PERFORMANCE AND SMOKE TEST ON CI ENGINE USING COTTON SEED OIL AS FUEL

Raj.H. Korawar[1], S.C. Kamate[2], S.N. Toppannavar[3], B.M.Dodamani[4]

[1]Student of Thermal Engineering, Hirasugar Institute of Technology, Nidasoshi, Belagavi, India
[2]Principal, Hirasugar Institute of Technology, Nidasoshi, Belagavi, India
[3]Associate professor, Hirasugar Institute of Technology, Nidasoshi, Belagavi, India
[4]Assistant professor, Hirasugar Institute of Technology,Nidasoshi, Belagavi, India

Abstract These conventional sources of energy are depleting in nature and may be exhausted near the middle end of this century. The diminishing and continuous increasing cost of petroleum resources associated with their alarming pollution levels from diesel engines has caused an interest in finding renewable, alternative and suitable fuels to diesels fuels of bio origin can give a feasible solution for this problem. Diesel engine being life line of the society operation can be made to run on bio fuels.In this project bio diesel is produced by using cotton seeds. Free fatty acid content & viscosity of the oil is reduced by the chemical reaction called esterification and transesterification process. Characteristics of the bio diesels such as calorific value, viscosity, flash & fire point are determined by using the apparatus available in the laboratory.The performance, smoke test and the combustion characteristics of the various blends proportion of the bio diesel with diesel are obtained from the experiment conducted on the computerized VCR engine with data acquisition system.

Index terms: **Cotton seed oil, Bio-fuel, Engine Performance, Emission**

I. INTRODUCTION

Introduction Due to the Rapid urbanization and development in automobile industries the consumption of fossil fuels has increased in a higher rate in the past few years and has developed the problems of fossil fuel degradation or decrease of natural fossil fuels and has caused huge scarcity of petroleum and increase its economic value.The objective of producing biofuel is to reduce the consumption of non-renewable resources due to heavy usage of non-renewable resources like fossil fuel, petroleum, coal, the energy is depleting due to Rapid urbanization of industries and advancing automobile and industries. The energy consumption has raised causing the scarcity of energy. To resolve the issue and to produce energy with the same efficiency Alternative resources are made such as; wave energy biofuels, geothermal power,natural gas, biomass energy,wind energy, hydrogen gas energy,tidal energy these are the top most replacements non-renewable. Biodiesel The concept of using vegetable oil as a transportation fuel in 1893 when Dr. Rudolf Diesel developed the first diesel engine to run on vegetable oil. later the engines and oil where modified according to requirements. The engine was a great success and till today these engines are used prominently in automobiles and heavy machinery. Biodiesel are produced by using cotton seeds through a process called transesterification and esterification using c a l c i n e d eggshell as catalyst[1] (refer...Suprabhat seal et al 2015) consisting of a molar ratio of 6:1 and 1% of catalyst concentration yield 93% of biodiesel.[2] Transesterification is the process which ids carried out to separate the fatty acids from gyyserol backbone to fatty acid esters (FAE) and free glycerol [Meher, et al., 2006; Morrison and Boyd, 2005; Abhullah, etal., 2007] Biodiesel can reduce the emissions of carbon monoxide, sulphur dioxide, particulate matter, with slightly increased levels of nitrogen oxides (refer....David M Fernandes and Daleylli S Sequeiria 2012) The Biodiesel can sustain a temperature of 44°c and a low temperature at 4°c . Biodiesel gives similar power output comparing to diesel and with the same efficiency generates remarkable energy (refer.... PankajS.Shelkeetall 2016) in 1930 and 1940 vegetable oil were used as diesel fuel but usually on emergency situation in 1940 the vegetable oil methyl and ethyl esters where used. Diesel engines in Belgium where using ethly oil as fuel for local vehicles it was mixed to the proportion of 5% of regular diesel oil and proportion of 29% into diesel fuel used by some fleet's engine running on biodiesel have similar mileage to engines running on other fuels like petroleum engines. The fuel consumption power rate and torque are unaffected by use of biodiesel. It also reduces health hazard issue & biodiesel is less toxic than petroleum diesel reduces. ingredients that cause health problems such as asthma and lung cancer it produces 80% less of carbons than other fuels even mixed or blended with petroleum diesel biodiesel significantly reduces the harmful effect on humans and the environment (refer.vedkumar). The engine can run on the fuel extracted from the cottonseed Methyl Ester without any major losses of power.The use of cotton seeds methyl Ester (CSOME) caused the thermal efficiency rate to decrease by 0.7 % the energy consumption of the brake specific energy was increased by rate of 0.01%. (**Anirudh Gautam** et all). due to the resemblance of their different chemical properties the cotton seed oil i.e. diesel was declared as a versatile alternative fuel. **Allen Jeffrey 2017** *et all.* There were increase in BTE of CSOME blends B10 and B20 and BTE of B30 is nearly equal to diesel fuel. BSEC gives better values than diesel fuel and B30 having low BSFC than B10 and B20. CO and HC emissions are less compared with standard diesel fuel.**A.Rama Krishna2015 et all.**with few loads with an increase of percentage of COME in the blends. There was a suitable in increase in COME percentage in the blends the emission of CO was observed to be low for all testing fuels considerable e increase was observed and noted after 60% of the load was reduced in CO emission for higher blends. refer [5]. problems worldwide alternative energy source was created which can reduce the dependency of fossil fuels and is less pollutants& it is renewable

II. PROPERTIES OF FUEL

The properties of cotton seeds biodiesel and diesel were determined and given in the table.

Table 1 Properties of biodiesel and diesel

Sl. No	Properties	Diesel	Biodiesel	B20	B40	B60
1	**Density(ing/m^3)**	830	880	840	850	860
2	**Viscosity**	4.2	4.1	4.18	4.16	4.14
3	**Flash point (in ˚c)**	60	207	90	120	148
4	**Fire point (in ˚c)**	65	230	98	131	164
5	**Calorificvalue (in KJ/kg)**	43000	39650	42330	41660	40990

Figure 1. Crude oil of cotton seeds

Figure 2. Trans esterified biodiesel

III. EXPERIMENTAL SET UP

ENGINE SET-UP

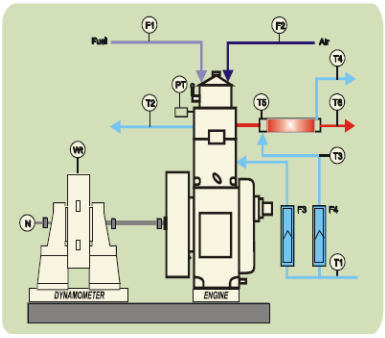


Fig 3. Schematic Diagram of set-up

Fig 4. Engine set-up

T1 & T2 – Temperature sensor for water inlet & outlet of Engine (°c),T3 & T4 – Temperature sensor for water inlet & outlet of Calorimeter (°c),T5 & T6 – Temperature sensor for Exhaust Gas inlet & outlet of Calorimeter (°c),P1 – Pressure sensor to sense the Fuel injection pressure (Bar), P2 – Pressure sensor to sense the Air inlet to the Engine (Bar), PT - Pressure sensor to sense the cylinder pressure (Bar), F3 – Rotameter for Engine to measure the water (lph),F4 - Rotameter for Calorimeter to measure the water (lph),Wt. – Load sensor to sense the loading of Engine, N – Tachometer to sense the RPM

About EngineICEngine set up under test is Kirloskar TV1 having power 5.20 kW @ 1500 rpm which is 1 Cylinder, four stroke, Constant Speed, Water Cooled, Diesel Engine, with Cylinder Bore 87.50(mm), Stroke Length 110.00(mm), Connecting Rod length 234.00(mm), Compression Ratio 17.50, Swept volume 661.45 (cc)

- **Procedure:**Tighten the nut and bolts of the engine, dynamotor, propeller shaft, and to the base frame of the engine properly.Fill the lubricant oil in the engine sump tank and check for marking with the help of Level stick.Make sure that enough fuel (biodiesel-diesel blend) is filled inside the tank remove if excess air is filled in the air pipe line. supply an electrical current and make sure that PPU [piezo power unit] DLU [dynamically loading unit] load indicator and voltmeter are ON.Open “engine soft V” on your computer select the option “engine model” then go to the option “open” and “press” on “configuration” to check the configuration values and the constants from the system the values will be displayed on the engines setup panel press “apply” If any changes required.Start the pump in which water is flowing adjust the rate of flow through Rotameter (engine) for about 250-350 lite per hour and the “Rotameter[calorimeter] to 75-180 litre per. By creating variation in the Globes walls provided on the Rotameter inlet make sure that water is flowing through the dynamometer at a pressure of 0.5-1kg/cm2.The DLU knob should be kept at its least moving position (minimum position) To change the fuel cock position from “measuring” to “tank”.To start the process first start the engine and let it run liberally for about 2-5 minutes.Select the option “measurement on” on the monitor screen.Make sure that speed, temperatures and manometer reading are perfectly displayed on your PC screen the reading should be similar and tallied with the readings on display of the engine panel. By rotating the DLU knob the load increases and confirm through readings and indicators and on the computer monitor screens.Adjusting the DLU knob set it at 2Kg on indicator wait for about 3 minutes make sure that the load is constant during the cycle, changing the fuel cock position from “tank” to “measuring” click on the option “log on” the fuel metering is ON for the next 60 second during the first 30 seconds of the cycle enter engine water flow, calorimeter jacket cooling water flow in liter per hour (and compression ratio of VCR engine) then click on the option “OK” after recording the fuel readings after completion of the cycle is now saved enter the desired name for the record so that the readings can be stored the second cycle reading data is now saved check and change the fuel cock position from “measuring” to “tank” again follow the above steps for different loads and different timingsAfter the completion of the cycle remove the load of the engine by DLU you click “measurements stop” option on the Monitor screen. By pressing the stop liver on the engine, it will stop. immediately the flow of water will stop the activity of the engine becomes stationary let the water circulate inside the engine for about 5-6 minutes for the purpose of cooling and then stop the pump directly

Fig. 5 SMOKE METER

Smoke meter specification

- Measurement range :absoption 0-99.99 m-1.
- Opacity: 0-100%.
- Operating tempertaure :0˚C -50˚C.
- Weight :22kg.
- Power supply :AC190-240V,DC 11V-36V.

Printer :built in impact printer with provision for multiple printouts, computer interface RS232 serial interface to operate on PC for communicating data.

IV. Results &Discussion

4.1 Brake power

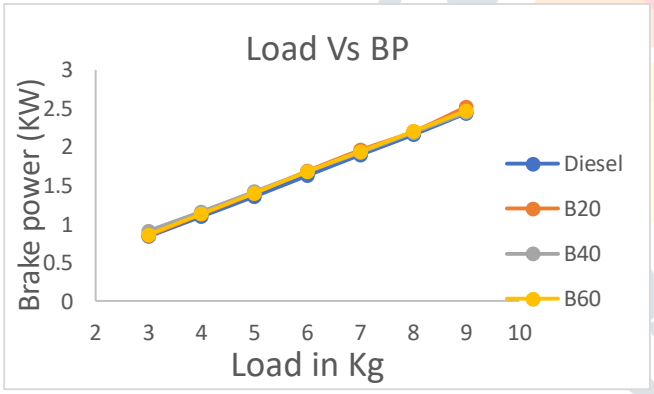
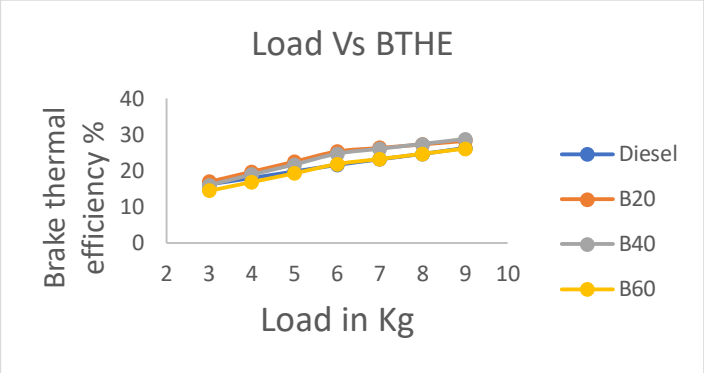


Fig 4.1: Comparison of Brake power

Load (kg)	BRAKE POWER (KW)			
Load (kg)	Diesel	B20	B40	B60
3	0.84	0.85	0.91	0.86
4	1.1	1.13	1.16	1.13
5	1.36	1.4	1.42	1.4
6	1.63	1.69	1.68	1.68
7	1.9	1.96	1.93	1.94
8	2.16	2.2	2.19	2.2
9	2.44	2.52	2.45	2.47

The deviation of all the blends the brake power obtained using both the diesel fuels and the bio diesel blends lies within the range of 0.01 to 0.08. B20 gives higher brake power at load of above 5 kg compare to B40 and B60 blends whereas at load below 5 kg, B40 gives higher efficiency compare to B20 & B60 blends over all B20 gives an optimized result giving a maximum output at full load of 9 kg.

4.2 Brake Thermal Efficiency

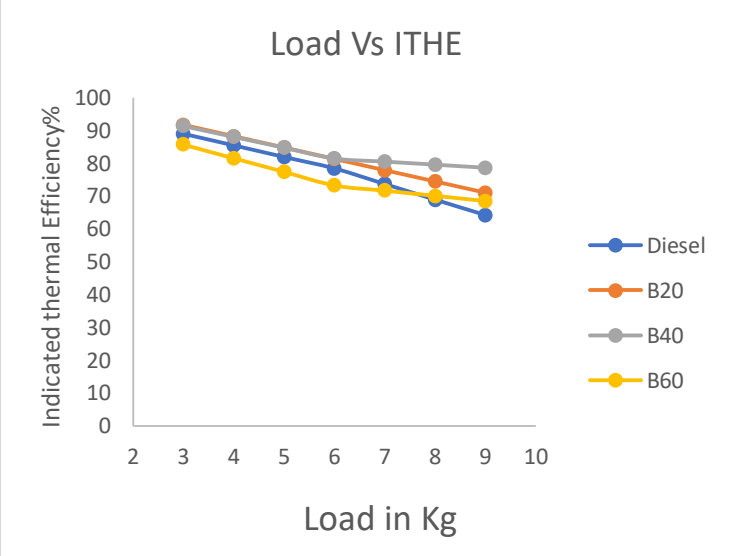


Load (kg)	BRAKE THERMAL EFFICIENCY %			
Load (kg)	Diesel	B20	B40	B60
3	16.1	16.9	15.99	14.49
4	17.9	19.72	18.87	16.89
5	19.72	22.54	21.67	19.29
6	21.53	25.37	24.65	21.81
7	23.1	26.35	26	23.22
8	24.6	27.33	27.35	24.63
9	26.26	28.31	28.7	26.06

Fig 4.2: Comparison of Brake Thermal Efficiency

From the graph it is observed that B20 blend gives higher brake thermal efficiency up to the load of 7 kg whereas B40 gives slightly higher efficiency at loads above 7kg. the diesel fuel gives lower value of brake thermal efficiency compares to B20 & B40 blends. Whereas B60 gives lower value of brake thermal efficiency compare to diesel fuel. Over all B20 gives optimized brake thermal efficiency compare to other blends.

4.3 Indicated Thermal Efficiency



Load (kg)	INDICATED THERMAL EFFICIENCY %			
Load (kg)	Diesel	B20	B40	B60
3	88.86	91.57	91.34	85.63
4	85.34	88.12	88.03	81.47
5	81.8	84.68	84.72	77.32
6	78.31	81.23	81.41	73.17
7	73.57	77.8	80.47	71.58
8	68.8	74.38	79.53	70
9	64.11	70.96	78.59	68.42

Fig 4.3: Comparison of Indicated Thermal Efficiency

From the graph it is found that bio diesel blends give higher value of indicated thermal efficiency compared to diesel. B20 & B40 gives almost same value of indicated thermal efficiency up to the load of 6kg and there after it is observed that B40 gives higher values of indicated thermal efficiency than other blends. Diesel fuel gives lower value of indicated thermal efficiency compare to the B20 & B40 & whereas B60 blends as gives lower value of indicated thermal efficiency compare to diesel up to load of 7 kg & higher at above 7 kg of load.

4.4 Specific Fuel Consumption

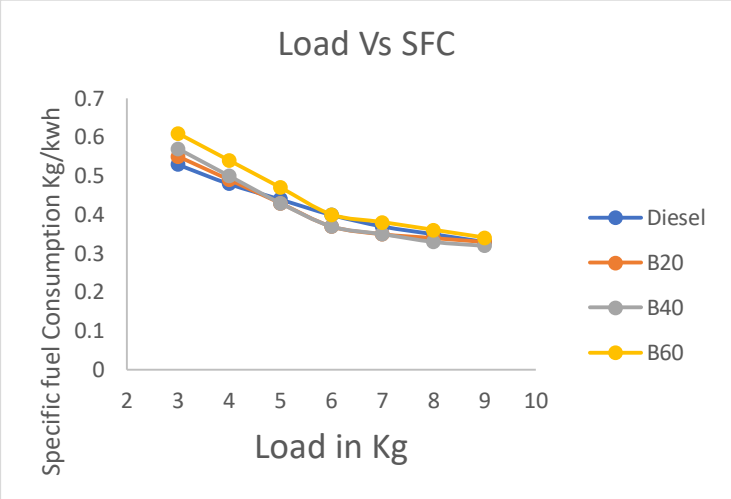


Fig 4.4 Comparison of load vs. specific fuel consumption

Load (kg)	SPECIFIC FUEL CONSUMPTION kg/kwh			
Load (kg)	Diesel	B20	B40	B60
3	0.53	0.55	0.57	0.61
4	0.48	0.49	0.5	0.54
5	0.44	0.43	0.43	0.47
6	0.4	0.37	0.37	0.4
7	0.37	0.35	0.35	0.38
8	0.35	0.34	0.33	0.36
9	0.33	0.33	0.32	0.34

Both B20 & B40 gives low specific fuel consumption values compare to B60 blend & diesel but B20 gives higher specific fuel consumption at loads above 8 kg whereas diesel gives higher specific fuel consumption compared to biodiesel blends. Over all B20 gives better results as regarding the specific fuel consumption compare to other fuels.

4.5 Volumetric Efficiency

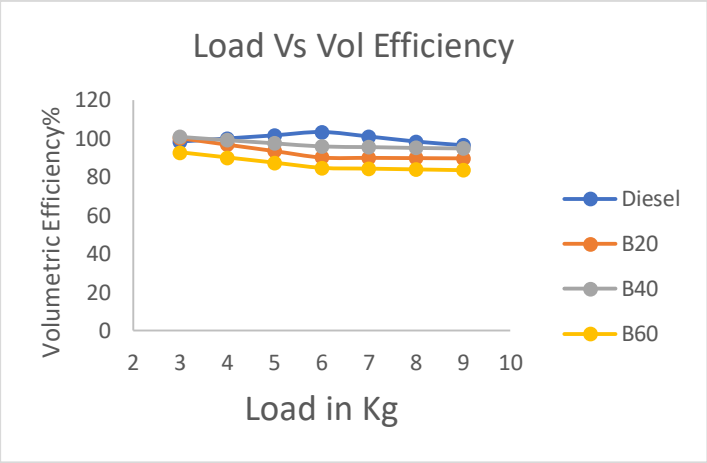


Fig 4.5 Comparison of Volumetric Efficiency

Load (kg)	Volumetric Efficiency %			
Load (kg)	Diesel	B20	B40	B60
3	98.28	100.21	100.82	92.67
4	99.9	96.8	99.1	90
5	101.5	93.47	97.5	87.33
6	103.2	90.1	95.87	84.66
7	100.9	89.94	95.55	84.25
8	98.3	89.8	95.1	83.85
9	96.41	89.66	94.85	83.44

It is observed that B40 gives higher values of volumetric efficiency compared to other blends were as diesel gives higher values of volumetric efficiency compared to all other blends. B60 gives lower value compare to all other fuels. & B20 have higher value compare to B60 & it gives lower value compare to diesel & B40.

4.6 Mechanical Efficiency

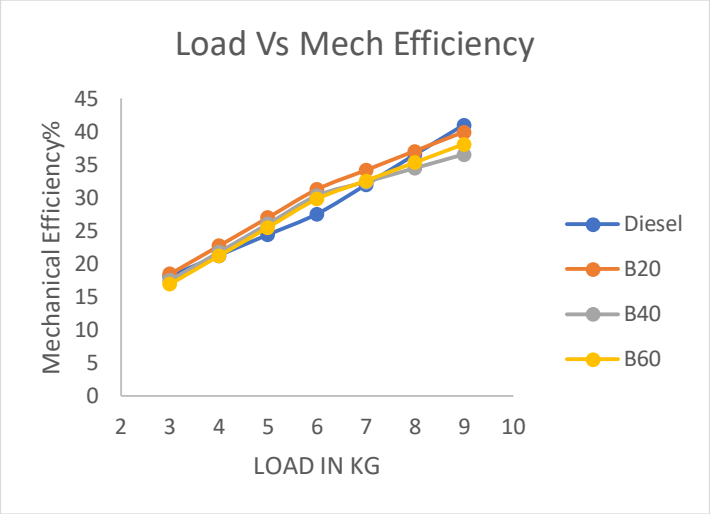


Fig 4.6: Comparison of Mechanical Efficiency

Load (kg)	Mechanical Efficiency %			
Load (kg)	Diesel	B20	B40	B60
3	18.11	18.45	17.5	16.92
4	21.23	22.7	21.76	21.21
5	24.36	26.97	26.02	25.5
6	27.49	31.23	30.28	29.8
7	31.9	34.13	32.36	32.56
8	36.47	37.03	34.44	35.32
9	40.96	39.9	36.52	38.09

It is observed that B20 gives higher value of mechanical efficiency compared to the other blends whereas diesel gives lower value of mechanical efficiency compared to bio diesel up to 7 kg of load. And there after the mechanical efficiency of diesel engine increases as compared to B40 & B60 blends.

4.7 Net Heat Release

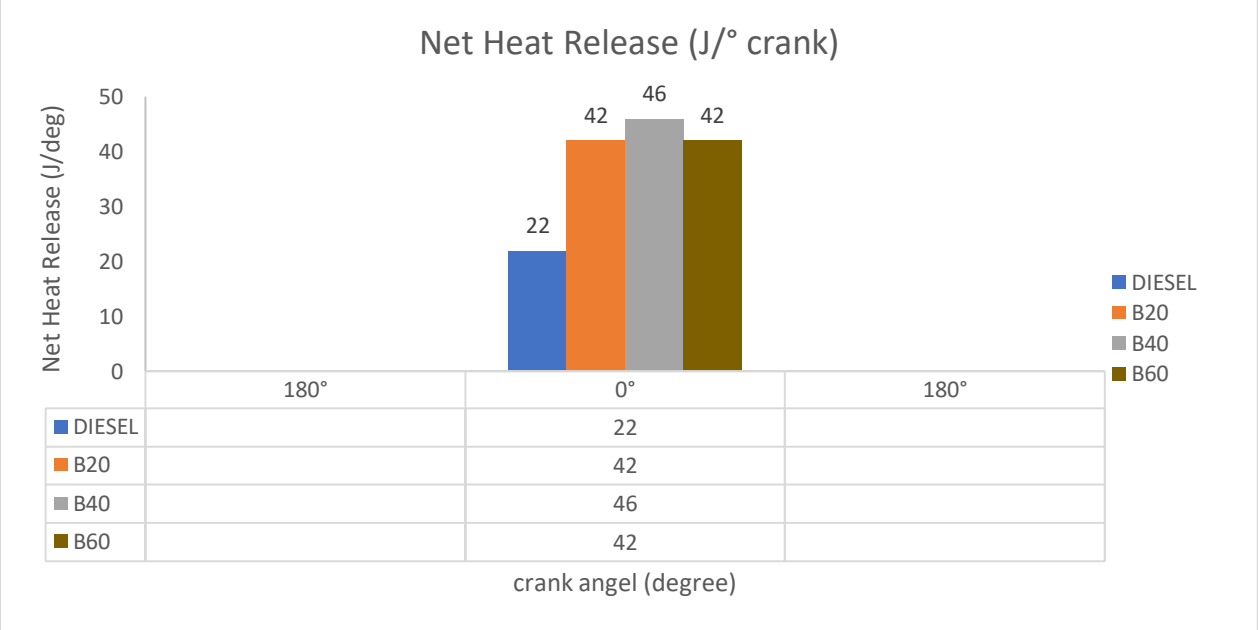


Fig 4.7: Crank Angel Vs Net Heat release

The main intension of studying this combustion parameter is to know the total net heat generated during the combustion process. From the figure 8.7 it is observed that blended fuels release more heat compare to conventional fuels among all fuels, B40 having the highest rate of heat generation.

4.8 Cylinder peak pressure

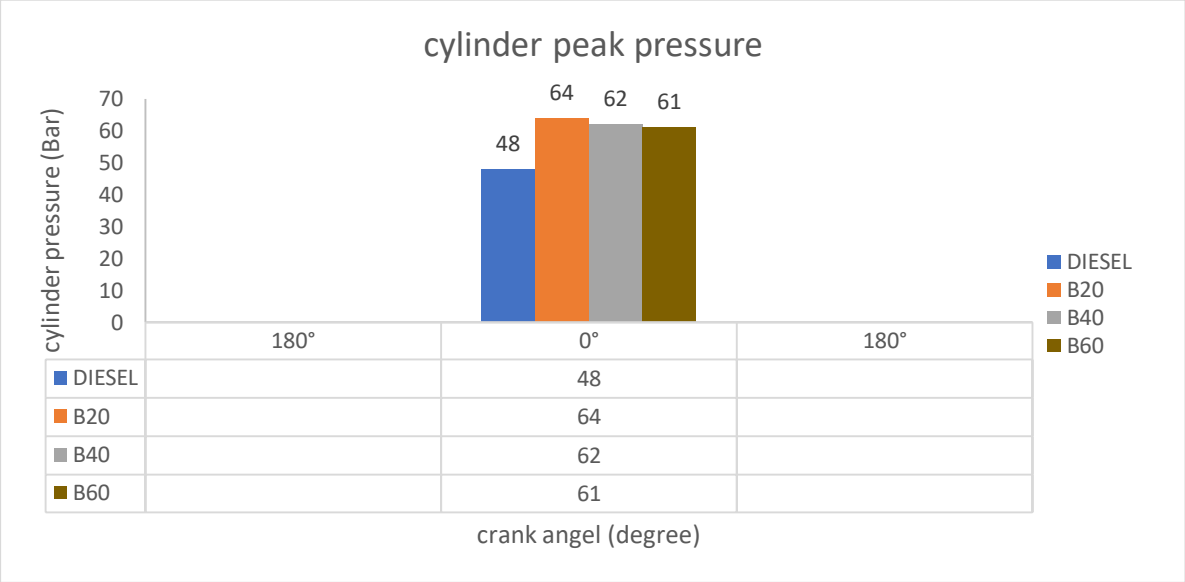


Fig 4.8: Crank Angel Vs Cylinder

It is observed from Figure 8.8 that the conventional (diesel) is having lowest value of cylinder peak pressure among all the fuels. B20 gives higher cylinder peak pressure whereas B40 & B60 are giving almost the same value of cylinder peak pressure. This is due to improvement in thermal efficiency obtained using the bio diesel blends.

4.9 Hart ridge Smoke Unit

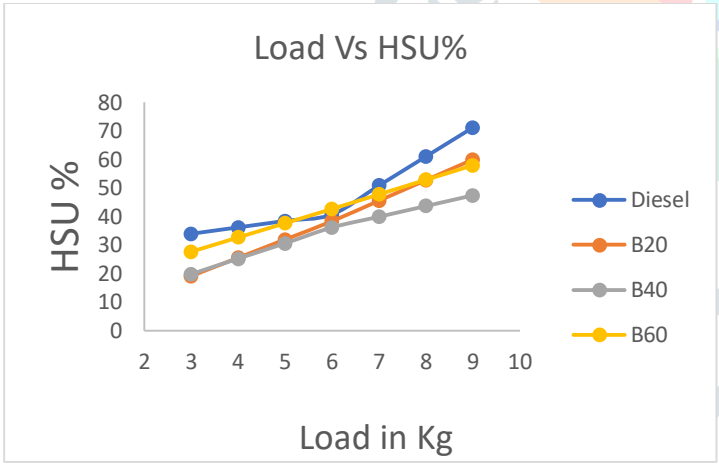


Fig 4.9: Comparison of Hart ridge Smoke Unit

Load (kg)	HART RIDGE SMOKE UNIT %			
Load (kg)	Diesel	B20	B40	B60
3	33.8	19	19.69	27.57
4	36.05	25.4	25.14	32.57
5	38.3	31.8	30.5	37.57
6	40.57	38.22	36.06	42.57
7	50.72	45.4	39.81	47.67
8	60.87	52.6	43.56	52.77
9	71.02	59.81	47.31	57.87

The blended fuels give lower smoke emission compare to diesel. B40 lower smoke value compare to other blends whereas B20 gives slightly higher value of smoke value up to a load of 6 kg and gives higher value of smoke value at loads above 6 kg when compare to B40 blend. For diesel, smoke produces increases rapidly at load above 6kg.

4.10K value

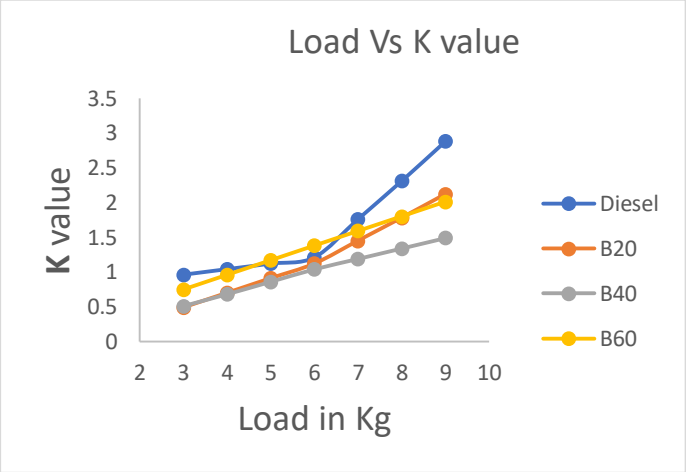


Fig 4.10: Comparison of K value

Load (kg)	K value			
Load (kg)	Diesel	B20	B40	B60
3	0.96	0.49	0.51	0.75
4	1.04	0.7	0.68	0.96
5	1.12	0.91	0.86	1.17
6	1.21	1.12	1.04	1.38
7	1.76	1.45	1.19	1.59
8	2.31	1.78	1.34	1.8
9	2.88	2.12	1.49	2.01

The blended fuels give lower opacity value compare to diesel. B40 have lower opacity value compare to other blends whereas B20 gives slightly higher value of opacity value up to a load of 6 kg and gives higher value of opacity value at loads above 6 kg when compare to B40 blend. For diesel, smoke produces increases rapidly at load above 6kg.

V. Conclusions:

Similar engine behavior is observed in performance parameters related to the brake power (BP), fuel consumption (SFC) and brake thermal efficiency. B20 and B40 blends give better performance in terms of brake power and brake thermal efficiency. Overall B20 blend is the optimized blend which gives better performance, specific fuel consumption and combustion characteristics compared to diesel and other blends. Overall the biodiesels obtained from cotton seeds oil gives better performance, lower emissions and better combustion characteristics compared to diesel fuels. The oil can be extracted from the locally available seeds and biodiesel can be produced which will be cost effective.

VI. REFERENCE

1. Anirudh Gautam and Avinash Kumar Agarwal, September 4, 2012. International Journal of Engine, Experimental investigations of comparative performance, emission and combustion characteristics of a cottonseed biodiesel-fueled four-stroke locomotive diesel engine, Volume: 14 issue: 4, page(s): 354-372
2. Allen Jeffrey, Kiran Kumar, Antonynishanthraj, Arivoli, Balakrishnan. 3 March 2017. International Journal of Science, Engineering and Technology Research Volume 6, Issue 3, March 2017, ISSN: 2278 -7798, Experimental Analysis of Cotton Seed oil Biodiesel in a Compression Ignition Engine.
3. Xiaohu Fan, Xi Wang and Feng Chen, e Open Fuels & Energy Science Journal, 2011, 4, 1-8, Biodiesel Production from Crude Cottonseed Oil: An Optimization Process Using Response Surface Methodology.
4. A.Rama Krishna, B.Prabakaran, March 2015 international journal of engineering sciences & research technology ISSN: 2277-9655 performance and emission characteristics of cottonseed oil methyl ester in a disel engine.
5. International Journal of Engineering Research and General Science Volume 3, Issue 4, July-August, ISSN 2091-2730, 2015, Experimental investigation of non-edible cotton seed oil biodiesel in single cylinder diesel engine,
6. D.Sinha ,S.Murugavelh on" Biodiesel production from waste cotton seed oil using low cost catalyst:Engine performance and emission characteristics " Received 2 February 2016;accepted 11 April 2016, pages 237-240.
7. T.Eevera,K.pazhanichamy on "cotton seed oil:A feasible oil source for biodiesel production" pages 1118-1128."Biodiesel production from cotton seed oil" pages 86-97.
8. Pankaj S. Shelke,NitinM.Sakhare,SubhashLahane on "Investigation of combustion characteristics of a cottonseed biodiesel fuelled diesel engine"pages 1049-1055.
9. Huseyinserdaryucesu,Cumaliilkilic on "Effect of cotton seed oil methyl ester on the performance and exhaust emission of a diesel engine" pages 389-398.
10. BasavrajM.Shrigiri,OmprakashD.Hebbal,K.Hemachandra Reddy on "Performance, emission and combustion characteristics of a semi-adiabatic diesel engine using cotton seed and neem kernel oil methyl esters" pages 699-706.
11. G. Suresh, H.C. Kamath, N.R. Banapurmath on "Effects of injection timing, injector opening pressure and nozzle geometry on the performance of cottonseed oil methyl ester-fueled diesel engine" vol.7, No. 1, pages 82-92.
12. R. Anand, G.R. Kannan, Rajasekar Reddy, S. Velmathi on "The performance and emissions ofa variable compression ratio diesel engine fueled with Bio-Diesel from cotton seed oil" vol 4, No 9 November 2009, pages 72-87.
13. Hariram Venkatesan, Godwin John, SeralathanSivamani on" Cotton seed biodiesel as alternative fuel: production and its characterization analysis using spectroscopic studies" vol.7, No.3,2017, Received:19.02.2017 Accepted:01.04.2017, pages 1334-1339.