A Review Study on Exhaust Gas Recirculation (EGR) and Catalytic Converter by using blend of Karanja Biodiesel in Diesel engine

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Abstract – World is facing two important problems, one is Energy crises and another one is Pollution. Day by day increasing number of industrialization and number of automobiles causes these two problems. In this study, before treatment as Exhaust Gas Recirculation and after treatment system as Catalytic converter used with Karanja Biodiesel in CIDI engine. This study investigate the suitable use of Karanja Biodiesel in conventional diesel engine and exhaust emissions like carbon monoxide (CO), Hydrocarbon (HC), oxides of nitrogen (NOx) reduced simultaneously by the systems.

I. INTRODUCTION

The large number of increasing industrialization and automobiles in recent years has resulted in higher demand of petroleum products. Today world is facing two problems of energy crisis and environmental degradation. Irreplaceable petroleum reserves, high price fluctuations, high expenditure on fuel import, harmful effects of various exhaust emission on humans and environment forces to search for alternative fuels. Biodiesel is the name of clean burning alternative fuels, produce from domestic, renewable sources. Biodiesel contains no petroleum, but it can be blended at any level with petroleum diesel to create a biodiesel blend. Biodiesel can be used in the existing engine, without any modification. Experimental result shows that reduction in emissions like UBHC, CO, and PM at certain level with biodiesel and there is no Sulphur content in biodiesel. [12-17].

The major problem of using vegetable oil in diesel engine is their high viscosity. The high viscosity of non-edible oils and low volatility affects the atomization and spray patterns of fuel, leading to incomplete combustion and severe carbon deposits, injector chocking and piston ring sticking [1].

The methods used to reduce viscosity are:

- Emulsification,
- Pyrolysis,
- Dilution and
- Transesterification.

Among all four processes, Transesterification is commonly used commercial process to produced clean and environmental friendly fuel. Transesterification involves a reaction in a triglyceride and alcohol in presence of a catalyst to produce glycerol and ester [17]. Methyl or ethyl ester of vegetable oils referred to as biodiesel have several advantages and can be used in any existing design. Methyl ester gives better performance than ethyl ester. [17]. Many researchers have used methyl esters of karanja [2], jatropha[2], sesame oil [2], mahua oil [3], and kusum oil [4], reported the performance and emission characteristics in diesel engine.

Karanja is medium sized tree is found almost throughout India. India is a tropical country and offers most suitable climate for the growth of karanja tree. [14].

Exhaust Gas Recirculation is system in which exhaust gases are recirculated in engine by some proportion of 5%, 10%, 15% 20%, 25% and 30%, which causes to reduce exhaust gas temperature. Due to so the NOx emission reduces but HC, CO and PM emission increases because of incomplete combustion. So, we are using Catalytic Converter to reduce exhaust emission of HC and CO by this system. Strategies used to reduce NOx emission include: injection timing retard, injection rate shaping, charge air chilling, water fuel emulsions, exhaust gas recirculation etc.

II. PERFORMACE AND EMISSION ANALYSIS

C.V.Mahesh, E.T.Puttaiah[1], studies carried out on the performance and emission characteristics of HOME and its blends with diesel oil in DICI engine and experiment on 4 stroke single cylinder naturally aspirated water cooled diesel engine having 5 BHP as rated power at 1500 rpm. Fig. 1 shows that specific fuel consumption increases with increase in percentage of HOME in the blend due to the lower calorific value of HOME. Fig. 2 show that HOME results in slight increase in thermal efficiency as compared to diesel. Fig. 3 shows CO2 emissions are lower , fig 4 shows CO emission is low at higher loads and fig 5 shows NOx emission is higher in case of HOME than diesel.

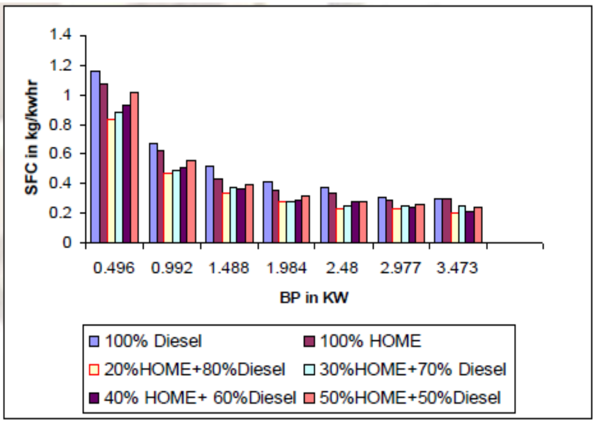


Fig 1: variation of SFC with BP[1]

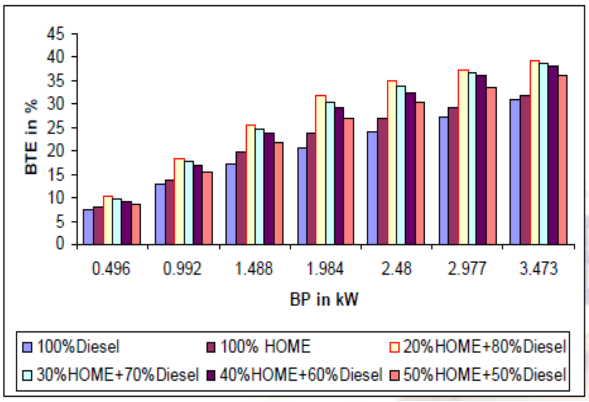


Fig 2: variation of BTE with BP[1]

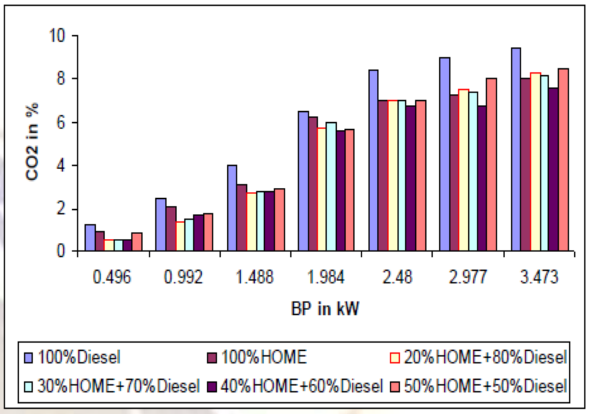


Fig 3: CO_2 emission with BP[1]

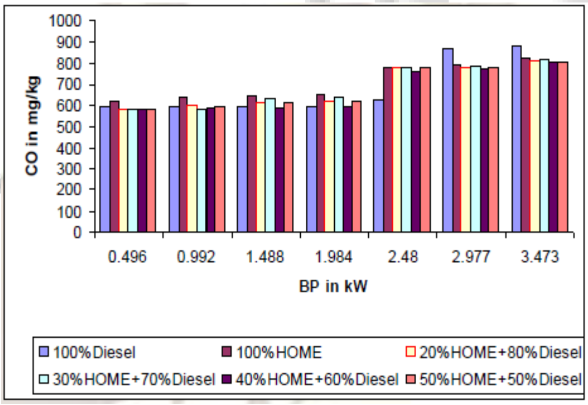


Fig 4: CO emission with BP[1]

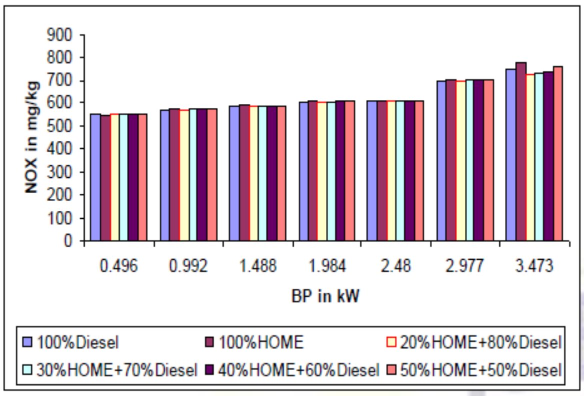


Fig 5: NOx emission with BP[1]

N.R.Banapurmath et al [2], compares sesame oil with Hone oil and Jatropha oil methyl ester in DICI engine of single cylinder four stoke of 5.2 kW at 1500 rpm. Compared to neat diesel operation, methyl esters of Honge oil, Jatropha and sesame oils results in poor performance associated with higher emission. The brake thermal efficiency with HOME, SOME and JOME is 29.51%, 30.4% and 29%, respectively, at 80% load and 31.25% with diesel. The HC and CO emissions with SOME, JOME and HOME are found to be slightly more than the diesel operation.

N.Kapilan, R.P.Reddy [3], study was investigated on performance and emission of Honge oil and Mahua oil Biodiesel in DICI engine on 7 BHP at 1500 rpm. Based on engine test brake thermal efficiency of the biodiesel is close to diesel operation at higher load. Fig 6 shows that the Honge biodiesel results in slightly higher efficiency than the mahua biodiesel. The Honge biodiesel results in lower engine emissions as compared to the mahua biodiesel.

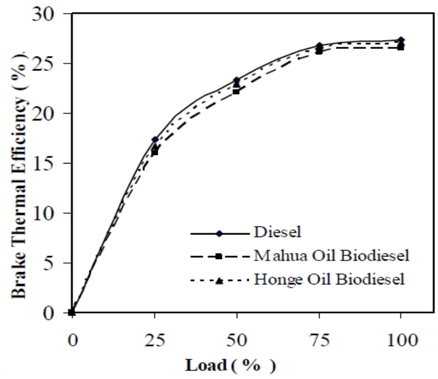


Fig 6: variation of BTE with load[3]

S.K.Acharya et al [4], engine performance with kusum and karanja oil (preheatd) was found to be very close to that of diesel. The preheated oil's performances were found to be slightly inferior in efficiency due to low heating value. Fig 7 and fig 8 shows the performance of karanja oil was found better than kusum oil in all respect.

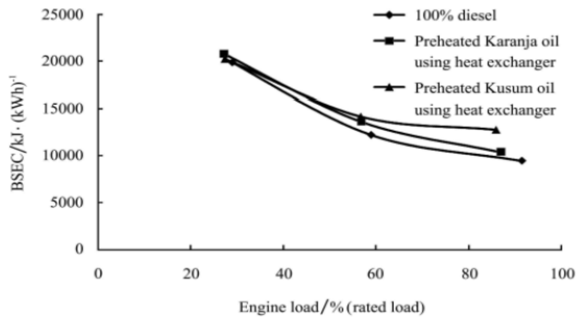


Fig 7: variation of BSFC with load [4]

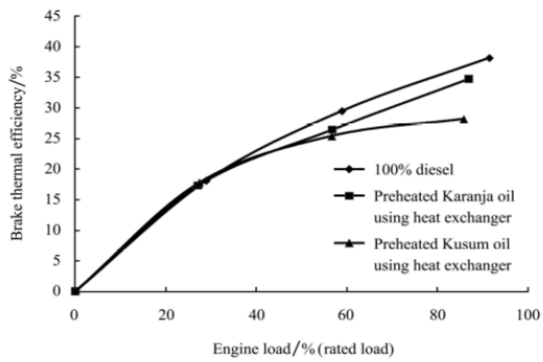


Fig 8: variation of BTE with load [4]

Deepak Agrawal et al [5], EGR controls the NOx because it lowers oxygen concentration and flame temperature of the working fluid in the combustion chamber. The experiments were carried out to experimentally evaluate the performance and emissions for different EGR rates of the engine. The engine was operated for 96 h in normal running conditions and the deposits on vital engine parts were assessed. Soot deposits on various vital engine parts were done photographically. Piston rings were weighed before and after 96 h of the engine test run for set of experiments to measure wear of piston. It can be observed from fig 9, 10, 11 and 12 that 15% EGR rate is found to be effective to reduce NOx emission without deteriorating engine performance and in terms of thermal efficiency, BSFC and emissions.

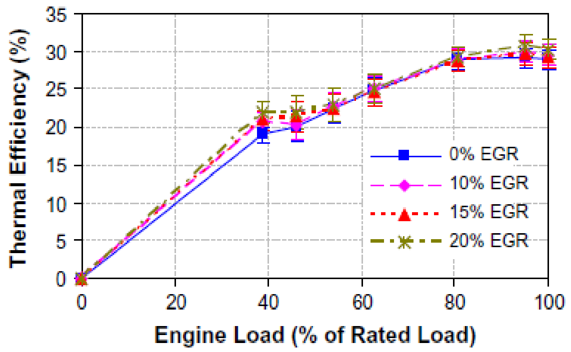
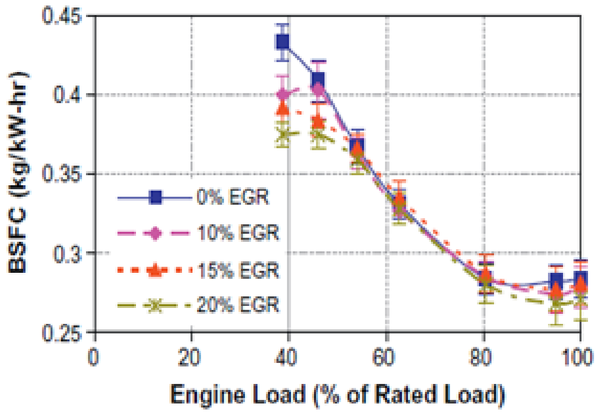


Fig .9. variation of thermal efficiency with load [5]



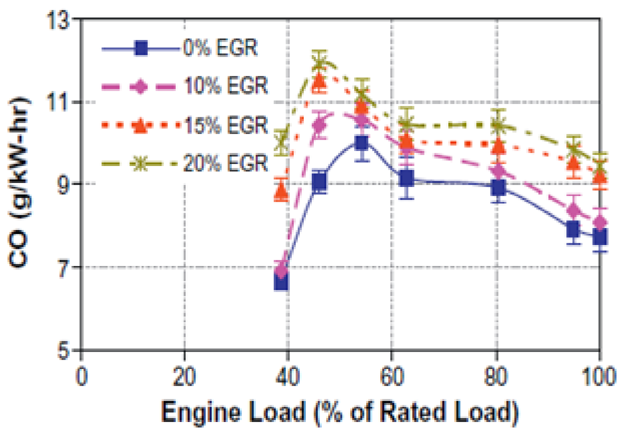


Fig.11. CO emission with load [5]

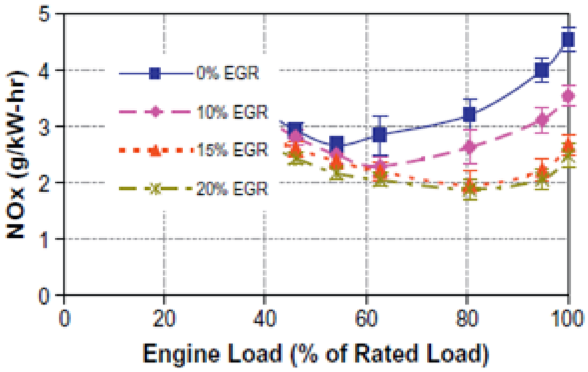


Fig 12: NOx emission with load [5]

Murari Mohan Roy et al [6], investigate on EGR and cyclonic separator for simultaneous reduction of NOx and PM in DICI engine under different load and speed. There is reduction of NOx by EGR but increase in PM, and PM is reduced by the use of cyclonic separator.

Average NOx reduction at 10% EGR rate under different loads and speeds is about 24%, but average PM increase is about 12%. NOx is reduced about 47% at 20% EGR rate, but PM increase is about 65%. At 30% EGR rate, NOx reduction is about 77%, but PM increase is about 156%.

A simple cyclonic separator reduces PM from diesel exhaust about 34-61% without deteriorating other emissions and fuel consumption. Average cyclonic efficiency increased with the increase in speeds and loads. Average cyclonic efficiency increased from 37% at 650 rpm to 59% at 1200 rpm.

Use of EGR and cyclonic separator together can simultaneously reduce NOx and PM from diesel exhaust. Combining the cyclonic separator with 10% EGR rate, average PM reduction than non-EGR is 53% maintaining average NOx reduction of 24%. At 20% EGR rate, average PM reduction than non-EGR is 40% maintaining average NOx reduction of 47%. And at 30% EGR rate, average PM reduction than non-EGR is 12% maintaining average NOx reduction of 77%.

V.Pradeep, R.P.Sharma [7], diesel running on JBD is found to emit higher oxides of nitrogen, NOx. By using hot EGR reduction of NOx achieved. Variation of brake thermal efficiency (BTE) at optimized EGR level of 15%. Beyond 15% EGR level, BTE also reduced significantly. Brake specific energy consumption (BSEC) is more effective than brake specific fuel consumption (BSFC) in comparing fuels of different calorific value. BSEC of biodiesel was slightly higher for all levels of EGR compared to corresponding diesel value. Higher values of CO were observed at full load for both fuels beyond 15% EGR. For 15% EGR, diesel and biodiesel HC was comparable at full load. NO was found to be 1255ppm for diesel and 1350ppm for biodiesel at full load and 0% EGR operation. With 5% EGR, the NO level came down to 1105ppm for biodiesel and 900ppm for diesel, at full load. With 10% EGR, NO levels were 885ppm for diesel and 910ppm for biodiesel. With 15% EGR, NO levels were found to be 772ppm for biodiesel and 780ppm for diesel at full load. Even though 20 and 20% EGR were able to reduce NO by a large amount, reduction in BTE and large increase in smoke, CO and HC emissions were observed. Conclude that HOT EGR of 15% effectively reduced NO emission without much adverse effect on the performance, smoke and other emissions.

H.E.Saleh [8], effect of EGR with jojoba methyl ester on diesel engine is attempted to reduce nitrogen oxide. At high speed, the engine output and efficiency with JME were higher than that with diesel fuel. The BSFC with JME is lower than that with diesel fuel by 8.2%, 9.8% at 1200rpm and 1600 rpm respectively. The NOx concentration with JME fuel is higher than that with diesel fuel. At 1200 rpm, the increase of approximately 16% in the NOx emissions with JME compared with diesel fuel and about 14% at 160 rpm. It is difficult to employ an EGR rate larger than 12%, and this may result in an excessive increase in BSFC up to 11%. The reduction in NOx was 33% at that level of EGR rate. For all operating conditions, a better trade off between HC, CO and NOx emissions can be attained within a limited EGR rate of 5-15% with little economy penalty.

V.V.Prathibha Bharathi, Dr. Smt. G. Prasanthi [10], investigates the effect of EGR with Karanja Biodiesel and Grooved Piston with Knurling in an IC engine of single cylinder water cooled, 3.68 rated HP at 1500 rpm. Tests were conducted on 10%, 15% and 20% EGR with 9 grooved piston. The BTE for normal engine at ¾ of rated load is 26% and 28.1%, 27.9% and 27.6% BTE were observed for 10%, 15% and 20% EGR respectively. There is a gain of 7.4% with 20% EGR compared to normal engine. By EGR20 2.94% of fuel consumption were observed compared to normal engine.13%, 5.4% and 2.9% reduction of NOx , HC and CO were measured. Investigated that combination of karanja biodiesel with EGR20 and piston with nine grooves give better performance and reduced emissions.

Hwanam Kim [11],carried out an experiment on four cylinder Common Rail DI engine with the used of three different types of ultra lowsulfur fuel as ethanol-diesel blend, ethanol-diesel blend with Cetane improver, pure diesel to evaluate the effect of upstream and downstream warm up catalytic converter (WCC) in their exhaust gas emissions under the ECE 13 mode. Conclusions shows that the BSFC curves for all fuels found different at low load condition, and increased by 6.5 % when ethanol blend was used in middle and high load condition. Fuel consumption for E15-CI is lower than E15, due to cetane improver effect. CO conversion efficiency with WCC was found about 80 % in each mode except in 1, 2 and 13 modes (low exhaust gas temperature condition). Total hydro carbon (THC) conversion efficiency on the catalyst found 40-60% in each mode except in mode 7.

III. CONCLUSION

From literature review it is concluded that:

1) Karanja Biodiesel can successfully be used in Diesel Engine upto 30%.
2) 15% EGR gives best performance without deteriorating engine performance.
3) EGR is best method to reduce NOx emission.
4) Emissions like HC and CO emit by due to EGR can be reduced by catalytic converter.
5) Methyl ester is gives better performance and emission characteristics than Ethyl ester.
6) Karanja have better performance and emission characteristics than Mahua, Sesame and Kusum Biodiesels.

ACKNOWLEDGEMENT

I am thankful to all the faculty members of Mechanical Engineering Department and my parents and all my friends who helped me in prepare review paper and give direction with their suggestions and their rich experience.

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