

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

Experimental Investigation of Cotton Seed Bio Diesel for Various Compression Ratios on Single Cylinder Diesel Engine

K B S V D Prasad¹, R Sam Sukumar², T.Venkata Srinivasa Rao³

Assistant Professor, Department of Mechanical Engineering, Dhanekula Institute of Engineering and Technology, Ganguru, Krishna District, Andhra Pradesh, India.¹

Associate Professor, Department of Mechanical Engineering, Swarnandhra College of Engineering and Technology, Narasapur, West Godavari District, Andhra Pradesh, India.²

Assistant Professor, Department of Mechanical Engineering, Andhra Loyola Institute of Engineering and Technology, Vijayawada, Krishna District, Andhra Pradesh, India.³

ABSTRACT: Diesel is the major source for transportation and power generation but burning of diesel causes production of dangerous emissions which results to causes of air pollution and also diesel becoming abundant. So there is greater demand for an alternative to diesel. The vegetable oils are rich in hydro carbons. So the researches are found several bio diesels. But straight bio diesels are not used for investigation due to high viscosity low volatility. In the present work neat cotton seed oil is converted into their respective methyl ester of cotton seed by transesterification process. Experimental investigation was carried out to compare performance and emission analysis for several blends such as (CBD20, CBD40, CBD60, CBD80 and CBD100) with diesel on single cylinder four stroke variable compression ratios diesel engine. Study is conducted at different compression ratios (CR15, CR16.5, and CR18) and loads (for 25% load interval). The performance and emission results are compared with baseline test results. For standard compression ratio at full load of the engine cotton biodiesel with 20% blend (CBD20) shows optimum results. The emissions of CO₂, CO were reduced gradually.

KEYWORDS: Biodiesel, Methyl Ester of Cotton Seed Oil, Performance, Emission, Combustion.

I. INTRODUCTION

Diesel fuel has an essential function in the industrial economy of a developing country and used for transport of industrial and agricultural goods and operation of diesel tractors and pump sets in agricultural sector. Because of the reduction of petroleum of reserves and air pollution emerged from exhaust emissions like CO₂, CO, NO_x and Total Hydro Carbon, there have been great efforts to use alternative fuels in diesel engines for substitution diesel fuel. As far as India is concerned because of its vast agro forestry base, fuels of bio origin can be considered to be ideal alternative renewable fuels to run the internal combustion engines. Vegetable oils like soybean oil, castor oil, rapeseed oil and Jatropha curcas oil from plants like both edible, non-edible and methyl esters (Biodiesel) are used as an alternate source for diesel fuel. Biodiesel was found to be the best alternate fuel, technically, environmentally acceptable, economically competitive and easily available. Biodiesel is the latest alternate fuel which is used in countries like India, for the purpose of pollution free and renewable, nontoxic, biodegradable and environment friendly fuel which can be obtained from vegetable oils and animal fats. It can be used in all types of compression ignition engines directly or in the blended form. The engine run by biodiesel exhibits the reduced amount of pollutant gasses such as soot, THC, CO₂,

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

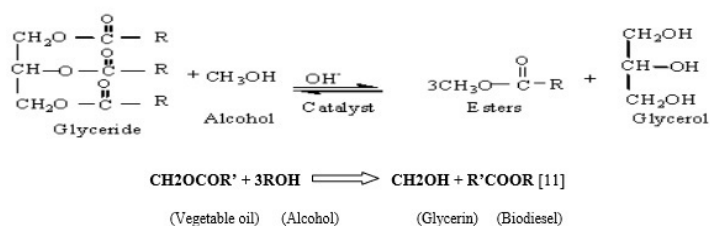
Vol. 6, Issue 10, October 2017

CO, particulate matter (PM), oxides of sulfur (SO_x), carcinogenic polycyclic hydrocarbons, and polycyclic aromatic hydrocarbons (PAH). Biodiesel is an oxygenated fuel, so its combustion is better than that of mineral diesel resulting in lower harmful pollutant emissions.

According to the research experimental investigations of methyl ester of cotton seed oil reported that there will be higher break thermal efficiency and lower break specific fuel consumption for B25, compared to other diesel blends[1]. The cotton seed biodiesel has better lubrication nature compared with mineral diesel, which ultimately helps to enhance the life time of the CI engine without any modification [2,3]. The review on bio diesel which extracted from different types of vegetable oils, and concluded that bio diesel combustion in CI engines gives maximum values of brake power and break thermal efficiency as well as minimum values of specific fuel consumption [4,5].

II. TRANSESTERIFICATION

To obtain biodiesel, the vegetable oil or animal fat is subjected to a chemical reaction termed as transesterification. In this reaction, the vegetable oil or animal fat is reacted in the presence of a catalyst (usually a base like KOH) with an alcohol (usually methanol CH₃OH) to give the corresponding alkyl esters (or for methanol, the methyl esters) of the FA (fatty acid) mixture that is found in the parent vegetable oil or animal fat, which depicts the transesterification reaction. The reaction mix is kept just above the boiling point of the alcohol (around 70 °C, 158 °F) to speed up the reaction though some systems recommend the reaction take place anywhere from room temperature to 55 °C (131 °F) for safety reasons. Recommended reaction time varies from 1 to 8 hours; under normal conditions the reaction rate will double with every 10 °C increase in reaction temperature. Excess alcohol is normally used to ensure total conversion of the fat or oil to its esters. The glycerine phase is much denser than biodiesel phase and the two can be gravity separated with glycerine simply drawn off the bottom of the settling vessel. In some cases, a centrifuge is used to separate the two materials faster [6-10].



Now the Biodiesel is checked for its fuel properties like Viscosity, Density, Flash and Fire point, acid value, Cloud and Pour point. The viscosity was measured with Redwood viscometer (IS: 1448(P25)) at 40°C. Flash and Fire point were measured with Pensky Marten flash point apparatus (IS: 1448(P66)). The density was measured with Hydrometer (IS:1448(P16)). Acid value can be measured according to ASTM D974 by indicator titration method. Cloud and Pour points were found by using a test tube ,thermometer rapid cloud and pour point tester (IS: 1448(P10)).

S.No	Property	Units	Diesel	Cotton Seed
1	Calorific Value	KJ/Kg	42500	40800
2	Flash Point	⁰ C	54	98
3	Fire Point	⁰ C	65	134
4	Kinematic Viscosity	CST	4.3	8.62
5	Density	Kg/m ³	830	920

Table 1: Properties of Diesel and Cotton seed Oil.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

III. EXPERIMENTAL SETUP

The analysis is done on the Computerized Variable Compression ratio multi fuel direct injection water cooled engine. Initially the base line test was conducted its standard specifications (16.5 compression ratio). Then the experiment is conducted for with various fuel blends such as CBD20, CBD40, CBD60, CBD80 and CBD100 for each blend the experiment is repeated for different compression ratios (i.e. CR15, CR16.5 and CR18). The performance and emission results were compared with the baseline test results.

Engine specifications

Engine	: 4 stroke computerized variable compression ratio multi fuel direct injection water cooled engine
Make	: TECH-ED
Basic engine	: Kirloskar
Rated power	: 5 HP (DIESEL)
Rated power	: Up to 3 HP (PETROL)
Bore diameter	: 80mm
Stroke length	: 110mm
Connecting rod length	: 234mm
Swept volume	: 551cc
Compression ratio	: 5:1 to 20:1
Rated speed	: 1500 rpm

During the running of the engine the performance analysis is done with different blends at various loads and at a particular fuel injection pressure. The emission analysis is done by using Indus Six Gas Smoke Analyzer & Smoke Meter. The six gas analyzer gives the percentages of CO (carbon monoxide), NO_x (Nitrogen oxides), SO_x (sulphur oxides), O₂ (oxygen), CO₂ (carbon dioxide), HC (Hydro carbons) and the smoke meter gives amount of smoke coming from engine exhaust.

IV. RESULTS AND DISCUSSION

The experiment carried out by using diesel as the base line fuel. At particular base line test we have to change the compression ratios (CR14, CR16.5 and CR18). We have to analyse the different exhaust parameters per every compression ratio. And also calculate the Break Power (BP), Break Specific fuel consumption (BSFC) and Break thermal efficiency (BTE) for three compression ratios.

Break Power

From fig 1 it is observed that the break power varies linearly with load. At full load of the engine at Compression ratio 16.5 the engine produces maximum break power. At full load of the engine with various blends CBD20 shows high break power compared to baseline test results and with other biodiesel blends such as CBD40, CBD60, CBD80, and CBD100. At standard compression ratio i.e. 16.5 CBD20 shows 2% increase in break power compared to diesel results.

The experiment carried out by using diesel as the base line fuel. At particular base line test we have to change the compression ratios (CR14, CR16.5 and CR18). We have to analyse the different exhaust parameters per every compression ratio. And also calculate the Break Power (BP), Break Specific fuel consumption (BSFC) and Break thermal efficiency (BTE) for three compression ratios.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

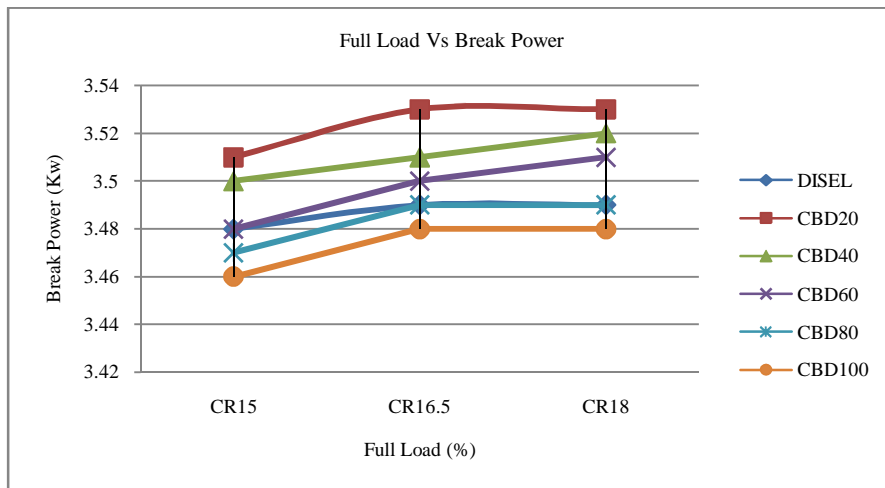


Fig. 1. Variation of BP with load at different CR

Break Thermal Efficiency

The trend break thermal efficiency shown in fig 2 indicate that BTE varies linearly with load. At full load of the engine at Compression ratio 16.5 the engine produces maximum BTE. At full load of the engine with various blends CBD20 shows high BTE compared to baseline test results and with other biodiesel blends such as CBD40, CBD60, CBD80, CBD100. At standard compression ratio i.e. 16.5 CBD20 shows increase in BTE compared to baseline results.

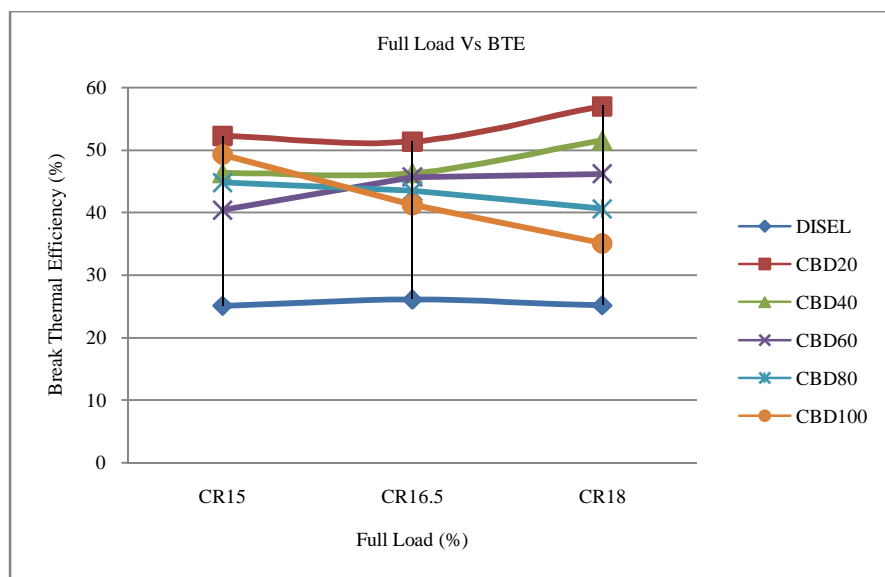


Fig. 2. BTE at full load for different CR

Break Specific Fuel Consumption

The trend BSFC shown in fig 3 indicate that BSFC varies linearly with load. At full load of the engine at Compression ratio 16.5 the engine shows minimum BSFC. At full load of the engine with various blends CBD20

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

shows low BSFC compared to baseline test results and with other biodiesel blends such as CBD40, CBD60, CBD80, CBD100. At standard compression ratio i.e. 16.5 CBD20 shows optimum results compared to baseline results.

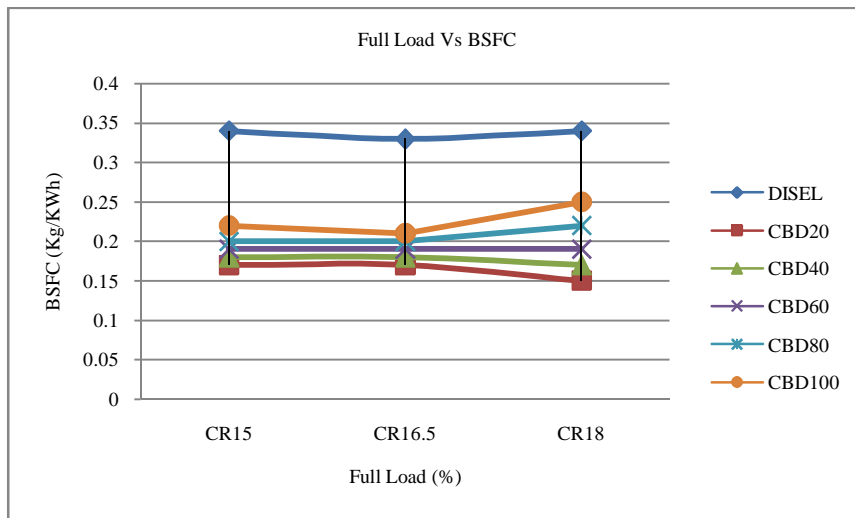


Fig. 3. BSFC full load for various CR

Carbon Monoxide (CO)

Carbon Monoxide is dangerous polluted gas which is part of exhaust emissions of the engine. It affects the nerves respiratory system. The amount of CO increases with the load as shown in the figure 4. Among all blends pure cotton seed biodiesel (CBD100) shows minimum CO emissions. CBD20 shows 7% decrease in CO compared to baseline.

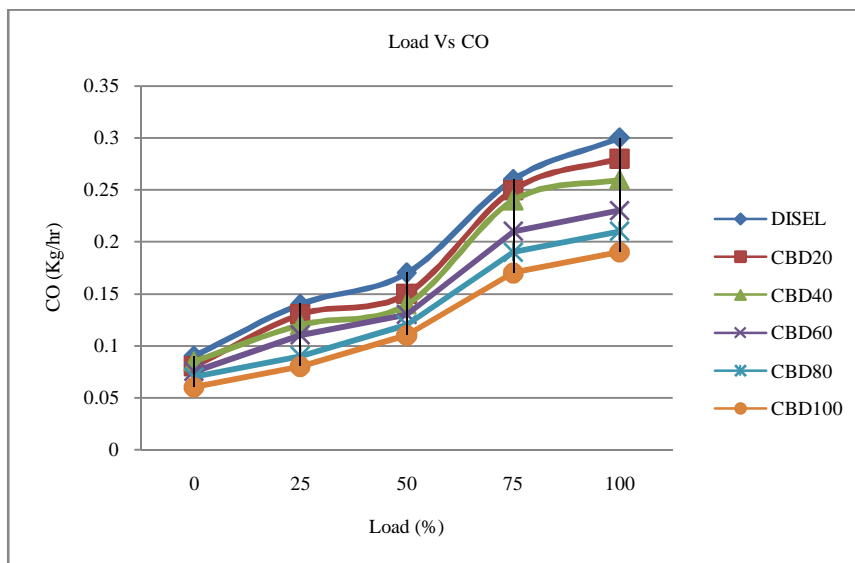


Fig. 4. CO for different blends

Oxides of Nitrogen

The oxides of nitrogen (NOX) emissions are precarious pollutant emissions, which are produced, when the fuel is burnt at high temperature causing dissociation of N₂, which ultimately leads to the formation of nitric acid. The NOX

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

is also responsible for weakening the ozone layer. Figure 5 shows that NOX is very low for lower loads and is increases with load. The NOX level increases with increasing percentage of cotton seed biodiesel in the blends of fuel. The rise of NOX is not very much appreciable up to CBD20. But it rises sharply for higher ratios of CBD.

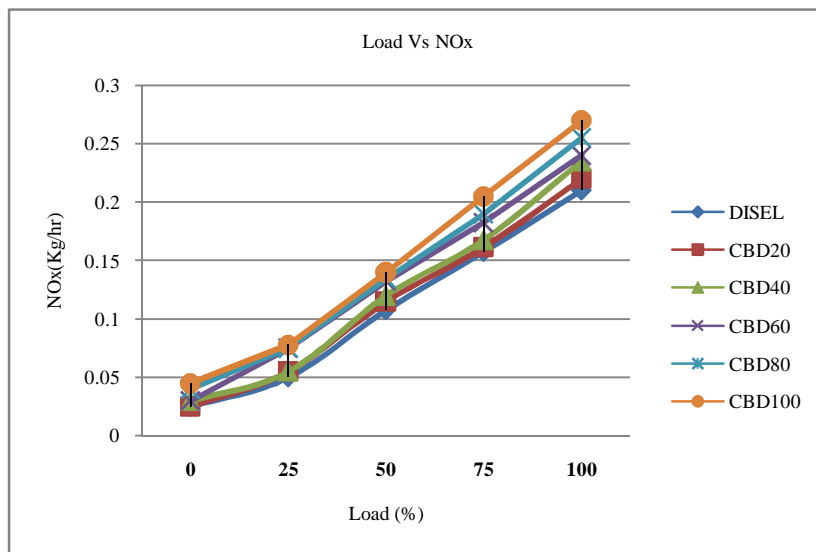


Fig. 5. NOx % for different blends

Carbon Dioxide

Carbon Dioxide major constituents in the exhaust emissions of the engine which causes global warming and green house effects. The amount of CO₂ increases with load as per the figure 6. Pure biodiesel shows lesser CO₂ compared to all blends. CBD20 shows lesser CO₂ emission compared to base line results.

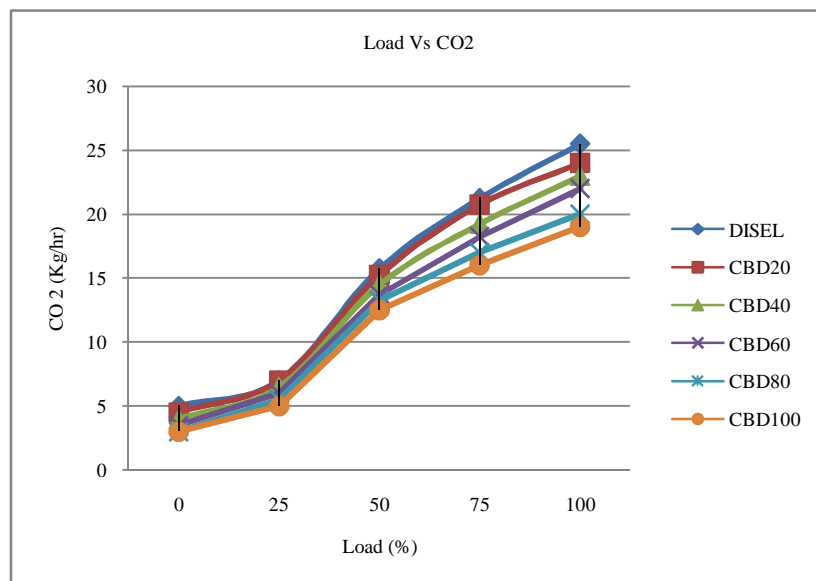


Fig. 6. CO₂% for different blends

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijirset.com

Vol. 6, Issue 10, October 2017

Engine Combustion

The figure 7 shows the variation of cylinder pressure with crank angle for diesel, cotton seed biodiesel and its blends at 1500 rpm and full load conditions. Peak pressure mainly depends upon the combustion rate in the initial stages. The combustion process of all test fuel is similar at consist of phase of premixed combustion followed by phase diffusion combustion. It is absorbed that for CBD20 high peak pressure recorded compare to other blends.

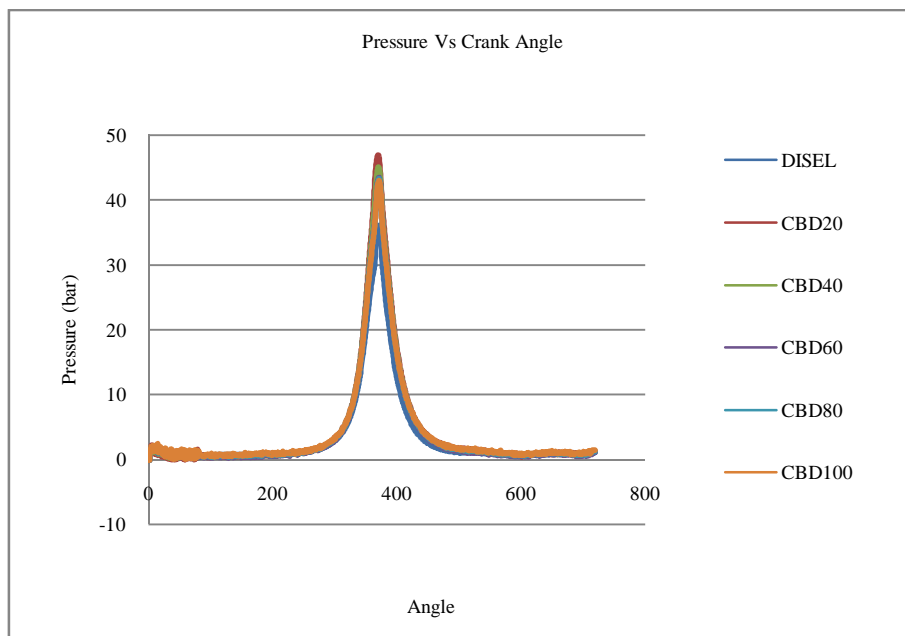


Fig. 7. Pressure Vs crank Angle diagram for various blends

Fuel saving and reduction of exhaust emissions are the key concern of the present study. As per the results higher break power, higher break thermal efficiency and lower break specific fuel consumption are observed for CBD20 than other blends. Exhaust emissions such as carbon monoxide and carbon dioxide were decreased due to more oxygen content and better atomization of the blended fuel. High NO_x emissions for absorbed due to oxygen rich concentration and lower cetane number of the biodiesel. Higher cylinder pressure was occurred for biodiesel blend due to combustion rate in the initial stages of premixed combustion, complete combustion of the air fuel mixture and due to amount of fuel accumulated in the delay period.

V. CONCLUSION

In the present investigation, the performance, emission and combustion characteristics of a direct injection, compression ignition engine fuelled with methyl ester of cotton seed oil and its blends have been analyzed and compared with diesel fuel. The biodiesel is produced from raw cotton seed oil by a method of transesterification. The tests for properties of biodiesel demonstrate that almost all the important properties of biodiesel are in close agreement with the diesel fuel. Thus the diesel engine can perform satisfactorily on biodiesel and its blends with diesel fuel without any engine modifications. The results of the present work are summarized as follows:

- (1) From the engine performance results high break power, high break thermal efficiency and low break s f c were observed at CBD20 and CR 16.5.
- (2) It is observed that CO, CO₂ and HC emissions were reduced for biodiesel blends.
- (3) The combustion starts earlier for biodiesel than the diesel peak cylinder pressure and the heat release rate shows optimum results closed to diesel.

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Visit: www.ijrset.com

Vol. 6, Issue 10, October 2017

(4) From the above conclusions without modifying the engine design cottonseed biodiesel CBD20 shows optimum results in comparison with baseline test results.

REFERENCES

- [1] Vijayaraj, K. and A.P. Sathiyagnanam, "Experimental Investigation of Methyl Ester of Cotton Seed Oil Blend With Diesel on CI Engine". American Journal of Applied Sciences 11 (10): 1819-1829, 2014 ISSN: 1546-9239 © 2014 Vijayaraj and Sathiyagnanam, This open access article is distributed under a Creative Commons Attribution (CC-BY) 3.0 license doi:10.3844/ajassp.2014.1819.1829 Published Online 11 (10) 2014 .
- [2] M.Harinathareddy, Dr P.Nageswara Reddy and Dr.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.
- [3] E. M. Shahid and Y. Jamal, "Performance Evaluation of a Diesel Engine Using Biodiesel", Pak. J. Engg. & Appl. Sci. Vol. 9, Jul., 2011 (p.68-75)
- [4] M.V.S. Murali Krishna, D. Srikanth, and P.Ushasri, "Experimental investigations of comparative performance and exhaust emissions of cottonseed biodiesel fuelled DI diesel engine with low grade LHR combustion chamber", International Journal of Application or Innovation in Engineering & Management (IJAEM) Web Site: www.ijaem.org Email: editor@ijaem.org Volume 03, Issue 09, September 2014, ISSN 2319 – 4847
- [5] K.Dilip Kumar and P.Ravindra Kumar, "Experimental Investigation of Cotton Seed Oil and Neem Methyl Esters as Biodiesel on CI Engine", International Journal of Modern Engineering Research (IJMER) ,Vol.2, Issue.4, July-Aug 2012 pp-1741-1746 , ISSN: 2249-6645
- [6] Miss. J.M.Phate and Prof. A.V.Kulkarni, "Experimental Investigation of the Suitability of Orange Peel Oil as a Blend with Cotton Seed Oil as Alternate Fuel for Diesel Engines": A Review, International Journal of Innovative Research in Science, Engineering and Technology An ISO 3297: 2007 Certified Organization, Volume 3, Special Issue 4, April 2014.
- [7] Dr V. Naga Prasad Naidu and Prof. V. Pandu Rangadu, "Experimental Investigations on a four stroke Diesel engine operated by Cotton seed biodiesel blended with Diesel", International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, Issue 10, April 2014 ISSN: 2277-3754.
- [8] Gopinath A, Sairam K and Velraj R, "Experimental Investigation on the Effect of Biodiesel derived from Cottonseed oil on Environmental Emissions and Performance of a Stationary DI Diesel Engine", International Journal of Scientific & Engineering Research, Volume 5, Issue 5, May-2014 ISSN 2229-5518.
- [9] Shyam Kumar Ranganathan, Anil Gandamwad and Mayur Bawankure, "Performance Evaluation of C.I. Engine with Cotton Seed Oil", International Journal of Instrumentation, Control and Automation (IJICA) ISSN: 2231-1890, Vol-1 Iss-3,4, 2012
- [10] Vaneet Bhardwaj, Varun Singla, Pradeep Gaikwad and Gomish Sharma, "Study of Performance Characteristics of Compression Ignition Engine Fuelled with Blends of Biodiesel from Used Cottonseed Oil", International Review of Applied Engineering Research. ISSN 2248-9967 Volume 4, Number 3 (2014), pp. 289-296.
- [11] R.Sam Sukumar, M. Muralidhar Rao and A Gopala Krishna, "Performance and Emission Analysis on C.I Engine with Palm Oil Biodiesel Blends at Different Fuel Injection Pressures". International Journal of Innovative Research in Science, Engineering and Technology (An ISO 3297: 2007 Certified Organization) Vol. 4, Issue 4, April 2015. ISSN(Online): 2319 - 8753 ISSN (Print) : 2347 - 6710
- [12] Bhojraj N. Kale 1, Dr.S.V.Prayagi2, "Performance Analysis of Cottonseed Oil Methyl Ester for Compression Ignition Engines", International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, Volume 2, Issue 8, August 2012)
- [13] A. Siva Kumara, D. Maheswarb and K. Vijaya Kumar Reddy, "Comparision of Diesel Engine Performance and Emissions from Neat and Transesterified Cotton Seed Oil", © 2009 Jordan Journal of Mechanical and Industrial Engineering. All rights reserved - Volume 3, Number 3 (ISSN 1995-6665)
- [14] Xiaohu Fan 1, Xi Wang, Feng Chen, Daniel P. Geller and Peter J. Wan, "Engine Performance Test of Cottonseed Oil Biodiesel", The Open Fuels & Energy Science Journal, 2008, 1, 40-45
- [15] Sergio C. Capareda, Jacob Powell and Calvin Parnell, "Engine Performance And Exhaust Emissions Of Cottonseed Oil Biodiesel", Beltwide Cotton Conferences, Nashville, Tennessee, January 8-11, 2008
- [16] Amol. Patil, H M Dange and Vishal Patil, "Study of Cottonseed Oil and Maize Oil Biodiesel as a Fuel for C I Engine", IJSR - International Journal of Scientific Research, Volume : 3 | Issue : 9 | September 2014 • ISSN No 2277 – 8179

BIOGRAPHY

K.B.S.V.D.Prasad¹ is currently working as Assistant Professor in Dhanekula Institute of Engineering and Technology, Ganguru,Vijayawada-521139, Krishna District, Andhra Pradesh, India. He received his master's degree on Thermal Engineering under JNTUK, Kakinada, India.

R Sam Sukumar² is currently working as Associate Professor in Swarnadhra college of Engineering and Technology, Narasapur, West Godavari District, Andhra Pradesh, India. He received his master's degree on Heat Power-R&AC-JNTU Ananthapur, Doing Ph.D in JNTUK, Kakinada, India.

T.Venkata Srinivasa Rao³ is currently working as Assistant professor in Andhra Loyola Institute of Engineering and Technology, Vijayawada-520008, Krishna district, Andhra Pradesh, India. He received his master's degree on Thermal Engineering under JNTUK, Kakinada , India.