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Optimization of Injection Parameters of Ci Engine Using Cotton Seed and Pongamia Pinnata Bio Diesel as Fuel

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ABSTRACT

Due to the increasing demand for fossil fuels and environmental threat, a number of renewable sources of energy have been studied worldwide. An attempt is made to assess the suitability of vegetable oils for diesel engine operation without any hardware modifications in its existing engine construction. The important factors which influence of diesel engine are fuel injection pressure and fuel injection timing. The main objective of this study is to investigate the effect of injection pressures and injection timing on performance and emissions of the engine. Non edible cotton seed and pongmia pinnata bio diesel blended with diesel were tested for their use as substitute fuels for diesel engines. The results showed a better performance with 20% bio diesel and 80% diesel fuel at an injection pressure of 200 bar and injection timing 300 bTDC.

Keywords: Diesel Engine, Cotton Seed and Pongamia Pinnata Bio Diesel, Injection Pressure, Injection Timing, Performance Appraisal.

I. INTRODUCTION

Using vegetable oil in diesel engines is not a new idea. Dr. Rudolf Diesel first used peanut oil for demonstration of his newly developed compression ignition engine in the year 1900. Later with the availability of cheap petroleum, crude oil fractions were refined to serves as diesel, a fuel for CI engines. During the period of world war-II, vegetable oils were again used as fuel in emergency situations when fuel availability became scarce. Now days, due to limited resources of fissile fuels, rising crude oil prices and increasing concerns for environment, there has been renewed focus on vegetable oil and animal fats as an alternative to petroleum fuels. In India only non-edible oil can be used as a raw material for bio diesel production. These non-edible oil seeds plants can be grown in non-fertile land and waste lands. In our country these lands are much available. Non edible oil seed like jatropha curcus, pongamia pinnata, cotton seed, neem etc., contains oil in seed. In our country there are more than 300 species of trees, which produce oil bearing trees. The collection and extraction of oil is carried out by Indian Biodiesel Corporation, Baramati. Bio diesel which is derived from triglycerides by the chemical process known as tranesterification. Bio diesel is usually produced by the transesterification of vegetable oils or animal fats with methanol. This source of diesel is attracted considerable attention during the past decade as a renewable, biodegradable, ecofriendly and nontoxic fuel. Several processes have been developed for production of bio diesel. Methyl esters are non-corrosive and are produced at low pressure and temperature conditions [1, 2 and 3].

II. METHODS AND MATERIAL

A. Transesterification

Transesterification is otherwise known as alcoholysis. It is the reaction of fat or oil with an alcohol to form esters and glycerine. A catalyst is used to improve the reaction rate and yield. Among the alcohols, methanol or ethanol are used commercially because of their low cost and their physical and chemical advantages. They quickly react with triglycerides and NaOH and are easily dissolved in them. To complete a transesterificaton process, 3:1 molar ratio of alcohol is needed. Enzymes, alkalis or acids can catalyze the reaction, i.e. lipases, NaOH and sulphuric acid, respectively. Among these, alkali tranesterification is faster and hence it is used commercially. A mixture of vegetable oil and sodium hydroxide (used as catalyst) are heated and maintained at 65 0C for 1 hour, while the solution is continuously stirred. Two distinct layers are formed, lower layer is glycerine and upper layer is ester. The upper layer is separated and moisture is removed from the ester by using calcium chloride. It is observed that 90% ester can be obtained from vegetable oils [4, 5 and 6].

B. Fuel Properties

The basic composition of vegetable oils is triglycerides which are the esters of three acids and one glycerol. The properties of methyl esters of cotton seed, honge oil and diesel are presented in Table 1[3 and 4].

C. Experimental Setup

The experimental set-up and schematic diagram of the present work with various components is shown in Figures 1. The experimental work carried out for the objectives, requires an engine test set up adequately instrumented for necessary performance characteristics and optimization of injection parameters of cotton seed oil methyl ester, honge (Pongamia pinnata) oil methyl ester and pure diesel fuel blend were used to test a TV1, Kirloskar, single cylinder, 4-Stroke, water cooled diesel engine having a rated output of 10 HP at 1500 rpm and a compression ratio of 17.5:1. The engine was coupled with an eddy current dynamometer to apply different engine loads.

1 = Control Panel, 2 = Computer system, 3 = Diesel flow line, 4 = Air flow line, 5= Calorimeter, 6 = Exhaust gas analyzer, 7 = Smoke meter, 8 = Rota meter, 9= Inlet water temperature, 10= Calorimeter inlet water temp., 11= Inlet water to engine jacket, 12 =Calorimeter outlet water temp., 13 = Dynamometer, 14 = CI Engine, 15 = Speed measurement, 16 = Burette for fuel measurement, 17 = Exhaust gas outlet, 18 = Outlet water from engine jacket, T1= Inlet water temperature, T2 = Outlet water temperature, T3 = Exhaust gas temperature.

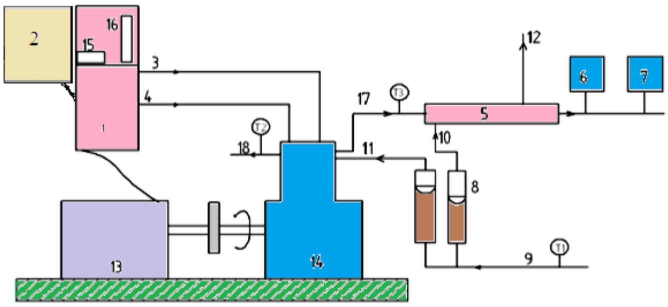

Figure 1: Setup Experimental Setup

III. RESULT AND DISCUSSION

D. Effect of injection pressure on engine performance

i) Brake thermal efficiency (BTE)

Variation of brake thermal efficiency (BTE) for compression ratio of 17.5:1 with Brake mean effective pressure (BMEP) at different injection pressure(IP) for methyl esters of cotton seed oil (COME) and honge oil (HOME) and at injetion timing (IT) of 27^0 bTDC is shown in Figure 2 to 5. The BTE of COME and HOME increases with increase in BMEP is shown in Figure 2 and 4, but the BTE for COME and HOME at 220 bar is less than other lower pressures, this is due to poor atomization and blending of vegetable oils with diesel.

The BTE is increased with increase in IP due to the reduction in the viscosity, improved atomization and better combustion. The BTE is maximum at 200 bar, this is due to fine spray formed during injection and improved atomization is shown in Figure 3. Further the BTE tends to decrease, this may be due to that at higher IP the size of fuel droplets decreases and very high fine fuel spray will be injected, because of this, penetration of fuel spray reduces and momentum of fuel droplets will be reduced. The maximum break thermal efficiency of COME and HOME at 200 bar pressure is 33.21% and 34.72% is shown in Figure 3 and 5, it is very close to diesel fuel efficiency at full load condition.

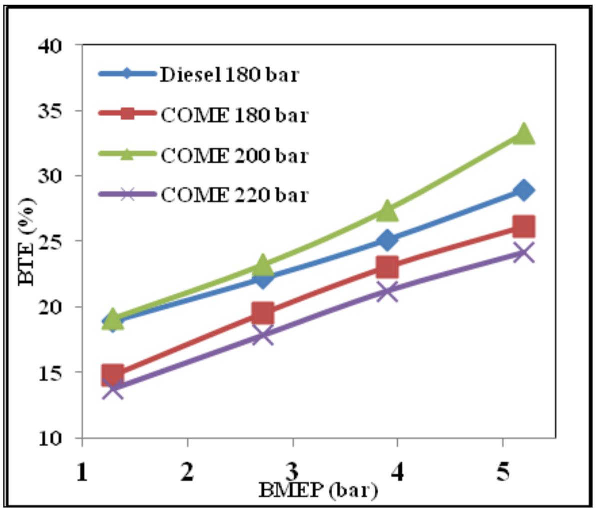

Figure 2: Variation of BTE Vs BMEP

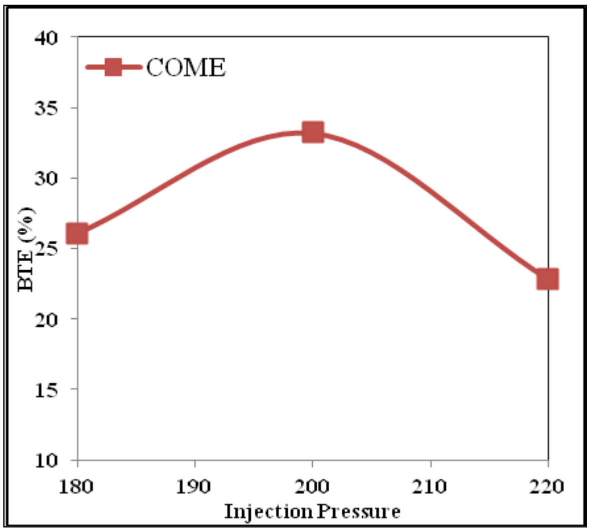

Figure 3: Variation of BTE Vs IP

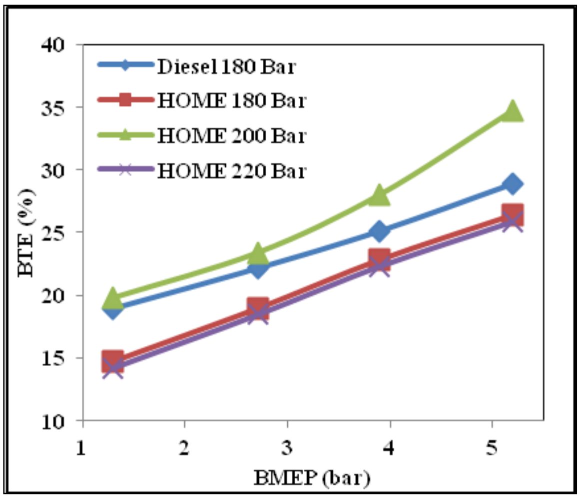

Figure 4: Variation of BTE v/s BMEP

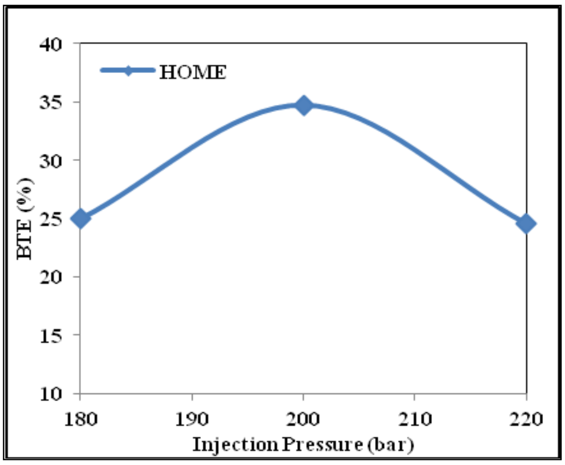

Figure 5: Variation of BTE v/s IP

ii) Brake specific fuel consumption (BSFC)

Variation of brake specific fuel consumption (BSFC) with BMEP at different IP is shown in Figures 6 to 9. Figure 6 and 8 shows the BSFC decreases with increase in BMEP, The BSFC of COME and HOME is higher than diesel; it may be due to lower calorific value of bio diesel. Figure 7 and 9 shows the variation of BSFC with varying IP for COME and HOME. It is found that the BSFC is decreased with increase in IP up to 200 bar. This may be due to that, as IP increases the penetration length and spray cone angle increases. From the Figure BSFC for COME and HOME is 0.268 kg/kW-hr and 0.268 kg/kW-hr at 200 bar and increase in IP from 180 to 220 bar, the BSFC is increased to 0.259 kg/kW-hr.

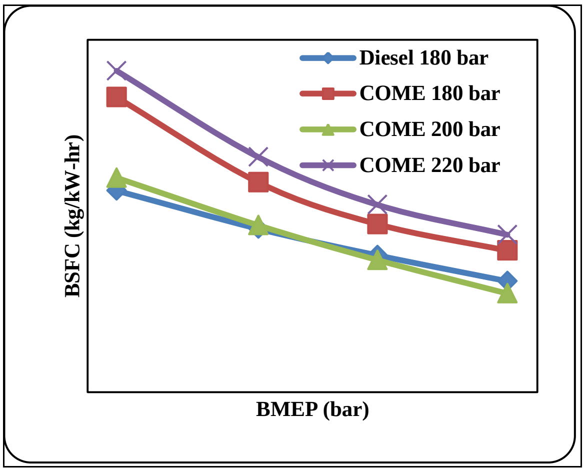

Figure 6: Varitation of BSFC Vs BMEP

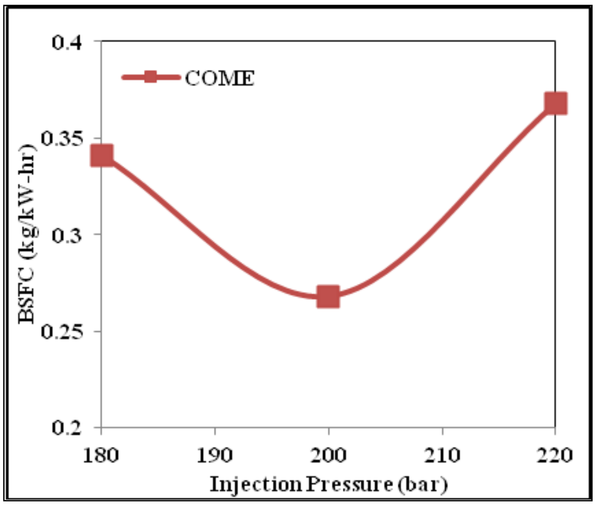

Figure 7: Varitation of BSFC Vs IP

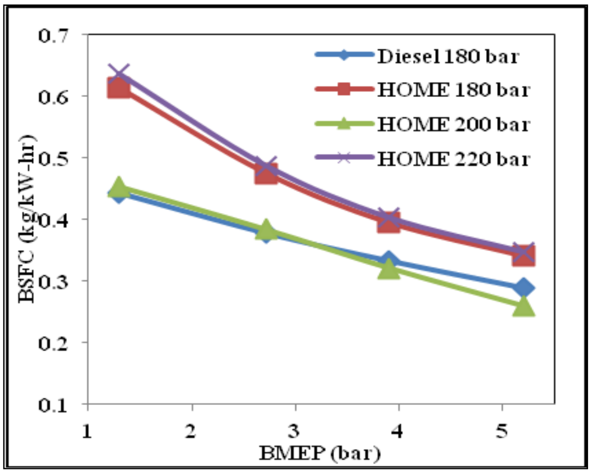

Figure 8: Varitation of BSFC v/s BMEP

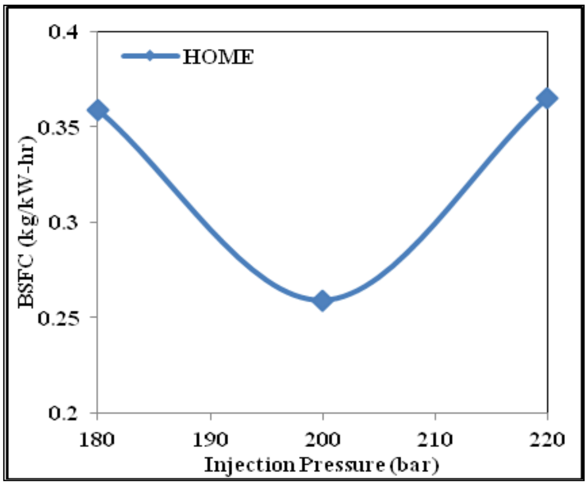

Figure 9: Varitation of BSFC v/s IP

E. Effect of IT on engine performance at optimized IP of 200 bar as fuels.

i) Brake thermal efficiency

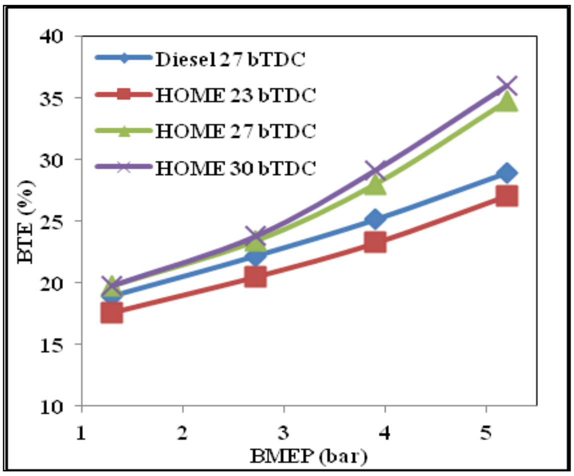

Figure 10: Varitation of BTE Vs BMEP

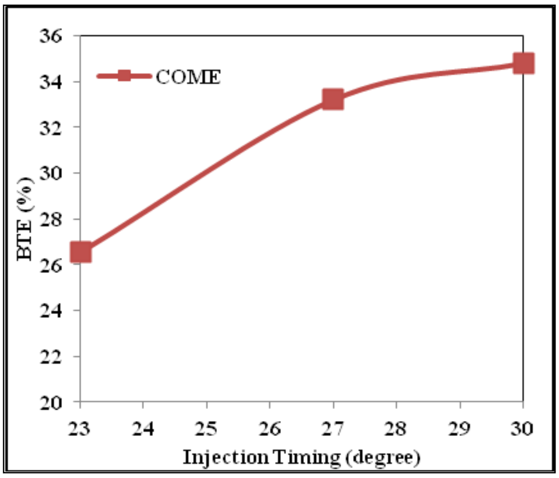

Figure 11: Varitation of BTE Vs IT

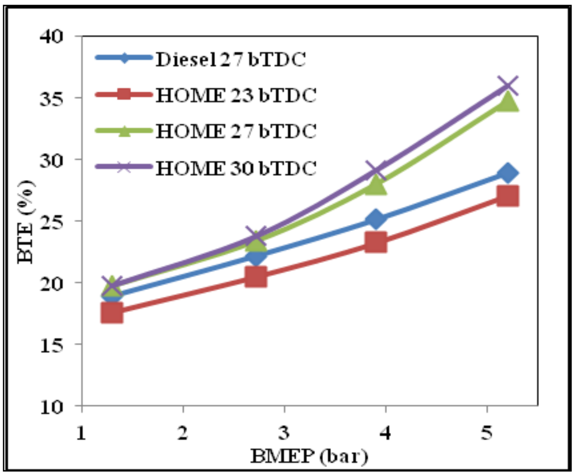

Figure 12: Varitation of BTE v/s BMEP

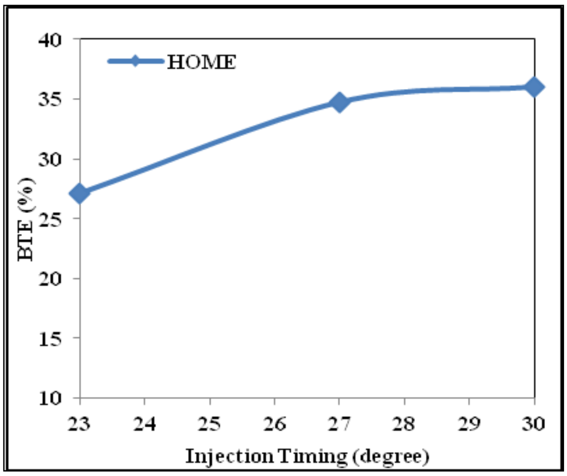

Figure 13: Varitation of BTE v/s IT

Variation of BTE with BMEP at various IT for COME and HOME is shown in Figures 10 to 13, the BTE is improved with increase in BMEP can be observed in Figures 10 and 11. Brake thermal efficiency as seen in Figure 11 and 13 increases when the IT is advanced. This is because starting the combustion earlier compensates the effect of slow burning.

Combustion is slow with conditioned bio diesel on account of its high viscosity which leads to a poor spray and mixture with air. The BTE occurred at the static IT of 30^{0}bTDC which is selected as optimal. This is 3^{0} more advanced than that of diesel.

Hence changing the IT from the one optimum for diesel to the one suitable for conditioned bio diesel increases the BTE at full load to 33.21% for COME and to 34.72% for HOME.

ii) Brake specific fuel consumption

Variation of BSFC with BMEP at IP of 200 bar for COME and HOME is shown in Figures 14 to 17. BMEP of a diesel engine directly relates to the brake power. From Figures 14 and 16 shows larger amount of conditioned bio diesel is supplied to the engine compared that of standard diesel. The higher BSFC values in the case of vegetable oil esters due to the higher density and lower calorific values. It can also observed from Figure 15 and 17, that advance of IT leads with lower BSFC, this is due to optimum delay period and smaller amount of fuel during after burning.

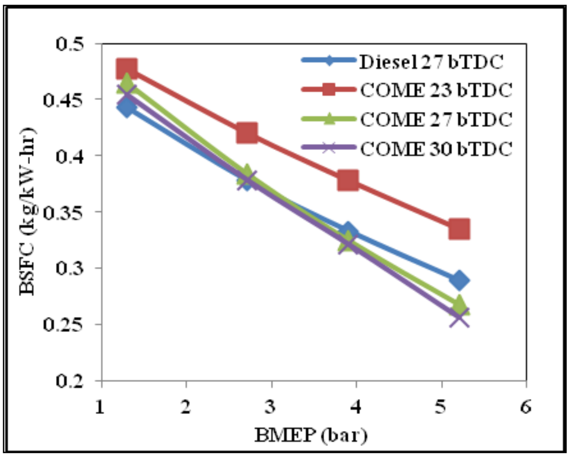

Figure 14: Variation of BSFC Vs BMEP

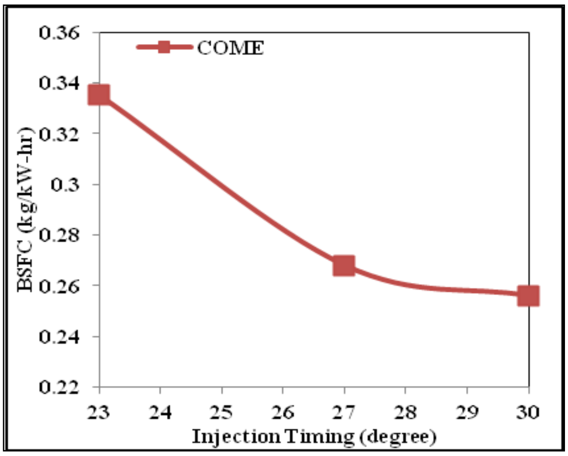

Figure 15: Variation of BSFC Vs IT

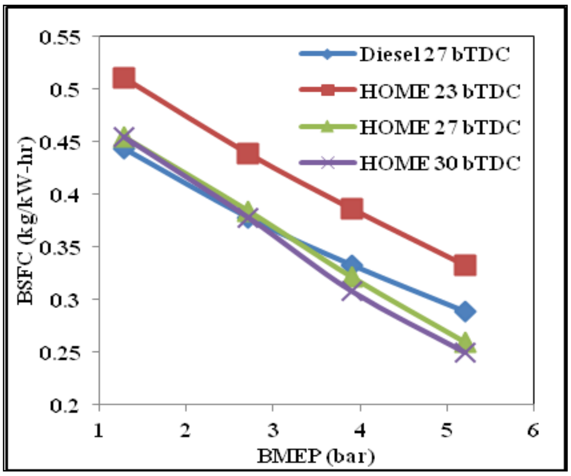

Figure 16: Variation of BSFC v/s BMEP

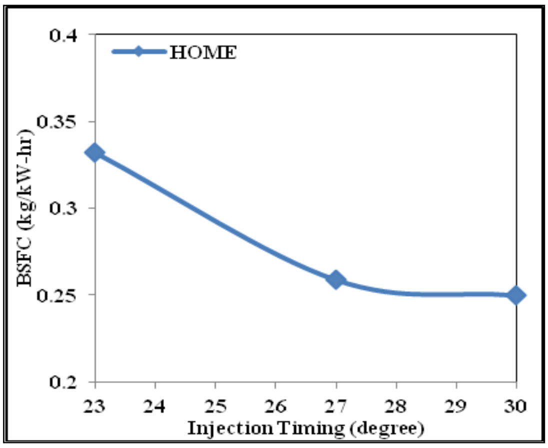

Figure 17: Variation of BSFC v/s IT

Table 1: Comparison of Properties of Raw Vegetable Oils and its Methyl Ester with Conventional Diesel Fuel.

Properties	Diesel	Raw Honge	HOME	Raw Cotton Seed	COME
Density (kg/m^3) at 40^{0}C	828	915	873	941	890
Specific Gravity at 40^{0}C	0.828	0.915	0.873	0.912	0.872
Kinematic Viscosity (centi stokes) at 40^{0}C	3.0	42.78	5.46	50	4.2
Calorific Value (kJ/kg)	42960	35800	38874	39600	40600
Flash Point (^{0}C)	56	231	171	220	142
Fire Point (^{0}C)	63	243	184	253	176
Iodine Value (gm I_2/kg)	38.3	82.78	90	96.4	100
Saponification Value	Nil	179.55	90	193.2	100

IV. CONCLUSION

1. Injector opening pressure increases from the rated value for diesel from 180 bar to 200 bar shows significant improvement in performance with COME and HOME. At injector opening pressure 220 bar performance inferior than injector opening pressure 200 bar.
2. Usage of bio diesel the performance characteristics has improved significantly when injection timing advanced by 3^0.
3. There is a significant improvement in the performance, when the injector opening pressure and injection timing properly optimized (say 200 bar and 30^{0}bTDC), when a diesel engine is operated with conditioned oils of COME and HOME.

V. REFERENCES

[1]. Kalam M.A, Husnawan M and Masjuki H.H ,"*Exhaust emission and combustion evaluation of coconut oil-powered indirect injection diesel engine*", Renewable nergy, Vol.28, pp.2405 to 2415, 2003

[2]. Sukumar Puhan, Vedaraman N, Sankaranarayanan and Bharatram V "*Performance and emission study of mahua oil methyle ester in a four stroke naturally aspirated DI dieel engine*" Renewable Energy 30, pp 1269 to 1278, 2005

[3]. Nagaraja A.M and Prabhukumar G.P "*Effect of Injection pressure on the engine performance with Ricebran oil as Biodiesel*", XVIII NCICEC, pp.581 to 587, 2003

[4]. Bhanodaya G. Reddy, Redy K.V and Ganeshan V, "*Utilization of non-edible vegetable oil in diesel engine*", XVII NCICEC, pp. 211 to 214, 2001

[5]. Anjana Srivastava and Ram Prasad, "*Triglycerides-based diesel fuels*", Renewable and Sustainable Energy Reviews, Vol. 4, pp. 111 to 133, 2000

[6]. Yamane K, Ueta Atsushi and Shimamoto Yuzuru, " *Effects of High-Pressure Injection and Biodiesel Fuel Sources on Combustion and Emission Characteristics of a DI Diesel Engine*", Transaction of Society of Automotive Engineers of Japan, vol.32, no.2, pp 25 to 30, 2001

[7]. Avinashkumar Agarwal and Rajamanoharan K, "*Experimental investigations of performance and emissions of Karanjaoil and its blends in a single cylinder agricultural diesel engine*", Applied Energy, Volume 86, Pages 106 to 112, 2009

[8]. Sawant Rath, "*Performance and Emission Analysis of blends of Karanja Methyl Ester in a Compression Ignition Engine*", Ph.D. thesis, N.I.T, Rourkela, 2011

[9]. Surendra R, Kalbande and Subhash D "*Jtaropha and Karanja Bio-fuel: An alternative fuel for diesel engine*", ARPN, Journal of Engg, and Applied Sciences, 3, 2008

[10]. Konthe G., "*Analyzing Biodiesel: Standards and Other Methods*", *J. Am. Oil Chem. Soc*., 83, pp823 to 833, 2006

[11]. Konthe G, "*Structures indices in FA chemistry, how relevant is the iodine value?*" J. Am. Oil Chem. *Soc.*, 9, pp847 to 853, 2002.

[12]. Shrivastava A. and Prasad R, "*Triglycerides based diesel fuel*", *Oil Energy Rev*., 4, pp111 to 113, 2000

[13]. Reid, J. F., Hansen A. C and Goering C. E. "*Quantifying diesel injector coking with computer vision*". Transactions of the ASAE 32(5): pp1503 to 1506, 1989

[14]. Ryan III, Dodge T. W., L. G, and Callahan T. J. "*The effects of vegetable oil properties on injection and combustion in two different diesel engines"*. J. Am. Oil Chem. Soc., 61(10): pp1610 to 1619, 1984

[15]. Gopalkrishnan K.P. and Rao P.S, "*Use of non-edible vegetable oil as alternate fuels in diesel engines*", DNES project report I.C.E. lab, Madras 36, 1996

[16]. Banwal B.K. and Sharma M.P, "*Aspects of biodiesel production from vegetable oils in India*", Renewable and Sustainable Energy Reviews, pp1 to 16, 2004

[17]. Surendra R., Kalbande and Subhash D., "*Jtaropha and Karanja Bio-fuel: An alternative fuel for diesel engine*", ARPN, *Journal of engg. and applied sciences,* 3, 1 2008

[18]. Senthil M. Kumar, Ramesh A. and Nagalingam B, "*Investigation on use of jatropha curcus oil and its methyl esters as a fuel in compression ignition engine*", International Journal of Institute of Energy, 74, pp24 to 28, 2001

[19]. Senthil M. Kumar, Ramesh A and Nagalingam B, "*An experimental comparison of methods to use methanol and jatropha curcus in a compression ignition engine*", International Journal of Institute of Energy, 25, pp301 to 318, 2003

[20]. Agrawal A.K, "*Vegetable oils verses diesel fuel development and use of biodiesel in compression ignition engine*", TIDE, 83, pp191 to 204, 1998