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Performance of the IC Engine Using Alternative Fuels

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Abstract:

The internal combustion (IC) engine is a heat engine that converts chemical energy into mechanical energy, usually made available on a rotating output shaft. Chemical energy of the fuel is first converted to thermal energy by means of combustion or oxidation with air inside the engine. This thermal energy raises the temperature and pressure of the gases within the engine, and the high-pressure gas then expands against the mechanical mechanisms of the engine. This expansion is converted by the mechanical linkages of the engine to a rotating crankshaft, which is the output of the engine. The crankshaft, in turn, is connected to a transmission and/or power train to transmit the rotating mechanical energy to the desired final use. For engines this will often be the propulsion of a vehicle.

Previous work has concentrated on the engine performance using the different alternative fuel for a particular time period. This period considered for testing the engine performance cannot be compared with actual running of the for the specified life of of the Automobile. From the published literature it is clearly observed that the effect of using al ternative fuel on the design and life and the efficiency on IC engine parts like combustion chamber, Liner,piston, piston rings are not addressed. Here an attempt is made to design and develop IC engine parts that are most suitable for alternate fuels that last longer without affecting the performance of the Engine. Some of the results presented are the indication of the scope for considering this research work to be done in detail.

Keywords:

Alternative Fuel, Combustion chamber, Piston and Piston Rings, Cylinder liner.

1. Introduction:

1.1. Internal Combustion Engines:

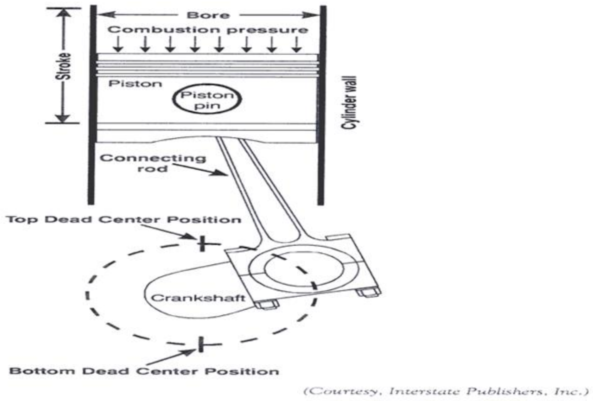
Internal combustion engines are seen every day in automobiles, trucks, and buses. The name internal combustion refers also to gas turbines except that the name is usually applied to reciprocating internal combustion (I.C.) engines like the ones found in everyday automobiles. There are basically two types of I.C. ignition engines, those which need a spark plug, and those that rely on compression of a uid. Spark ignition engines take a mixture of fuel and air, compress it, and ignite it using a spark plug. Figure 1.1 shows a piston and some of its basic components.

The name `reciprocating' is given because of the motion that the crank mechanism goes through. The piston- cylinder engine is basically a crank-slider mechanism, where the slider is the piston in this case. The piston is moved up and down by the rotary motion of the two arms or links. The crankshaft rotates which makes the two links rotate. The piston is encapsulated within a combustion chamber. The bore is the diameter of the chamber. The valves on top represent induction and exhaust valves necessary for the intake of an air-fuel mixture and exhaust of chamber residuals.

1.1.1 Parts of the Engine Block:

- Cylinder – the part of the engine block where the combustion takes place.
- Piston – a plunger with rings that fit against the inside cylinder walls and prevent air from leaking past
- Connecting rod – connects the piston to the crankshaft. Fastened by the wrist pin
- Crankshaft – shaft with offsets to which the connecting rods are attached

1.1.2 Bore and Stroke of a Cylinder:



The Fig. 1. Shows the different parts viz., crankshaft, bore, connecting rod, piston, piston pin, cylinder wall and the combustion pressure in the cylinder.

1.1.3 Piston and Connecting rod:

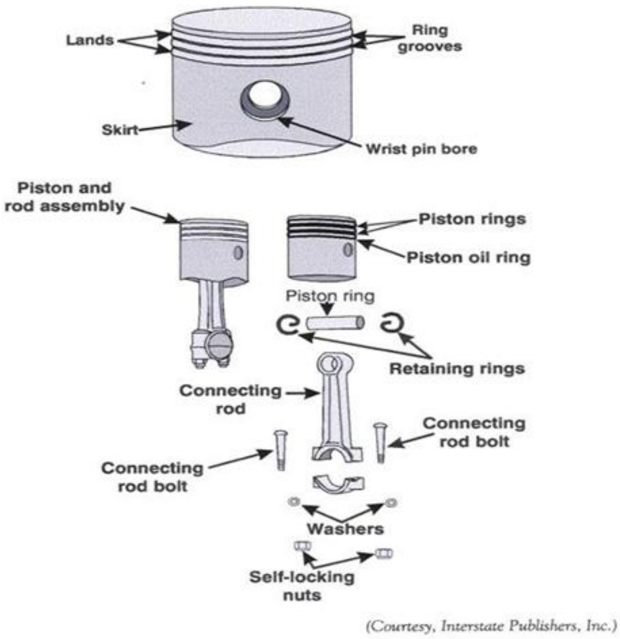


Fig. 2 shows the components of the piston assembly

1.1.4 Crank Shaft assembly:

The crankshaft and the components of crankshaft assembly is shown in Fig. 3.

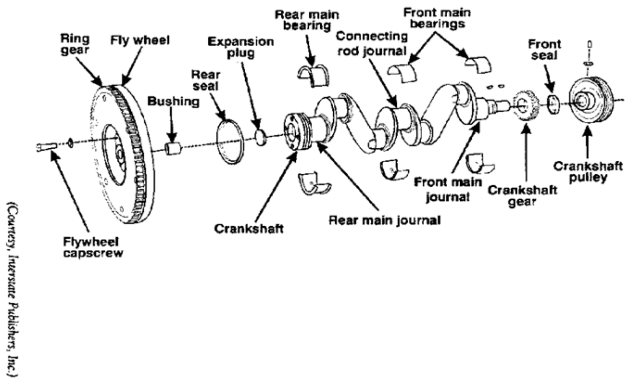


Fig. 3. Components of crankshaft assembly

1.2. Alternative Fuel:

The large increase in number of automobiles in recent years has resulted in great demand for petroleum products. With crude oil reserves estimated to last only for few decades, there has been an active search for alternate fuels. The depletion of crude oil would cause a major impact on the transportation sector. Of the various alternate fuels under consideration, biodiesel, derived from vegetable oils, is the most promising alternative fuel to conventional diesel fuel (derived from fossil fuels; hereafter just “diesel”) due to the following reasons

• Biodiesel can be used in existing engines without any modifications.

• Biodiesel is made entirely from vegetable sources; it does not contain any sulfur, aromatic hydrocarbons, metals or crude oil residues.

• Biodiesel is an oxygenated fuel; emissions of carbon monoxide and soot tend to be reduced compared to conventional diesel fuel.

• Unlike fossil fuels, the use of biodiesel does not contribute to global warming as CO_2 emitted is once again absorbed by the plants grown for vegetable oil/biodiesel production. Thus CO_2 balance is maintained.

• The Occupational Safety and Health Administration classify biodiesel as a non-flammable liquid.

• The use of biodiesel can extend the life of diesel engines because it is more lubricating than petroleum diesel fuel.

• Biodiesel is produced from renewable vegetable oils/animal fats and hence improves fuel or energy security and economy independence.

A lot of research work has been carried out using vegetable oil both in its neat form and modified form. Studies have shown that the usage of vegetable oils in neat form is possible but not preferable . The high viscosity of vegetable oils and the low volatility affects the atomization and spray pattern of fuel, leading to incomplete combustion and severe carbon deposits, injector choking and piston ring sticking. Methods such as blending with diesel, emulsification, pyrolysis and transesterification are used to reduce the viscosity of vegetable oils. Among these, the transesterification is the most commonly used commercial process to produce clean and environmentally friendly fuel. A large number of studies on performance, combustion and emission using raw vegetable oils and methyl/ethyl esters of sunflower oil, rice bran oil, palm oil, mahua oil, jatropha oil, karanja oil, soybean oil, rapeseed oil and rubber seed oil have been carried out on Compression Ignition(CI) engines. The purpose of this paper is to review previous studies that look into the effect of bio-diesel on CI engine from the viewpoint of performance, combustion and emissions.

1.3. Production of biodiesel:

Vegetable oils are chemically complex esters of fatty acids. These are the fats naturally present in oil seeds, and known as tri-glycerides of fatty acids. The molecular weight of these tri-glycerides would be of order of 800 kg/m3or more. Because of their high molecular weights these fats have high viscosity causing major problems in their use as fuels in CI engines. These molecules have to be split into simpler molecules so that they have viscosity and other properties comparable to standard diesel oils. Modifying the vegetable oils (to make them lighter) can be achieved in many ways, including; Pyrolysis, Micro emulsification, Dilution and Transesterification. Among these, transesterification is the most commonly used commercial process to produce clean and environmentally friendly light vegetable oil fuel i.e. biodiesel.

1.4. Transesterification:

The fatty acid triglycerides themselves are esters of fatty acids and the chemical splitting up of the heavy molecules, giving rise to simpler esters, is known as Transesterification. The triglycerides are reacted with a suitable alcohol (Methyl, Ethyl, or others) in the presence of a catalyst under a controlled temperature for a given length of time. The final products are Alkyl esters and Glycerin. The Alkyl esters, having favorable properties as fuels for use in CI engines, are the main product and the Glycerin, is a by-product.

2. Literature Survey:

Wang Wenzhong, HU Yuanzhong, WANG Hui & LIU Yuchuan[1] they have found that Piston and piston ring lubrication is a factor that strongly affects the performance of the reciprocating internal combustion engine. T heir work is based on a unified numerical approach assuming that the pressure distribution obeys Reynolds equation in hydrodynamic lubrication regions while in asperities contact regions, the contact pressure can be obtained through the so-called reduced Reynolds equation. Arka Ghosh [2] has worked on the essentials of combustion chamber, their design, influence in combustion process, timing, etc. They emphasize research on newer designs requirement for combustion chambers. Balvinder Budania1and Virender Bishnoi [3] developed 'A New Concept of I.C. Engine with Homogeneous Combustion in a Porous Medium'.

They have proposed a new combustion concept that fulfils all requirements to perform homogeneous combustion in I.C. engines using the Porous Medium Combustion Engine, called "PM - engine". S. Jaichandar and K. Annamalai [4], have discussed the effect of use of biodiesel fuel on engine power, fuel consumption and thermal efficiency are collected and analyzed with that of conventional diesel fuel. Maro JELIĆ and Neven NINIĆ [5], have discussed the 'Analysis of Internal Combustion Engine Thermodynamic Using the Second Law of Thermodynamic'.

They applied the numerical simulations in modeling the ICE engine processes together with the analysis by the second law of thermodynamics, they got a very potent tool for better insight and optimization of spark- and compression-ignition engines achieving lower fuel consumption and lower emissions. N.H.S.Ray, M.K.Mohanty and R.C.Mohanty [6] have worked on Biogas as Alternate Fuel in Diesel Engines'. They reviewed the current status and perspectives of biogas production, including the purification & storage methods and its engine applications. Lower hydrocarbon (HC), smoke and particulates emission has been reported in diesel engines operating on biogas diesel dual fuel mode.

C D Rakopoulos, E G Giakoumis, and D C Rakopoulos [7] have discussed the Study of the short-term cylinder wall temperature oscillations during transient operation of a turbo- charged diesel engine with various insulation schemes. The work investigates the phenomenon of short-term temperature (cyclic) oscillations in the combustion chamber walls of a turbocharged diesel engine during transient operation after a ramp increase in load. The investigation reveals many interesting aspects of transient engine heat transfer, regarding the influence that the engine wall material properties have on the values of cyclic temperature swings.

Er. Milind S Patil, Dr. R. S. Jahagirdar, and Er. Eknath R Deore [8] have worked on Performance Test of IC Engine Using Blends of Ethanol and Kerosene with Diesel. They used 3.75 kW diesel engine AV1 Single Cylinder water cooled, Kirloskar Make to test blends of diesel with kerosene and Ethanol. This paper presents a study report on the performance of IC engine using blends of kerosene and ethanol with diesel with various blending ratio. Parameters like speed of engine, fuel consumption and torque were measured at different loads for pure diesel and various combination of dual fuel.

Break Power, BSFC, BTE and heat balance were calculated. Paper represents the test results for blends 5% to 20%. M. Lackner, F. Winter [9] have discussed the Laser Ignition in Internal Combustion Engines.

Laser ignition tests were performed with the fuels hydrogen and biogas in a static combustion cell and with gasoline in a spray-guided internal combustion engine. A Nd:YAG laser with 6 ns pulse duration, 1064 nm wavelength and 1-50 mJ pulse energy was used to ignite the fuel/air mixtures at initial pressures of 1-3 MPa. Compared to a conventional spark plug, a laser ignition system should be a favorable ignition source in terms of lean burn characteristics and system flexibility. Yet several problems remain unsolved, e.g. cost issues and the stability of the optical window.

Sutaria B.M, Bhatt D.V and Mistry K.N [10] has worked on study of basic tribological parameters that influences performance of an internal combustion engine. Mathematical model is developed using average Reynolds equation. Parametric study is performed on 150 CC, 2 Stroke Internal Combustion Engine. The oil film thickness (OFT), piston friction forces (PFF), and Ring friction variations are simulated under different variable i.e engine speed, lubricants and different ring geometry. The simulated results of piston friction force, ring friction force and oil film thickness are compared with published literature.

D. Ramesh and A. Sampathrajan [11] in their work entitled 'Investigations on Performance and Emission Characteristics of Diesel Engine with Jatropha Biodiesel and Its Blends' used a 5.2 kW diesel engine with alternator was used to test jatropha biodiesel and its blends. A pilot plant was developed for biodiesel production from different vegetable oils and used for this study. In the case of jatropha biodiesel alone, the fuel consumption in the diesel engine was about 14 per cent higher than that of diesel. The percent increase in specific fuel consumption ranged from 3 to 14 for B20 to B100 fuels.

The brake thermal efficiency for biodiesel and its blends was found to be slightly higher than that of diesel fuel at tested load conditions and there was no difference between the biodiesel and its blended fuels efficiencies. The CO_2 emission from the biodiesel-fuelled engine was slightly higher than diesel fuel as compared with diesel.

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The carbon monoxide reduction by biodiesel was 16, 14 and 14 per cent at 2,2.5 and 3.5 kW load conditions. The NOx emissions from biodiesel was increased by 15, 18 and 19 per cent higher than that of the diesel at 2, 2.5 and 3.5 kW load conditions respectively.

A.S. Ramadhas, S. Jayaraj, and C. Muraleedharan [12] have discussed the Use of vegetable oils as I.C. engine fuel. The increasing industrialization and motorization of the world has led to a steep rise for the demand of petroleum products. This paper reviews the production and char- acterization of vegetable oil as well as the experimental work carried out in various countries in this field. In addition, the scope and challenges being faced in this area of research are clearly described.

N.R. Banapurmatha,, P.G. Tewaria, R.S. Hosmathb [13] has worked on Performance and emission characteristics of a DI compression ignition engine operated on Honge, Jatropha and sesame oil methyl ester. Biodiesel can be used in its pure form or can be blended with diesel to form different blendsThis paper presents the results of investigations carried out on a single-cylinder, four-stroke, direct-injection, CI engine operated with methyl esters of Honge oil, Jatropha oil and sesame oil. Comparative measures of brake thermal efficiency, smoke opacity, HC, CO, NOX, ignition delay, combustion duration and heat release rates have been presented and discussed. Engine performance in terms of higher brake thermal efficiency and lower emissions (HC, CO, NOX) with sesame oil methyl ester operation was observed compared to methyl esters of Honge and Jatropha oil operation.

Jayant Singh, T. N. Mishra, T. K. Bhattacharya, and M. P. Singh [14] has worked on Emission Characteristics of Methyl Ester of Rice Bran Oil as Fuel in Compression Ignition Engine . The emission characteristics of methyl ester of refined rice bran oil – diesel blend mixed in the proportion of 10:90, 20:80, 30:70, 50:50 and 10:0 (v/v) were studied. The emission of carbon monoxide from the engine was found to be lower on all the blends of methyl ester of rice bran oil-diesel compared to diesel at rated load.

The emission of unburnt hydrocarbon from the engine at higher loads was found to be more on all the fuel blend as compared to diesel. The emission of Nox from the engine found to be higher on the all fuel blend as compared to diesel.

B.K.Venkanna and C.Venkataramana Reddy [15] in their work entitled Influence of injector opening pressures on the performance, emission and combustion characteristics of DI diesel engine running on calophyllum inophyllum linn oil (honne oil) .The use of neat honne oil (H100) in diesel engine has not been reported in the literature. A direct injection (DI) diesel engine typically used in agricultural sector was operated on neat diesel (ND) and H100. Injector opening pressure (IOP) was changed to study the performance, emission and combustion characteristics. It was observed that increasing the IOP with H100 from the rated injector op ening pressure (200 bars) increased the brake thermal efficiency and reduced CO, HC and smoke opacity emissions. However, NOx emission was increased. With H100, ignition delay decreased as injector opening pressure increased. Improved premixed heat release rate was observed with H100 when the injector opening pressure is advanced. The best IOP is 240 bars with H100 based on brake thermal efficiency.

B.K. Venkanna and C. Venkataramana Reddy [16] in their work entitled ‘Performance and emission characteristics of calophyllum inophyllum linn oil (blends and preheated) in an agricultural diesel engine’ examines the use of a non-edible oil namely honne oil. The performance and emission characteristics of unheated honne oil blend (20% honne oil and 80% diesel fuel by volume) are found to be close to neat diesel. The performance and emission characteristics of preheated honne oil blends (10% to 50%) are better than unheated honne oil blends Pavan Pujar, B. K. Venkanna [17] has worked on Production and characterization of biodiesel from Mackerel fish oil. Mackerel Fish oil was used as the raw material to produce the biodiesel in this study. The raw oil (RO) was collected from discarded fish products. This oil was filtered and heated to 1100C and made it moisture free.

The filtered and moisture free RO was transesterified to produce biodiesel. The experimental results showed that oleic acid and lauric acid were the two major components of the fish oil biodiesel (FOB). It was found that cetane number was 59 for FOB which was more than RO, which showed 57. Blends (B20, B40, B60, B80: example: B20: 20% FOB + 80% ND) of FOB and ND were prepared on volume basis and comparative study was carried out with ND and FOB.

A.K. Hossain and P.A. Davies [18] has worked on Performance. Emission and combustion characterstics of an indirect injection multi-cylinder compression ignition engine operating on neat jatropha and karanj oils preheated by jacket water. In this a multi-cylinder water cooled IDI type CI engine has been tested with jatropha and karanj oils and comparisions made against fossil diesel. The engine cooling water circuit and fuel supply systems were modified such that hot jacket water preheated the neat plant oil prior to injection. They found out that compared to fossil diesel, the brake specific fuel consumption on volume basis is around 3% higher for the plant oils and the brake thermal efficiency was almost similar. Jatropha and karanj operation resulted in higher CO_2 and NO_x emission by 7% and 8% respectively, as compared to diesel.

Liyan Feng, Wuqiang Long and Wenqi Feng [19] in their work entitled Reseaech on match of swirl-chamber and conical spray in indirect injection engine worked on to improve the fuel economy of a swirl -chamber diesel engine, the engine was modified by applying a conical spray injector in the swirl-chamber to improve its fuel- air mixture formation and combustion processes. In addition, a series of swirl-chamber schemes were designed, and the match of the conical spray with these swirl-chamber schemes were investigated with the aid of a 3-D CFD software package.

3. Outcome of Literature Survey And Scope For Present Work:

• Previous work has concentrated on the engine performance using the different alternative fuel and from the published literature it is clearly observed that the effect of using alternative fuel on the design and life and the efficiency on IC engine parts like combustion chamber, piston, piston rings are not addressed.

• It is observed that by using the alternative fuel gum or wax is formed in the fuel tank after long period. This wax will mix with he fuel and effect the IC engine performance. This problem is not exist in the regular fuel (diesel).

• Using Alternative fuel, the Combustion chamber redesign that includes the position of injector and valve is to be optimized.

4. Methodology:

• Performance and the operation characteristics of the IC engine choosen is conducted with desired and results are plotted.

• The above procedure is repeated with the most efficient alternative fuel and the results are plotted and Compared.

• In both the cases the study on effect of fuel on the behaviour/performance of the combustion chamber, piston, piston rings, cylinder wall are carried out.

• The performance study of the above includes tribological and geometrical behaviour like wear and tear, cylinder liner, ovality of cylinder liner.

5. Expected Outcomes:

• The wear and tear of piston rings and liner is expected to be more when compared with the engine using Diesel as a fuel. This leads to more fuel consumption and may demand for reboring of cylinder at the early stages.

•The above situation demands for newer material for piston, piston rings, liner which are compatible for Alternative fuel.

References:

[1] WANG Wenzhong, HU Yuanzhong, WANG Hui & LIU Yuchuan, 'Numerical simulation of piston ring in the mixed lubrication' State Key Laboratory of

Tribology, Tsinghua University, Beijing 100084, China, 2001.

[2] ARKA GHOSH, ‘COMBUSTION CHAMBERS IN CI ENGINES’ SRM University.

[3] Balvinder Budania, Virender Bishnoi, ‘A New Concept of I.C. Engine with Homogeneous Combustion in a Porous Medium’ International Journal of Latest Trends in Engineering and Technology (IJLTET).

[4] S. Jaichandar and K. Annamalai, ‘The Status of Biodiesel as an Alternative Fuel for Diesel Engine’ Journal of Sustainable Energy & Environment 2 (2011) 71-75.

[5] Maro JELIĆ and Neven NINIĆ, ‘Analysis of Internal Combustion Engine Thermodynamic Using the Second Law of Thermodynamics’ M. JELIĆ et. al., A Review of Internal Combustion Engine, Strojarstvo 50 (2) 85-94 (2008).

[6] N.H.S.Ray, M.K.Mohanty and R.C.Mohanty, ‘Biogas as Alternate Fuel in Diesel Engines’ IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 9, Issue 1 (Sep. - Oct. 2013), PP 23-28 www.iosrjournals.org.

[7] C D Rakopoulos, E G Giakoumis, and D C Rakopoulos, ‘Study of the short-term cylinder wall temperature oscillations during transient operation of a turbo- charged diesel engine with various insulation schemes’ 4 February 2008.

[8] Er. Milind S Patil, Dr. R. S. Jahagirdar, and Er. Eknath R Deore, ‘Performance Test of IC Engine Using Blends of Ethanol and Kerosene with Diesel’ International Journal of Engineering Science and Technology Vol. 2(8), 2010, 3503-3509.

[9] M. Lackner, F. Winter, ‘Laser Ignition in Internal Combustion Engines - A Contribution to a Sustainable Environment’ Institute of Chemical Engineering, Vienna University of Technology, Getreidemarkt 9/166, A-1060 Wien, Austria.

[10] Sutaria B.M, Bhatt D.V and Mistry K.N, ‘Simulation and Modeling of Friction Force and Oil Film Thickness in Piston Ring – Cylinder Liner Assembly of an I. C. Engine’ Proceedings of the World Congress on Engineering 2009 Vol II WCE 2009, July 1 - 3, 2009, London, U.K.

[11] D. Ramesh and A. Sampathrajan, ‘Investigations on Performance and Emission Characteristics of Diesel Engine with Jatropha Biodiesel and Its Blends’ Vol. X. March, 2008.

[12]A.S. Ramadhas, S. Jayaraj, and C. Muraleedharan, ‘Use of vegetable oils as I.C. engine fuels’ Renewable Energy 29 (2004) 727–742.

[13]N.R. Banapurmatha,, P.G. Tewaria, R.S. Hosmathb, ‘Performance and emission characteristics of a DI compression ignition engine operated on Honge, Jatropha and sesame oil methyl esters’ Renewable Energy 33 (2008) 1982–1988.

[14] Jayant Singh, T. N. Mishra, T. K. Bhattacharya, and M. P. Singh, ‘Emission Characteristics of Methyl Ester of Rice Bran Oil as Fuel in Compression Ignition Engine’ International Journal of Chemical and Biomolecular Engineering Volume 1 Number 2.

[15] B.K.Venkanna and C.Venkataramana Reddy, ‘Influence of injector opening pressures on the performance, emission and combustion characteristics of DI diesel engine running on calophyllum inophyllum linn oil (honne oil)’ International Journal of Renewab le Energy, Vol. 6, No. 1, January - June 2011.

[16] B.K. Venkanna and C. Venkataramana Reddy, ‘Performance and emission characteristics of calophyllum inophyllum linn oil (blends and preheated) in an agricultural diesel engine’ Int. J. Renewable Energy Technology, Vol. 2, No. 3, 2011.

[17] Pavan Pujar, B. K. Venkanna, ‘Production and characterization of biodiesel from Mackerel fish oil’ International Journal of Scientific & Engineering Research, Volume 5, Issue 11, November-2014 ISSN 2229-5518.

[18] A.K. Hossain and P.A. Davies, 'Performance. Emission and combustion characterstics of an indirect injection multi-cylinder compression ignition engine operating on neat jatropha and karanj oils preheated by jacket water' biomass and bioenergy 46(1012) 332 - 342.

[19] Liyan Feng, Wuqiang Long and Wenqi Feng, 'Reseaech on match of swirl-chamber and conical spray in indirect injection engine' Engineering applications of Computional Fluid Mechanics Vol.7, No.2, pp. 272-281 (2013).