A Review Paper On Performance Evaluation And Emission Analysis Of Four Stroke Single Cylinder Diesel Engine Using Cotton Seed Biodiesel As an Alternative Fuel With Additives

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Abstract – To reduce environmental pollution and to find substitute for diesel has highly promoted the research of application of study of renewable fuel like biodiesel and its blends to internal combustion engine. In this paper, a review of the literature related to the topic of performance evaluation and emission analysis of a Four Stroke Single Cylinder Diesel Engine using cotton seed biodiesel with additives is presented. A variety of experimental and analytical work has been carried out on this topic. Research work is done in the field like use of cotton seed biodiesel diesel blends in diesel engine, direct application of cottonseed oil with diesel as a blend for diesel engine, application of cotton methyl ester (CME), cotton ethyl ester (CEE) i.e. Cotton Seed Biodiesel in diesel engine etc. Relevant literature pertaining to these systems has been reviewed. Beyond this work there is one technique which will reduce pollution; increase performance of engine using cotton seed biodiesel blending with diesel and additives is presented.

Index Terms – Cotton seed biodiesel, Diesel, fuel blends, Nitromethane, Nitroethane , Diesel engine, performance, Exhaust emission.

1. INTRODUCTION

1.1 Cottonseed Oil

It is cooking oil extracted from the seeds of cotton plant. All cotton that is grown is used to produce cotton fiber, animal feed, and oil. Cotton seed having an oil-bearing kernel surrounded by a hard outer hull; in processing, the oil is extracted from the kernel.

1.2 Cotton Seed Biodiesel Production:-

Biodiesel is commonly produced through chemical transesterification, a process in which triglycerides in vegetable oils or animal fats react with an alcohol in the presence of a catalyst. Transesterification reaction is accomplished in a stirred reactor maintaining the temperature 55-60˚C.The transesterification process of cotton seed oil was performed using 13 gm of potassium hydroxide and 250 ml of methanol per liter of raw cotton seed oil. First, raw cotton seed oil was taken in a container and stirred with a mechanical stirrer and simultaneously heated with the help of a heating coil. The speed of the stirrer should be minimal till the temperature of the raw oil reaches 55°C. Then, potassium hydroxide mixed with methanol separately in a beaker and stirred until they were properly dissolved. The solution was then added to the preheated cotton seed oil in the reactor and the reactor was closed with air tight lid. After the mixture was stirred for 30 min at a fixed temperature of 60°C, the solution was transferred to a glass container where the separation of glycerin takes place and allowed to settle down for 15h. Now the methyl ester of cotton seed oil (biodiesel) gets collected in the upper portion of the glass container, whereas glycerin gets collected at the bottom portion and drain the bottom layer containing glycerin. Then biodiesel was washed with water repeatedly for 4 to 5 times at a time interval of 1 hr until no glycerin was left in the biodiesel. Now the biodiesel was heated at 103°C to 105°C in order to remove the water contained in it. Finally, the produced Methyl Ester of Cotton Seed Oil (MECSO) was left to cool down and was ready for use.

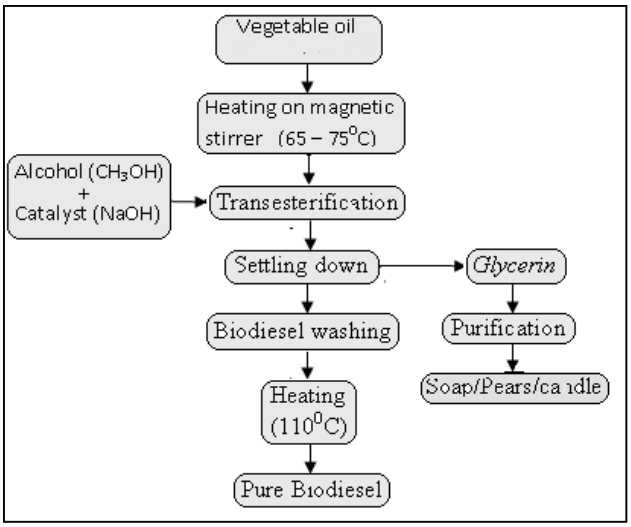

Fig.1.1 Flow chart of Biodiesel production

TABLE 1.1 Properties of Fuels

Properties	Cotton-seed oil	Bio-diesel	Diesel
Density (g/cc)	0.9	0.88	0.84
Boiling Point (° C)	319	262	248
Calorific Value(MJ/Kg)	41.95	38.51	45
Kinematic Viscosity at 34˚C(mm2/s)	29.215	7.2	

2. LITERATURE REVIEW

1. Mojtaba Saei Moghaddam (2012) " PERFORMANCE AND EXHAUST EMISSION CHARACTERISTICS OF A CI ENGINE FUELED WITH DIESEL NITROGENATED ADDITIVES" Nitromethane (NM) and Nitroethane (NE) were used as nitrogenated additives to improve brake specific fuel consumption(BSFC) ,combustion performance and reduce emission from diesel engine. Then exhaust emission of compression ignition (CI) engine have been evaluated experimentally for sole diesel, NM-Diesel and NE-Diesel fuel blends. The addition of nitrogenated additives to the standard diesel fuel caused brake thermal efficiency (BTE) increased. The smoke emission decreased at the maximum torque speed (1500 rpm) rather than at the rated power speed (2200 rpm).

Overall, NE has been found to be promising fuel additive in compare with another additive, capable of providing high thermal efficiency, low soot levels and decreased viscosity but have high level of NOx at the maximum torque speed (1500 rpm). Nitrogenated additives increased brake thermal efficiency (BTE), in all modes, the average smoke reduction rates of NM-Diesel and NE-Diesel were 16.2% and 35.7% of that of sole Diesel respectively.

2. A. Rama Krishna , B. Prabakaran (2015) "PERFORMANCE AND EMISSION CHARACTERISTICS OF COTTONSEED OIL METHYL ESTER IN A DIESEL ENGINE'' Cottonseed oil biodiesel is having higher cetane Number than diesel and higher viscosity than diesel and cottonseed oil is non-edible oil. Blends of biodiesel from cottonseed oil has been made in various proportions up to 30% volume with diesel and tested in a diesel Engine.Results show that the emissions of carbon monoxide (co) and unburned hydrocarbon (hc) has reduced for all the blends. Brake specific energy consumption for all the blends is lower than that of diesel. There was Increase in brake thermal efficiency for all the blends than diesel fuel. There was slight increase in oxides of Nitrogen (NOx) for all blends.

3. Vijayaraj, K. and A.P. Sathiyagnanam (2014) "EXPERIMENTAL INVESTIGATION OF METHYL ESTER OF COTTON SEED OIL BLEND WITH DIESEL ON CI ENGINE'' Experiments were conducted using various blends of methyl ester of cotton seed oil with diesel in a single cylinder, four stroke vertical and air cooled Kirloskar diesel engine.There is an appreciable decrease in HC emission while the decrease in CO emission is marginal. However, there is an increase in the emission of NOx. Reduction in smoke emission is observed for B25 at all loads, particularly there is a marked decrease of 5.4% at full load when compared to diesel. It was observed that the combustion characteristics of the blends of methyl ester of cotton seed oil with diesel followed closely with that of the base line diesel.

4. M.Harinathareddy, Dr P.Nageswara Reddy. (2013) "EXPERIMENTAL INVESTIGATION OF COMPRESSED IGNITION ENGINE USING COTTON SEED OIL METHYL ESTER AS ALTERNATIVE FUEL''At constant speed of 1500 rpm it is observed that brake thermal efficiency with use of CSO methyl ester is slightly greater in comparison with Jatropha biodiesel and petroleum diesel. It is also observed that indicated thermal efficiency with use of CSO methyl ester is considerably greater (i.e. 20.70%) in comparison with Jatropha biodiesel and petroleum diesel.

5. K.Velmurugan, S.Gowthamn.(2012) "EFFECT OF CETANE IMPROVER ADDITIVES ON EMISSIONS'' NOx is very undesirable. Regulations to reduce NOx emissions continue to become more and more stringent year by year. Released NOx reacts in the atmosphere to form ozone and is one of the major causes of photochemical smog. NOx is created mostly from nitrogen in the air. Nitrogen can also be found in fuel blends. At high temperature and pressure higher levels of NOx is created and at low temperature lower level of NOx is produced. In addition to temperature, the formation of NOx depends on pressure and air-fuel ratio. Engine emission from diesel fuel, paying special attention to the most concerning emissions. Many of the design changes for reduction in NOx emissions result in higher brake specific fuel consumption. Cetane number describes the auto ignition quality of the diesel fuel. Cetane improver additive of neopentane is used with the varying proportions of 1ml,3ml,5ml to the diesel fuel respectively. Addition of cetane improver additive to the diesel fuel is cost effective way to control NOx emission. Diesel fuel with the 3ml additive of neopentane shows the significant reduction in NOx and smoke .The sensitivity of NOx to change in cetane number is higher at low load than at high load.It is found that NOx emissions were reduced at low load than at high load.

6. Chandan Kumar, Ashish Nayyar. (2012) "ANALYSIS OF EMISSION CHARACTERISTIC OF NM-DIESEL BLEND ON VCR DIESEL ENGINE" Emission contents smoke and NOx can be reduced by adding additives with diesel fuel. As these additives are very costly and hence becomes unviable. These additives decrease the performance of combustion. Oxygenated compounds are most widely used among additives. The reason for this is the participation of their

oxygen in reactions leading to better combustion and hence lowering the emission contents the molecular structure of the oxygen contents of additives directly influence on smoke reduction and the oxygen concentration of the fuel flame also effects the emission specially Nitro paraffin compound additives have high oxygen contents is then molecular structure.

Only NOx has been reduced by lowering the compression ratio, otherwise CO, HC and smoke has been increased due to reduced compression ratio. Thus it is concluded that lowering the compression ratio from normal (i.e. 17.5) to 16.5 is not in favour for emission of C.I. Engine with NM-Diesel blend.

7. M. Martin, D. Prithviraja (2011) "PERFORMANCE OF PRE-HEATED COTTONSEED OIL AND DIESEL FUEL BLENDS IN a COMPRESSION IGNITION ENGINE'' A remarkable improvement in the performance of the engine is noticed as the viscosity of the oil is reduced. Brake thermal and volumetric efficiencies of the engine increased with a significant reduction in the exhaust gas temperature. Reductions in smoke, CO and HC emissions are also noticed. Results show that a blend containing 60% of cottonseed oil with diesel, which is heated to a temperature of 70°C, can be used as an alternate fuel without any engine modification.

8. Raghuvaran S (2015) "PERFORMANCE AND EMISSION ANALYSIS OF DIESEL ENGINE (DI) USING COTTON SEED OIL METHYL ESTER''

The results showed that the Brake Thermal Efficiency and Brake Power obtained by using Biodiesel were higher than that used from conventional diesel by 6 % and 3% at 60% and at full load conditions respectively. Also, the total fuel consumptions per load of biodiesel were lower than conventional diesel. The unburned hydrocarbons are reduced by 9%. And Carbon di oxides are reduced by 15% . However, the NOX is increased by 13% by emission standards. Overall, when we look at the emissions of Biodiesel, it is very lower than diesel. The only hindrance is that the NO_x is high by a small amount for the market expansion.

Advantages of biodiesel

Biodiesel is Environmentally Friendly.

Biodiesel has Economic Advantages.

No Engine Modifications Necessary.

Biodiesel can be made at Home.

Biodiesel can be made from Waste Products.

Biodiesel by products.

Biodiesel prolongs Engine Life.

Disadvantages of biodiesel

Biodiesel Gels in Cold Weather.

Biodiesel Grows Mold.

Biodiesel Fuel versus Food.

Biodiesel has Higher NOx Emissions.

Biodiesel decreases Horsepower.

3. EXPERIMENTAL SET UP

For test engine, windows based engine performance analysis software package "engine-soft" was taken for on line performance evaluation. The emissions of various gases were measured by fuel efficiency monitor. The tests were conducted at the rated speed of 1500 rpm at different break power. The engine was started with diesel fuel and warmed up. The warm up period ends when cooling water temperature is stabilized. Then fuel consumption, brake power, brake specific fuel consumption, brake thermal efficiency, exhaust gas temperature etc. were measured.

Fig 3.1 Photographic View of Experimental set up

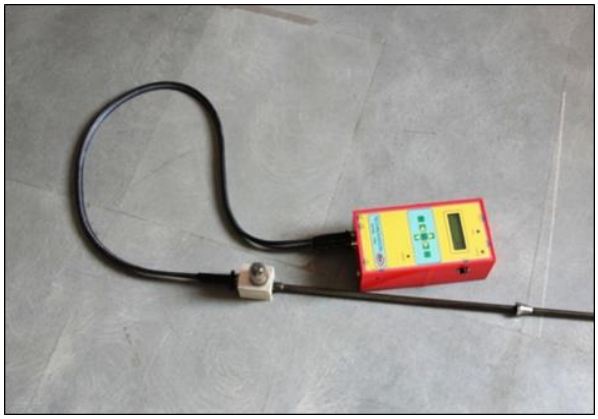

Fig. 3.2 Photographic View of Emission analyzer

TABLE 3.1 SPECIFICATION OF ENGINE.

Particulars	Specifications
Product	VCR Engine test setup 1 cylinder, 4 stroke, Diesel (Computerized)
Engine	Make Kirloskar, Type 1 cylinder, 4 stroke Diesel, water cooled, power 3.5 kW at 1500 rpm, stroke 110 mm, bore 87.5 mm. 661 cc, CR 17.5, Modified to VCR engine CR range 12 to 18
Dynamometer	Type eddy current, water cooled, with loading unit
Propeller Shafts	With universal joints
Fuel Tank	Capacity 15 lit with glass fuel metering column
Calorimeter & Pump	Pipe in pipe, Mono-block Pump
Crank angle	Resolution 1 Deg, Speed 5500 RPM
sensor	with TDC pulse
Temperature sensor	Type RTD, PT100 and Thermocouple, Type K
Load indicator	Digital, Range 0-50 Kg, Supply 230VAC
Load Sensor	Load cell, type strain gauge, range 0-50 Kg
Rota meter	Engine cooling 40-400 LPH; Calorimeter 25-250 LPH
Overall Dimensions	W 2000 x D 2500 x H 1500 mm

OBSERVATION TABLES

In all these paper followings readings tables are plotted,

-Readings for BSFC at various Brake power

-Readings for BTH Effn at various BP

-Readings for CO emission at various BP

-Readings for HC emission at various BP

-Readings for NOx emission at various BP

-Readings for Smoke Density at various BP

RESULTS

In all these paper followings results are made based on the basis of following graphs,

-Variation of BSFC with BP

-Variation of Thermal Efficiency with BP.

-Variation of CO emission with BP.

-Variation of HC emission with BP.

-Variation of NOx emission with BP

-Variation of smoke density with BP

4. CONCLUSION

Cotton seed oil is renewable, clean burning fuel. Cotton seed oil blends can show performance characteristics close to diesel (Brake power, mechanical efficiency, and brake specific fuel consumption) hence can be used in compression ignition engine to reduce use of diesel. Also some of the blends show better performance than that of diesel (friction power).

Although calorific value of Cotton seed oil is lower than that of diesel, but by using some additives it may be improved. Emission of blended fuel more (CO, NO) but it can be reduced by supercharging, exhaust gas recirculation & catalytic converter. It is observed that the exhaust emission reduced by Cotton seed oil (NO_2).

Therefore cotton seed oil blended diesel can be used in existing CI engines at least in rural area for meeting energy requirement. If Cotton seed oil production is done in mass basis, the use of diesel may be reduced significantly.

Future Work / Project stage 2 proposed works.

To carry the test computerized 4 stroke single cylinder kirlosker make CI engine & fuel efficiency monitor for emission analysis will be use.

In next stage of project practically investigate & compare the performance & emission of 4 stroke single cylinder diesel engine using diesel & diesel-cotton seed biodiesel blends with additives. In diesel, blends will be 10%, 20%, 30%, 40%, 50%, 60%, of cotton seed biodiesel with each 10 ml of Nitromethane and Nitroethane in each blend by volume basis . Nitromethane (NM) and Nitroethane (NE) can use as nitrogenated additives to improve brake specific fuel consumption (BSFC), combustion performance and reduce emission from diesel engine. Exhaust emission of compression ignition (CI) engine will evaluate experimentally for sole diesel and NM/NE-Diesel-cotton seed biodiesel fuel blends. The addition of nitrogenated additives to the standard diesel fuel caused brake thermal efficiency (BTE) will increase. Emission of NOx and smoke will decrease at the maximum torque speed (1500 rpm).

Exhaust gases of an engine can have up to 2000 ppm of oxides of nitrogen. Most of this will be nitrogen oxide(NO), with a small amount of nitrogen dioxide(NO2).NOx is very undesirable. Released NOx reacts in the atmosphere to form ozone and is one of the major causes of photochemical smog. NOx is created mostly from nitrogen in the air. At high temperature and pressure higher levels of NOx is created and at low temperature lower level of NOx is produced. In addition to temperature, the formation of NOx depends on pressure and air-fuel ratio.

Performance evaluation contains evaluation of brake power, friction power, brake specific fuel consumption, brake thermal efficiecy. Emission analysis contain analysis of co%, no (ppm), no_2 (ppm), exhaust gas temp (^0c).

If Cotton seed Biodiesel production is done in mass basis, the use of diesel may be reduced significantly .Also cost of cotton seed biodiesel and pure diesel will reduces. In coming year's cotton seed biodiesel blended diesel fuel station can be installed, to complete the search of alternative fuel and attaining the goal of GREEN EARTH.

REFERENCES

[1] MojtabaSaeiMoghaddam,Mohammad MataeiMoghaddam, SinaAghili, Ali Absala and Ali Najafi , " Performance and Exhaust Emission Characteristics of a CI Engine Fueled with Diesel-Nitrogenated Additives" ,International Journal of Chemical Engineering and Applications, Vol. 3, No. 5, October 2012.

[2] A.Rama Krishna , B.Prabakaran, Department of automobile engineering, Hindustan university, Chennai, India,"Performance And Emission Characteristics Of Cottonseed Oil Methyl Ester In A Disel Engine" International Journal Of Engineering Sciences & Research Technology,2015.

[3] Vijayaraj, K. And A.P. Sathiyagnanam, " Experimental Investigation Of Methyl Ester OfCotton Seed Oil Blend With Diesel On Ci Engine" , American Journal Of Applied Sciences 11 (10): 1819-1829, 2014 Issn: 1546-9239.

[4] m.Harinathareddy, 2dr P.Nageswara Reddy, 3dr.K.Vijayakumar Reddy ,"Experimental Investigation Of Compressed Ignition Engine Using Cotton Seed Oil Methyl Ester As Alternative Fuel" ,Research Inventy: International Journal Of Engineering And Science Isbn: 2319-6483, Issn: 2278-4721, Vol. 2, Issue 1 (January 2013), Pp 06-10.

[5] K. Velmurugan1, S. Gowthamn2 "Effect Of CETANE Improver Additives On Emissions International", Journal Of Modern Engineering Research (IJMER) Www.Ijmer.Com Vol.2, Issue.5, Sep-Oct. 2012 Pp-3372-3375 ISSN: 2249-6645.

[6] Chandan Kumar1, Ashish Nayyar2, Manish Bafna3, Ankit Agarwal4, Ved Parkash5, "Analysis Of Emission Characteristic OfNm-Diesel Blend On Vcr Diesel Engine" ,International Journal Of Recent Advances In Mechanical Engineering (IJMECH) Vol.4, No.1, February 2015.

[7] M. Martin,A.D. Prithviraja, "Performance Of Pre-Heated Cottonseed Oil And Diesel Fuel Blends In A Compression Ignition Engine",Jordan Journal OfMechanical And Industrial Engineering,Volume 5, Number 3, June 2011.

[8] Raghuvaran S,SaralaR2 , "Performance And Emission Analysis Of Diesel Engine Using Cotton Seed Oil Methyl Ester", International Journal Of Core Engineering &Management (IJCEM) Volume 1, Issue 12, March 2015.