability of oxygen. The NOx formation increases linearly with increase in load. This is because with increasing load, the temperature of the combustion chamber increases. It is observed that the NOx emission of the biodiesel operated engine is higher than the standard diesel operation. This occurs due to the presence of extra oxygen in the molecules of biodiesel which increases the in-cylinder temperature of the engine.

B. JothiThirumal et al [12] studied Performance and emission analysis of bio diesel fuelled engine with selective catalyst reduction (SCR). the NOx emission from the engine for four scenarios: Engine without any after-treatment system installed and three set of results with three different catalysts installed in it. It is seen from the base engine (only bio-fuel and no after-treatment system) that the NOx emission increases with increase in engine load. This is due to the fact that the engine temperature increases with increase in load, producing more NOx. For the maximum engine load, the NOx emission of diesel engine without SCR is maximum i.e. 610 ppm (Base engine) while there is a reduction of 52% of emission when SCR (zinc-sodium) is used. Further there is a reduction of 50% of emission when SCR (potassium-sodium) is used. There is a reduction of 20% of emission when SCR (magnesium-sodium) is used. Hence for the NOx reduction Zinc-Sodium catalyst is more effective than the other catalysts

[17]Thus, with 15% NOME, NOx emission can be reduced by proper adjustment of the fuel injection timing.

3.3. CO and UHC Emissions

Mingming Zhu et al.[3]studied the effect of a homogeneous combustion catalyst on exhaust emissions from a single cylinder diesel engine. CO and UHC emissions versus engine load. It was observed that for

all three fuels tested, the CO and UHC emissions tended to decrease with increasing the engine loads. This is due to the improved brake specific fuel efficiency and increased combustion temperature at high engine loads. However, the CO and UHC emissions increased again when the engine operated at the highest loads of 0.42 MPa BMEP. This is explained as that, under this highest load condition, in order to meet the high output power, a large amount of fuel was injected to the engine at each cycle which resulted in poor air–fuel mix and therefore an increase in the CO and UHC emissions.

3.4. Hydrocarbon Emission [HC]

T.Pushparaj et al.[4] Studied on karanja biodiesel fuelled diesel engine with ethanol as additive. HC emission variation with engine loads for the analyzed fuels. It may be observed that in the case of ethanol blend, HC emissions significantly decrease compared to B30 blend in all engine loads. An explanation could be sustained by the cetane number influence, biodiesel having a higher cetane number than diesel fuel facilitates an easier ignition and more complete fuel blends combustion. In the case of B30+EI0 very little HC emission was observed, this is due to higher oxygen content of ethanol.

J. Isaac JoshuaRamesh Lalvani et al [5] studied Performance Characteristics and Emission Analysis of a Single Cylinder Diesel Engine Operated on Blends of Diesel and Waste Cooking Oil. HC emission for all blends at every one load is high, when compared to diesel. The Hydro Carbon gets decreased when the brake power also increased. It affects proper mixture formation causes more HC emission, the HC of the engine for diesel is 22% lesser compare to 30 % of waste cooking oil – diesel blend. This may be due to poor atomization of the waste cooking oil diesel blends, because of higher viscosity, high density and poor volatility. Incomplete combustion of waste cooking oil causes more combustion.

B. Jothi Thirumal et al [12] studied Performance and emission analysis of bio diesel fuelled engine with selective catalyst reduction (SCR). The diesel or bio diesel engines run always on the oxygen rich mode there is a very low emission of HC and CO emission. Even though their emission level is insignificant an attempt has been made to quantify the effects of these metal catalysts on the HC emission reduction.

Pooja Ghodasara et al [13] studied Experimental studies on emission and performance characteristics in diesel using io-diesel blends and EGR. When engine is operated in diesel engine with EGR the HC emissions the higher at higher load due to less availability of O_2 results in poor air fuel ratio & tends to incomplete combustion but by adding biodiesel to diesel increase O_2 required for combustion because of presence of molecules oxygen in fuel.

3.5. Comparison of emissions from neem biodiesel and diesel

Literature has further reveals that the engine operation on biodiesel blend with diesel emit lower gaseous emission than diesel fuel expect NOX which increase to 2% with B20 and 10% with B100 use. Further, the use of biodiesel or its blend with diesel increases the NOx emission and decreases the CO and HC emission.

4. Conclusion

the literature review study of fuel additives in CI engine it is found that, there is a benefit of adding fuel additive in biodiesel in terms of improved Brake power, Antioxidants are quite effective in controlling NOx formations. Cold flow improvers improve viscosity–temperature characteristics of biodiesel. From this review indicate there are further scope in experimental investigation in direction of improvement of performance, reduced emission characteristics and save large quantity of diesel with use optimized blend of biodiesel and diesel instead of only diesel in CI Engine by use of latest available fuel additives from market in blend of biodiesel and diesel without modification in CI Engine.

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