Performance and Emission Analysis of single cylinder Diesel Engine using Jatropha oil with EGR

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Abstract— **Transesterified vegetable oil, also called bio-diesel is becoming increasingly important as a fuel for diesel engine due to several reasons. Bio-diesel is a renewable, inexhaustible and a clean burning fuel. Many studies have shown that properties of bio-diesel are very close to petro diesel. Bio-diesel can be used in diesel engine without modification. Bio-diesel has no aromatic, no-sulfur and contains 10-12% oxygen by weight. These characteristics of bio-diesel reduce the harmful emissions of unburned hydrocarbons and CO, research has shown that NOx, emission is higher in case of bio-diesel fueled engine. Exhaust gas recirculation is an effective technique to reduce NOx. The aim of present research work is to use B10,B20, B30, blend of jatropha methyl ester and cooled EGR in order to reduce pollutant from diesel engine emission of NOx, CO, HC,are recorded and compared with petro diesel. Various performance parameters was evaluated such as brake thermal efficiency, BSFC, SEC, TFC were calculated. Result indicates the reduction of NOx and brake thermal efficiency decreased with the application of EGR and Jatropha blends bio-diesel.**

***Index Terms*— Jatropha, Super Charger, Engine**

I. INTRODUCTION

Vegetable oils present very promising alternate to Diesel oil since they are renewable and have similar properties. Several research and project in the field of Internal combustion Engine are being focused on reduced Emission, which not only makes commercial sense but also helps benefit the environment reducing harmful emission from diesel vehicles helps improve local air quality which is no becoming increasingly important towards corporate social responsibility. The use of vegetable oils as fuels for diesel engines is not a new concept. It is known that when Sir. Rudolph Diesel invented diesel engine he used Peanut oil in his engine.

Biodiesel has no aromatics, no sulfur and contains 10-12% oxygen by weight. Biodiesel can be produced from food grade vegetable oil that are expensive than the diesel fuel. The most popular method to process of producing biodiesel is known as Transesterification Biodiesel is renawable diesel fuel substitue that can be made by chemically combining any natural oil or fat with alcohol. Transesterification process reduces the viscosity of vegetable oil. Alcohols such as methanol, ethanol can be used in the transesterification and the monoesters are named methyl esters.Methonal is commonly used alcohol for commercial production of biodiesel.Transesterification reaction improves the physical properties of vegetable oils,one is to reduce the molecular weight another effcet is conversion of long branched molecules into shorter and straight chain molecules. (9)

Jatropha an alternate fuel could be attributed to some important facts. Indian climate condition is suitable for Jatropha cultivation. Has no insects, pets and not browsed by animals, can survive long periods of drought. It can grow in saline and alkaline soils, arid and semi-arid condition. Its properties match with that of petroleum diesel.

From various researches it's found that NO_x emission is higher in Jatropha based bio-diesel.An effctive technique to reducing NO_x emission in diesel engine is Exhaust Gas Recirculation (EGR). NO_x are formed when the combustion temperature is high. Any technique that reduces the combustion temperature will thus lead to decreased NO_x formation (10-11). EGR technique involves recirculation of exhaust gas in to the intake system of the engine. The recirculated exhaust gas displaces some of the normal intake charge of the engine, which slows and cooles the combustion process, threby reducing NO_x formation.In this project the cooled EGR is used as it can reduce the NO_x emission. In cooled EGR the recirculatin is varied from 5 to 15%. EGR control valve controlled EGR-recirculation.

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II. CHARACTERIZATION OF JATROPHA OIL

Jatropha curcas is a large plant and belongs to the family of Euphorbiacea occurring almost throught India. It has a long productive period of around 40-50 years. It grows as a tree up to the height of 3-5 mt. it is a good plantation for Eco-restoration in all types wasteland

A) Properties of Jatropha oil

The properties of the methyl ester of jatropha oil summarized in Table 1.

B) Availability of Jatropha oil

India has rich and abundant resources of both edible and non edible oil seeds.Jatropha curcus is a large shrub or tree commonly found throught most of the tropical and sub-tropical reigns of the world. Jatropha curcus plant is a

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drought-resistant, perennial plant living up to40- 50 yearsit can grow in saline and alkaline soils, arid and semi-arid condition. The production of jatropha seeds is about 0.8 kg/m^2 per year. The oil content of jatropha seeds 40% by weight (3-6). Fresh jatropha is a slow drying, odorless and colorless oil, and turns yellow after aging. Jatropha an alternate fuel could be atributed to some important facts, Indian climate condition are suitable for Jatropha cultivation. Has no insect, pets and not browsed by animals, can survive long periods of drought.

Property	Diesel	Jatropha Methyl Ester
Density (kg/$m^{3)}$	840	870
Sp.gravity	0.840	0.870
Kinematic Viscosity (c St) at 40^0C	3.5	5.65
Flash point (^{0} C)	56	170
Calorific value (kj/kg)	42926	35717

TABLE I: Properties of Diesel and Jatropha Methyl Ester

Fig.1. Process flow chart

III. EXPERIMENTAL SETUP

The experimental investigation carried out in a single cylinder 4-stroke water cooled diesel engine developing 3.68 kW at 1500 RPM was used. The engine details are given in table 1. The schematic of the experimental set up is shown in fig 2. An eddy current dynamometer was used for loading the engine.

The EGR setup consist of a water cooled heat exchanger for cooling exhaust gas, reaction chamber and valves fitted to control the quantity of exhaust gas being recycled.

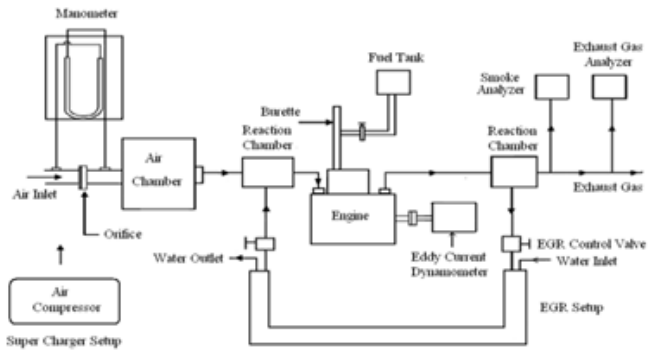

Fig.2. Schematic diagram of the experimental setup

TABLE II: ENGINE SPECIFICATION

Make	Kirloskar
Stroke	4
No. of cylinder	1
Rated Speed (RPM)	1500
Bore (mm)	80
Stroke (mm)	110
Compression Ratio	17.5:1
Rated Power (kW)	3.68

IV. EXPERIMENTAL PROCEDURE

The engine was coupled to an eddy current dynamometer to measure the output, fuel flow rates were timed with calibrated burette. Exhaust gas analysis was performed using exhaust gas analyzer.

The blends of B10, B20, and B30 of Methyl Ester of Jatropha Diesel was prepared by volume basis and used for experimental purpose.

The engine was tested no EGR and with EGR at the rate of 5, 10, and 15 % exhausts gas re-circulation. The amount of exhaust gas in to intake pipe is controlled through the EGR-valve. The EGR is cooled by water the intake temperature can be controlled at the range of about 25^0-35^0C. The engine speed, fuel consumption, and exhaust gas re-circulation rate also recorded. Exhaust gases were analyzed by gas analyzer in which CO, HC, NOx, were recorded.

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V. RESULTS AND DISCUSSION

Based on the experimental results the graphs were drawn. These graphs show the variation in brake thermal efficiency, BSFC, and emissions.

In fig.3 shows the variation of brake thermal efficiency on brake power with effect of EGR. The brake thermal efficiency is decreases with rise of EGR at the rate of 10 %.

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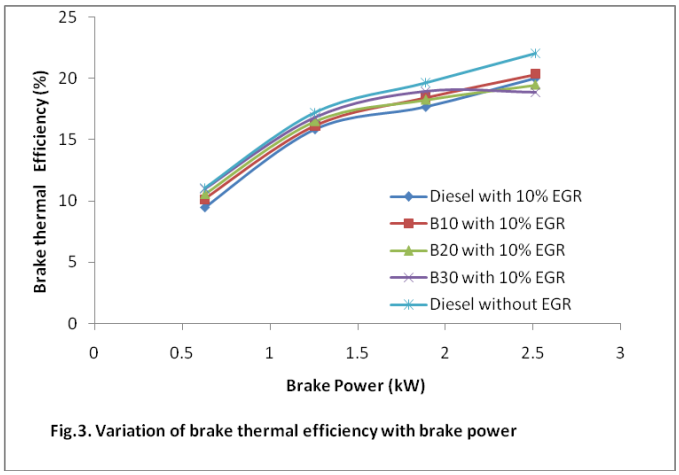

Fig.3. Variation of brake thermal efficiency with brake power

In fig.4 shows the variation of BSFC on brake power with effect of EGR. The BSFC values are increased in all blends of Jatropha oil compared to normal diesel operation.

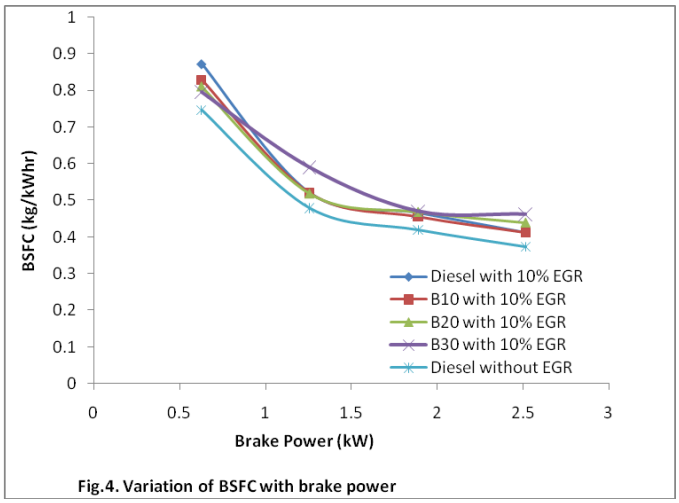

Fig.4. Variation of BSFC with brake power

In fig.5 shows the variation of Total fuel consumption on brake power with 10 % effect of EGR. The Total fuel consumption values are increased in all blends of Jatropha oil compared to normal diesel operation.

In fig.6 shows the variation of CO emission on brake power with effect of EGR. The CO emission increases because of the post-combustion oxidation are reduced with EGR recirculation on account of lower gas temperature and lower oxygen concentration.

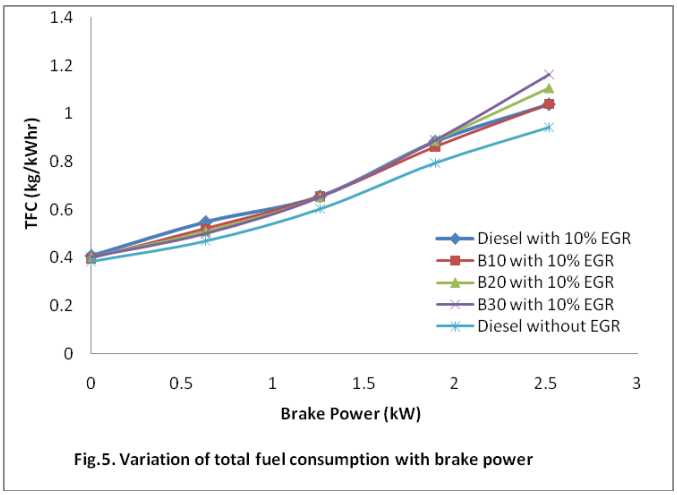

Fig.5. Variation of total fuel consumption with brake power

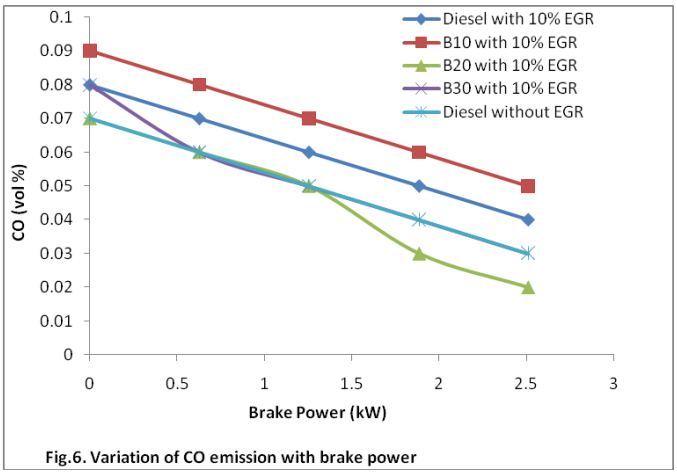

Fig.6. Variation of CO emission with brake power

The variation of HC emission on brake power with effect of EGR is shown in fig.7. The HC emission decreases with increasing EGR ratio, compared to normal diesel operation

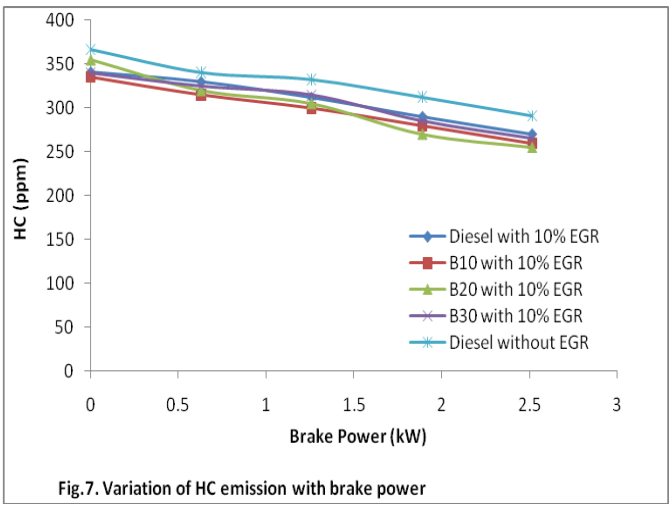

Fig.7. Variation of HC emission with brake power

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In fig.8 shows the variation of NO_X emission on brake power with effect of EGR. The NO_X emission decreases with EGR. The amount of EGR circulation is more it leads to more reduction of NO_X emission.

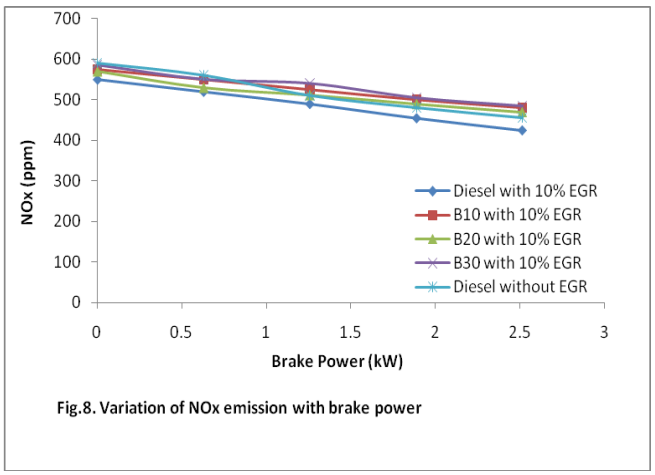

Fig.8. Variation of NOx emission with brake power

VI. Conclusions

An experimental investigation was conducted to test the performance and emission characteristics of Jatropha oil and its fuel blends with diesel in a single cylinder diesel engine with the effcet of EGR, the results obtained suggest the following conclusion.

- Petro diesel and blends of jatropha oil exhibited similar performance and similar emission characteristics under various normal and EGR operating condition.
- With the effect of EGR, brake thermal efficiency decreases with B10, B20 and B30 when compared to naturally aspirated diesel engine.
- With no EGR B10, B20 and B30 blends, BSFC values are increased compared to EGR incorperated engine.
- With no EGR B10, B20 and B30 blends, TFC values are increased compared to EGR incorperated engine.
- NOx emission decreased with EGR, CO emissions increased and HC emissions decreased in all blends of jatropha oil.
- B20 is the best blend with diesel showed better results with brake thermal efficiency, Brake specific fuel consumption, Total fuel consumption and and less NO_X emission with 10 % of EGR.

VII. NOMENCLATURE

BSFC - Brake Specific Fuel Consumption (kg/Kw. hr)
B10 - Blend of 10% Jatropha oil, 90% Diesel by volume
B20 - Blend of 20% Jatropha oil, 80% Diesel by volume
B30 - Blend of 30% Jatropha oil, 70% Diesel by volume
S.C - Super Charger
EGR - Exhaust Gas Recirculation
H.S.U - Hartridge Smoke Units
CO - Carbon monoxide
NO_X - Oxides of nitrogen
PPM - Parts per million
kW - kilowatt
HC - Unburned hydrocarbon

References

1. Deepak Agarwal and Avinash Kumar Agarwal, "Performance and Emission characteristics of Jatropha oil (preheated and blends) in a DI compression Ignition Engine", Applied thermal Engineering, Volume 27, Issue 13, Sept-2007, Pg 2314-2323.
2. S. Jindal, B.P. Nandawana, N.S. Rathore, V. Vasistha, "Variable Compression ratio engine was run with jatropha Methyl Ester (B100) at different compression Ratio and injection pressures to evaluate the Performance with Emissions along with the standard settings". Applied thermal engineering 30 (2010) Pg 442-448.
3. N.R. Banapurmath, P.G.Tewari and R.S. Hosmath," Performance and Emission characteristics of a DI compression ignition engine operated on Honge,Jatropha and Sesame oil methyl ester, Renewable energy,33(2008) 1982-1988
4. V. Manieniyan and S. Sivaprakasam, "Performance, Emission and Combustion characteristics of diesel engine using biodiesel", SAE International powertrains, Fuels and Lubrication Congress, Shanhai, China, June 23-25, 2008-01-1577.
5. M. Sundaresan, S. Chandrasekaran, P. Tamil Porai, " Analysis of Combustion, Performance and Emission characteristics of blends of Methyl ester of jatropha oil in DI Diesel engine", 20076566 (JSAE), pg 1-6.
6. Iman K. Reksowardojo, Ichsan H. Lubis, Wishnu manggala S.A., Tirto P. brodjonegoro, Tatang H. Soerawidjaja, W. Arismunandar Nguyen Ngoc, Dung and H. Ogawa " Performance and exhaust gas Emissions of using biodiesel fuel from physic nut (Jatropha curcas L) oil on a direct injection diesel engine", JSAE 200777278, pg 1232-1236.
7. "Iman K. Reksowardojo Tirto p. Brodjonegoro and W. Arismanandar R. Sopheak, H. Ogawa "The combustion and exhaust gas emission of a DI Compression ignition engine using physic nut oil (Jatropha curcas oil)".SAE 2007-01-3622
8. G. Amba prasad rao, P. Rama mohan "Performance evaluation of DI & IDI engines with Jatropha oil Based biodiesel". IE(I) jul 2005-vol-86 pg72-76
9. F. K. Forson, E. K. Oduro, E. Hammond-donkoh "Performance of Jatropha oil blends in a diesel engine". Renewable energy 29-2004 pg 1135-1145
10. "S. K. Mahla, L. M. Das, M. K. G. Babu, "Effect of cooled EGR on performance and exhaust emission characteristics of Biodiesel fueled engine". Proceedings of the third international conference on

ISSN: 2278 – 7798

thermal engg: theory and applications May 21-23, 2007, Amman, Jordan

11. S. Aldajahc, O.O. Ajayia, G.R. Fenskea and I.L. Goldblattb "Effect of Exhaust gas recirculation contamination of diesel engine oil on wear" 10 sep 2007, volume 263, issues1-6 , pg 93-98 ,16th international conference on wear materials

12. "Wang Ying, Zhou Longbao" Experimental study on Exhaust Emissions from a multicylinder DME engine operating with EGR & Oxidation Catalyst". Applied thermal engg ,28(2008) 1589-1595

13. R. Kumar. M. Sharma, S.S. Ray, A.S. Sarpal, A.A. Gupta, D.K. Juli, R. Sarin ,R.P .Verma and N.R. Raje "Biodiesel from Jatropha curcus and pongamia pinnata" IOC, R&D Centre , sector-13 ,Faridabad.SAE 2004-28-0087

14. S.R. Kalbande and S.D.Vikhe "Jatropha and karanj bio-fuel. An alternate fuel for diesel engine", ARPN Journal of Engg and Applied science, Feb 2008, vol - 3 pg7-12.

15. "M.G. Devanesan, T. Viruthahiri and N. Sugumar", "Transterification of Jatropha oil using immobilized pseudomonas fluorescens". African journal of biotechnology, Nov2007, vol 6(21), pg2497-2501

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