Experimental Investigation of Cotton Seed Oil and Neem Methyl Esters as Biodiesel On Ci Engine

K.Dilip Kumar[1] P.Ravindra Kumar[2]
[1,2]*Dept.of Mechanical Engineering,*
L.B.Reddy College of Engineering, Mylavaram-521230,JNTU, KAKINADA
A.P, India

Abstract: In a modern day world alternative source of energy are given importance due to gradual depletion of fossil fuels reserves vegetable oils can be used as an alternative to diesel in CI engines. The use of vegetable oils in CI engine results in low CO and HC emissions compared to conventional diesel fuel. The present study covers the various aspects of biodiesels fuel derived from cottonseed oil. Cottonseed oil is converted to cottonseed oil methyl esters by transesterification process

An experimental investigations were carried out on C.I.engine with Bio Diesel blends of cotton seed Methyl Esters and Neem Oil Methyl Esters .The engine used for the experiments was single cylinder Four Stroke water cooled, constant speed diesel engine . cotton seed Methyl ester (CSOME) and Neem oil methyl ester (NOME) are derived through transesterification process and parameters of transesterification were optimized. The blends of various proportions of the CSOME & NOME with diesel were prepared, analyzed and compared with diesel fuel, and comparison was made to suggest the better option among the bio diesel.

Various Tests have been carried out to examine properties, performance of different blends (C05, C10, C15, and C20) of CSOME and NOME in comparison to diesel. From the experimental Results it is indicated that C20 have closer performance to diesel. However, its diesel blends showed reasonable efficiencies. From the experimental results it is observed that cotton seed methyl ester gives better performance compared to Neem methyl esters and also the emissions and smoke for these diesel blends are less as compare to the pure diesel.

Keywords*:* Bio-diesel, Properties, Transesterification, Optimization, cottonseed oil methyl Ester (CSOME), Neem oil methyl ester (NOME)

I. Introduction

Energy is key input for technological, industrial, social and economical development of a nation. Five generations (125 years) ago, wood supplied up to 90% of our energy needs. Due to the convenience and low prices of fossil fuels wood use has fallen globally. The present energy scenario now is heavily biased towards the conventional energy sources such as petroleum products, coal, atomic energy etc, which are finite in nature besides causing environmental pollution. Of the available energy, the present energy utilization pattern is heavily biased for meeting the high energy requirement in urban and metropolitan cities. There are different types of BioDiesels are available such as Sunflower, Soyabean, Cottonseed, Linseed, Mahua, Jatropha, Pongamia, etc .[3]. The vegetable oils can be used in Diesel engines by various techniques such as fuel modifications by Transesterification , Diesel Vegetable blends and Vegetable oil heating etc.[4]. The present work was to investigate the evolution of Cotton seed and Neem seed oils with Diesel. Experiments were carried out at constant speed 1500 rpm and at different loads with different blends.

1.1 Fuel Modification

The alternative diesel fuels must be technically and environmentally acceptable and economically competitive. From the view point s of requirements, triglycerides (vegetable oils or animal fats) and their derivatives may be considered as viable alternative for diesel fuels [5]. The problems with substituting triglycerides for diesel fuels are mostly associated with high viscosity, low volatility and poly un-saturated character. The problems have been mitigated by developing vegetable oil derivatives that approximate the properties and performance and make them compatible with the hydro carbon based diesel fuels by following methods: Dilution (blending), Pyrolysis (cracking), Micro-emulsification [7] and Transesterification.

1.1.1 **Transesterification:**

Transesterification is the reaction of vegetable oil or animal fat with an alcohol, in most cases methanol, to form esters and glycerol. The transesterification reaction is affected by alcohol type, molar ratio of glycerides to alcohol, type and amount of catalyst, reaction temperature, reaction time and free fatty acids and water content of vegetable oils or animal fats. The transesterification reaction proceeds with or without a catalyst by using primary or secondary monohydric aliphatic alcohols having 1–8 carbon atoms as follows:

Triglycerides + Alcohol Glycerin + Mono-alkyl esters

Generally, the reaction temperature near the boiling point of the alcohol is recommended. Nevertheless, the reaction may be carried out at room temperature. The reactions take place at low temperatures (~65°C) and at modest pressures (2 atm, 1 atm = 101.325 kPa). Bio-diesel is further purified by washing and evaporation to remove any remaining methanol. The oil (87%), alcohol (9%), and catalyst (1%) are the inputs in the production of bio-diesel (86%), the main output . Pre-treatment is not required if the reaction is carried out under high pressure (9000 kPa) and high temperature (~240°C), where simultaneous esterification and transesterification take place with maximum yield obtained at temperatures ranging from 60 to 80°C at a molar ratio of 6:1. The alcohols employed in the transesterification are generally short chain alcohols such as methanol, ethanol, propanol, and butanol. It was reported that when transesterification of soybean oil using methanol, ethanol and butanol was performed, 96–98% of ester could be obtained after 1 h of reaction.

Table 1. Properties of Diesel and Crude Oils

S.NO	PROPERTY	DIESEL	COTTONSEED	NEEMSEED
1	Calorific Value	43,000 kJ/kg	39,648kJ/kg	35,125 kJ/kg
2	Flash Point	44^0 C	234^0C	178^0C
3	Fire Point	49^0 C	192^0 C	209^0 C
4	Viscosity	0.278 poise	2.52 poise	1.864 poise
5	Density	835 kg/m^3	850 kg/m^3	928 kg/m^3

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Table 1.1 Blending percentage of fuel

NOTATION	FUEL QUANTITY (Liters)	BIO-DIESEL QUANTITY (ml)	DIESEL QUANTITY (ml)
C10	1	100	900
C20	1	200	800
C30	1	300	700

Table 1.2 Properties of Pure Diesel, Cottonseed oil With Neem oil

Property	**Diesel**	**Cottonseed Methyl Ester**	**C10**	**C20**	**C30**
Heating value (kJ/kg)	43000	39648	42308	42116	41834
Carbon residue (% by weight)	<0.35	0.42	0.39	0.38	0.36
Density (g/cc)	0.815	0.850	0.830	0.852	0.862
Kinematic Viscosity(cSt)	3.5	6.0	4.68	4.87	5.05

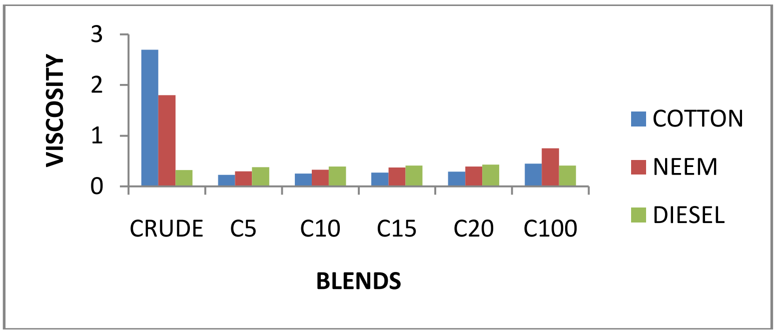

Fig. 1.Variation of viscosity of biodiesel blends and diesel

II. Experimental set up

The experimental set up used in this investigation is shown in Fig. 2. It consists of a single cylinder, four stroke, constant speed, water cooled, variable compression ratio, direct injection compression ignition engine with hemispherical open combustion chamber. The fuel injection system of the engine comprised of a plunger type pump with an injector having three spray holes, each 0.28 mm diameter. The injector needle lift pressure and fuel injection timing of the engine are 210 bar and 27^0 before TDC respectively. The specifications of the engine are shown in Table 2.

A single cylinder four stroke water cooled diesel engine was coupled to an eddy current dynamometer with a load cell. The In-cylinder pressure was measured by piezoelectric pressure transducer (Kistler) fitted on the engine cylinder head. A crank angle encoder was used to sense the crank position. Exhaust gas analysis was performed using five gas exhaust analyzer (Netel Make).A Hartridge smoke meter was attached to exhaust pipe to measure smoke levels.

3.1 FUEL PROPERTY MEASUREMENT

The improvement in the performance of the CI engines, over the past century, has resulted from the complimentary refinement of the engine design and fuel properties. Calculate the fuel properties like flash point, fire point, specific gravity, calorific value for different oils for different blends using the suitable equipment. Some of the fuel properties include are

Flash point
Fire point
Specific gravity
Calorific value
Viscosity
Carbon residue

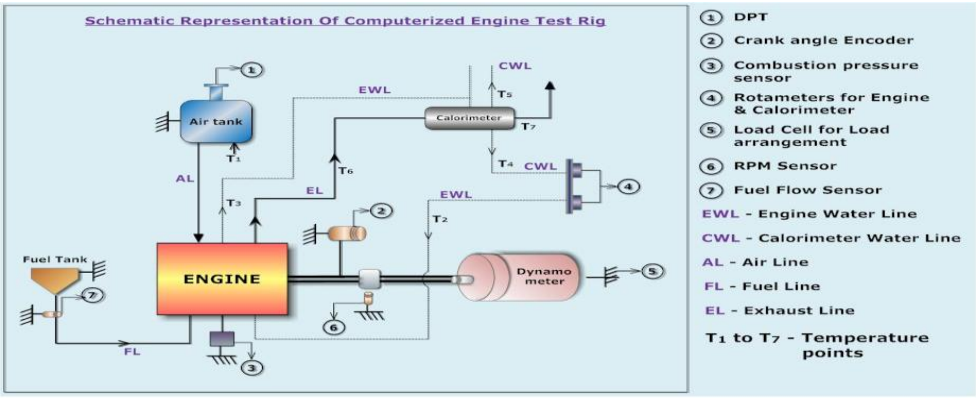

Fig. 2: Four Stroke Single Cylinder Diesel Engine setup

Table 2: Engine specifications

Manufacturer	Kirloskar engines Ltd, Pune, India
Engine Type	Four stroke, single cylinder, constant speed, compression ignition engine
Rated power	3.7 kW at 1500 RPM
Bore	80 mm
Stroke	110 mm
Swept volume	553 cc
Compression Ratio	12.5 to 21.5
Mode of injection	Direct injection
Cooling system	Water
Dynamometer	Eddy current dynamometer

Table 3: Properties of diesel fuel

Cetane number	53
Density at 30 ^0C	836 kg/m^3
Viscosity at 40^0C	2.68 mm^2/s
Calorific value	42500 KJ/ Kg


(a) (b)

Fig;3(a) 4- Stroke diesel engine (b) Dynamometer

III. PERFORMANCE

The performance test was conducted on Single cylinder 4-stroke Diesel Engine with water cooling, constant speed which is coupled to Rope brake dynamometer. Initially the engine was tested with Pure Diesel and later on with different blends of the LSOME and NOME with Diesel were prepared, analyzed and compared with Diesel Fuel, and comparison was made to suggest the better option among Bio Diesel blend, however its Diesel blends showed reasonable efficiencies. Different engine performance parameters like Brake Power, Brake Thermal Efficiency, bsfc, IP, CV, Mechanical Efficiency etc were determined and results were plotted with respect to load.

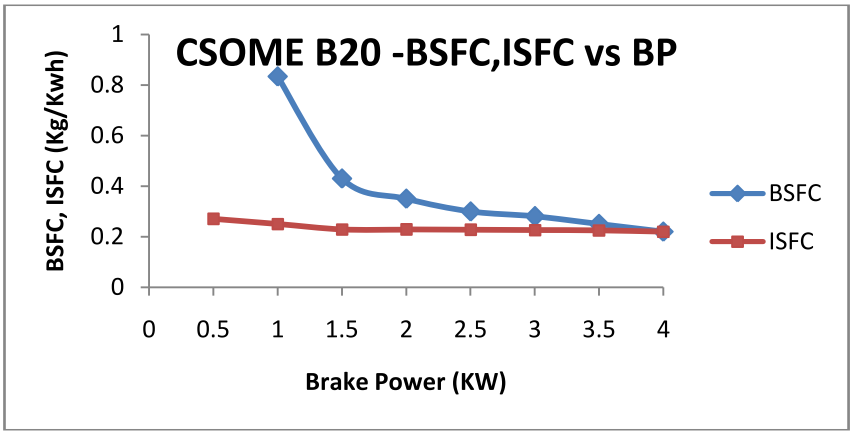

Fig. 3: Variations of CSOME C20-BSFC, ISFC Vs BP

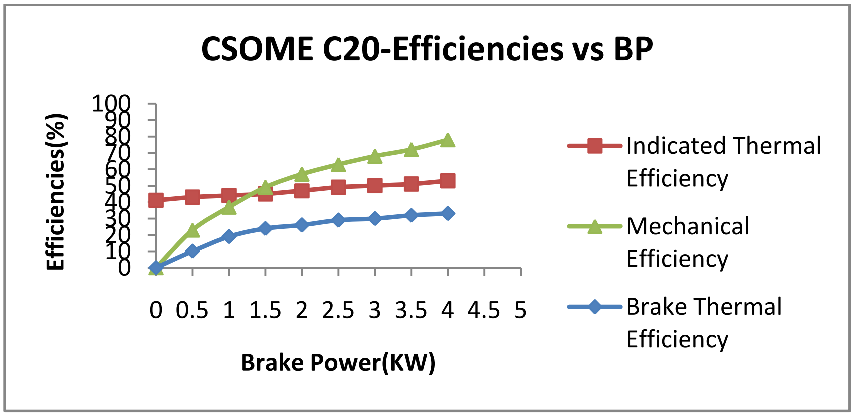

Fig 4: Variations of CSOME B20-EFFICIENCIES Vs BP

IV. RESULTS AND DISCUSSION

From the results obtained from experiments of Diesel and its blends the graphs were plotted with respect to load.

5.1 FUEL CONSUMPTION

The fuel consumption characteristics of an engine are generally expressed in terms of specific fuel consumption in kilograms of fuel per kilowatt-hour. It is an important parameter that reflects how good the engine performance is. It is inversely proportional to the thermal efficiency of the engine.

- Sfc = Specific fuel consumption per unit time/power

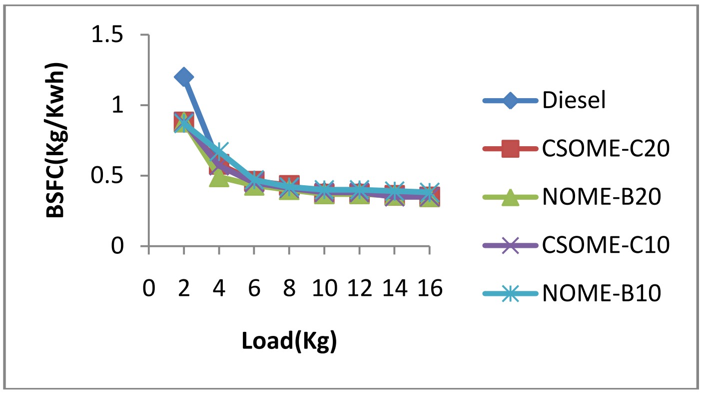

Fig 5: Variations of BSFC vs Load of CSOME & NOME blends with Diesel

From the above plot, it is observed that the brake specific fuel consumption (bsfc) for CSOME and NOME with Diesel are decreasing and these blends were giving better values as compared to the diesel fuel.

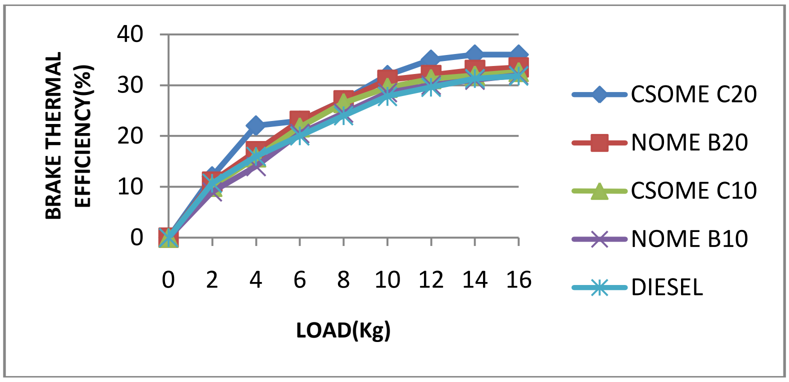

Fig 6: Variations of Brake Thermal Efficiency vs Load of CSOME & NOME with Diesel

From the plot, it is indicated that the Brake Thermal efficiencies of CSOME and NOME are slightly higher values as compared the Diesel because of complete combustion.

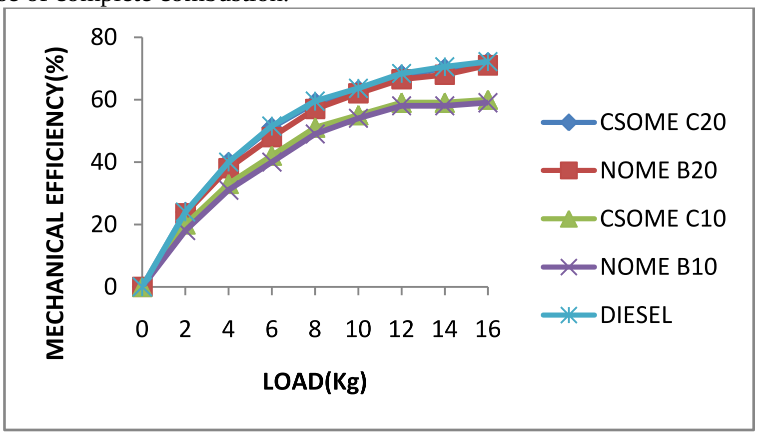

Fig 7: Variations of Mechanical Efficiency vs. Load of LSOME & NOME with Diesel

From the plot it is observed that Mechanical efficiency in case of Diesel with CSOME & NOME blends has been found that the mechanical efficiency is on par when compared to Diesel but a slight drop of efficiency was found with methyl esters (bio-diesel) when compared with diesel. This drop in thermal efficiency must be attributed to the poor combustion characteristics of methyl esters due to high viscosity. It was observed that the brake thermal efficiency of C10 and C20 are very close to brake thermal efficiency of diesel. C20 methyl ester had equal efficiency with diesel. So C20 can be suggested as best blend for bio-diesel preparation.

V. CONCLUSION

In the current investigation, it has confirmed that COTTONSEED and NEEM oil may be used as resource to obtain the bio diesel. The methyl esters of Cottonseed and Neem seed along with diesel may reduce the environmental impacts of transportation and also reduce the dependency on crude oil imports, and also provide employments in agricultural field. The conclusions are summarized as follows.

1. There was increase in Brake Thermal Efficiency of CSOME –C20 as compared to Pure Diesel because of complete combustion.
2. It was observed that the smoke and emissions for the blends of CSOME and NOME are less as compared to Pure Diesel.
3. Properties of the 20% blend of LSOME are nearer to the Diesel Fuel.
4. Thus the above investigations suggest that blend of CSOME – C20 is the optimum blend which can produce better values with Pure Diesel for Diesel engines as far as performance and emissions were considered.

References

[1] Srinivasa rao. P, Goplalakrishna KV. “Esterified oils as fuels in diesel engines”, 11th national conference on IC Engines, IIT Madras, India, 1983.
[2] Tomasevic AV, Marinkovic SS “Methanolysis of used frying oil”. Fuel process technology 2003; 81:1-6.
[3] A.S Ramadhas, S.Jayaraj, C Muraleedharan, “use of vegetable oils as IC engine fuels A review”, Renewable energy, Vol.29,203,727-742.
[4] Canakci and Vam Geroen (2003) “A pilot plant to produce biodiesel form high free fatty acid feedstock”, American society of agricultural engineers, 46(4), PP: 945-954
[5] Jon H. Van Gerpen, Charles L. Peterson, Carroll E. Goering, Biodiesel: An Alternative Fuel for Compression Ignition Engines, For presentation at the 2007 Agricultural Equipment Technology Conference Louisville, Kentucky, USA 11-14 February 2007.
[6] ASTM. 2002. D 6751 – Standard specification for biodiesel fuel (B100) blend stock for distillate fuels. West Conshohocken, Penn: ASTM International..
[7] Rupinder Sing, Biodiesel Production from Jatropha (Source- Kurukshetra, volume-55, No-4, February- Prof. (Dr.) R. K. Khotoliya, Dr. Harminder Kaur &2007).
[8] Knothe, G. 2005b. Cetane numbers—the history of vegetable oil-based diesel fuels. Chapter 2 in G. Knothe, J. Van Gerpen, and J. Krahl, eds. *The Biodiesel Handbook.* Champaign, Ill.: American Oil Chemists’ Society Press.
[9] Peterson, C.L. 1980. Vegetable oils—Renewable fuels for diesel engines. ASAE Paper No. PNW 80- 105. St. Joseph, Mich.: ASAE.
[10] Dizge N, Aydine C,Imer DY, Bayramoglu M, Tanriseven A, Keskinler B. Biodiesel production from sunflower, soybean and waste cooking oils by transesterification using lipase immobilized onto a novel microporus polymer.bioresour technol 2009;100:1983-91
[11] NBB. Biodiesel production and quality. Fuel fact sheets. Usa: National Biodiesel board:2007
[12] Bondioli p,Gasparoli A,Lanzani A, Fedeli E, veronese S, Sala M. storage stability of biodieseal. J Am oil chem soc 1995; 72:699-702.
[13] Bhattacharya S and Reddy CS (1994) Vegetable oils as fuels for internal combustion engines: a review, Instt.57, 157-166.
[14] Srivastava A and Prasad R (2000) Triglycerides –based diesel fuels, Renewable & Sustainable Energy Rev.4,111-133.
[15] Ayhan Demirbas , “ A Survey of Bio Diesel fuels from vegetable oils via Catalytic and Non Catalytic Alcohol Transesterifications and other methods” Journal of Energy Conversion and Management , September 2002.