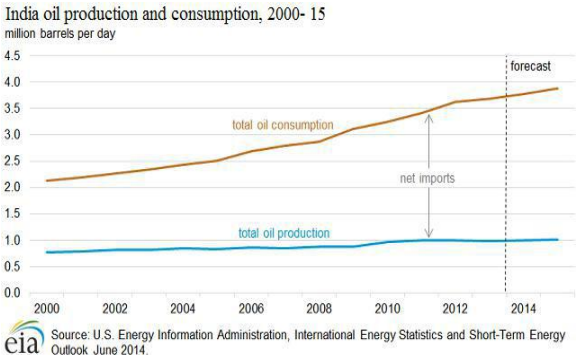
Performance Study on IC Engine Using Cotton Seed Oil

Prof. B. K. Purohit, Head
Automobile Department, GND Engineering College, Bidar

***Abstract*- Bio-diesel is an alternative to petroleum-based fuels derived from vegetable oils, animal fats, and used cooking oil including triglycerides. Vegetable oils are widely available from various sources, and the glycerides present in the oils can be considered as a viable alternative for diesel fuel. They have good heating power and provide exhaust gas with almost no sulphur and aromatic polycyclic compounds. In this work an attempt has been made to study various engine parameters using cotton seed oil to test its feasibility as bio-fuel.**

1. INTRODUCTION

Due to the increase in price of petroleum and environmental concern about pollution from automobile emission, use of biodiesel is an alternative solution. The world is confronted with the twin crises, i.e. fossil fuel depletion and environmental degradation. Alternative fuels promise to harmonize sustainable development, energy conversion, management, efficiency and environmental preservation. Vegetable oil is a promising alternative to petroleum products. The economic feasibility of biodiesel depends on the price of crude petroleum and the cost of transporting diesel over long distances to remote areas. It is a fact that the cost of diesel will increase in future owing to increase in its demand and limited supply. A great deal of research and development on internal combustion engines has taken place not only in the design area but also in finding an appropriate fuel. Many researchers have concluded that biodiesel holds promise as an alternative fuel for diesel engines, since its properties are very close to diesel fuel. The fuel properties of biodiesel such as cetane number, heat of combustion, and viscosity influence the combustion and so the engine performance and emission characteristics because it has different physical and chemical properties than petroleum based diesel fuel. The figure below shows the rate of total oil production and consumption from 2000 to 2015.



The use of vegetable oil for energy purposes is not new. As early as in 1900, a diesel-cycle engine was demonstrated to run wholly on groundnut oil at the Paris exposition. Even the technology of conversion of vegetable oil into biodiesel is not new and is well established. However the unprecedented rise in fuel prices recently has made it economically attractive. The present availability of vegetable oils in the world is more than enough to meet the edible oil requirements, and surplus quantity available can partially meet requirements of biodiesel production. However, there is a considerable potential to further enhance the oilseeds production in the world to meet the increasing demand for food and biodiesel.

2. LITERATURE REVIEW

A paper by Umer Rashid, Farooq Anwar, Gerhard Knothe [3] describes the production of biodiesel from cottonseed oil by transesterification with methanol using sodium hydroxide, potassium hydroxide, sodium methoxide and potassium methoxide as catalyst. A series of experiments were conducted to determine cetane number, flash point, fire point, kinematic viscosity, ash contents, density and free and bound glycerol.

Md.Nurun Nabi, Md.Mustafizur Rahman, Md.Shamim Akhter [4] during their research work different parameters for the optimization of biodiesel production from cotton seed were investigated in the first phase of this study, while in the next phase of

the study performance test of a diesel engine with neat diesel fuel and biodiesel mixtures were carried out. Cottonseed oil is non edible oil, thus food versus fuel conflict will not arise if this is used for biodiesel production.

Chen Jinsi; Wang Xiangyang; Hu Enzhu; Xu Yufu; Hu Xianguo; Pan Lijun; Jiang Shaotong et.al. [9] used a new process of biodiesel production by transesterification of cotton seed oil with ethanol using tetrahydrofuran (THF) as co-solvent. The result showed that the cotton seed oil can be conveniently used as biodiesel.

Review of above literatures encouraged to use cotton seed oil as bio-fuel in diesel engine to conduct performance study.

3. STUDY OF ENGINE PERFORMANCE

Engine performance is an indication of the degree of success with which the engine converts the chemical energy contained in the fuel into useful mechanical work. In the present study cotton seed oil is the working fuel. In the present study the basic parameters chosen are:

1. Brake specific fuel consumption [BSFC]
2. Brake thermal efficiency
3. Mechanical efficiency
4. Volumetric efficiency
5. Exhaust gas temperature
6. Cylinder pressure

The trials are conducted on single cylinder, four stroke, vertical, water cooled, direct injection computerized Kirloskar make CI engine using diesel and cotton seed oil. The experiment was conducted under varying load of 0, 3, 6, 9, and 12 Kg. with injection pressure of 200 bars. Firstly the normal diesel engine is run with diesel fuel under variable load conditions. The readings are always recorded after the engine attains stability of operation after 4-5 minutes of running. Then Cotton seed oil is used in place of diesel at different temperatures. The performance parameters such as Brake Thermal Efficiency, Indicated Thermal Efficiency, Brake Specific Fuel Consumption (BSFC), Exhaust Gas Temperature (EGT) and Mechanical Efficiency and Combustion parameters such as cylinder pressure, net heat release rate and rate of pressure rise are evaluated. These performance and combustion parameters of oils are compared to those of pure diesel. Observation tables are as given below:

Trial on diesel

S. No.	Load in Kg.	Speed in RPM	Fuel consumption in cc/min.	Exhaust gas temperature in ^{0} C
1	0	1592	8	154
2	3	1585	12	213
3	6	1536	14	261
4	9	1547	18	321
5	12	1545	21	388

Trial on pure cotton seed bio-diesel

S. No.	Load in Kg.	Speed in RPM	Fuel consumption in cc/min.	Exhaust gas temperature in ^{0} C
1	0	1706	11	171
2	3	1700	16	239
3	6	1682	21	297
4	9	1671	23	369
5	12	1663	29	643

4. RESULTS OF THE TRAILS

The following tables show the results of trails on diesel engine with diesel and bio-diesel as fuels under same loading conditions

Trial on diesel

S. No.	BP in KW	IP in KW	Mechanical efficiency %	Brake thermal efficiency %	Volumetric efficiency %	Brake specific fuel consumption in Kg/KW/hr	Maximum pressure in bar
1	0	2.5	0	0	91.9	--	42.5
2	1	3.5	28	1.2	91.6	0.66	48.2
3	2	4.5	43.8	20	91	0.4	51
4	3	5.4	53.5	24	90.8	0.32	53.2
5	3.8	6.3	60.3	26	90.7	0.31	54.8

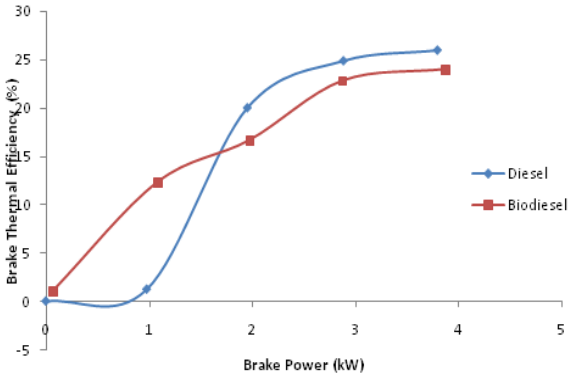
Trial on cotton seed bio-diesel

S. No.	BP in KW	IP in KW	Mechanical efficiency %	Brake thermal efficiency %	Volumetric efficiency %	Brake specific fuel consumption in Kg/KW	Maximum pressure in bar

						/hr	
1	0.06	2.6	2.4	1	90.5	--	41
2	1.1	3.5	32	12.3	90	0.8	46
3	2	4.5	45	16.7	88.8	0.6	48
4	2.9	5.4	54	22.8	87.8	0.44	50.3
5	3.9	6.3	63	24	87.5	0.42	51.3

5. CHARACTERISTIC CURVES AND DISCUSSIONS

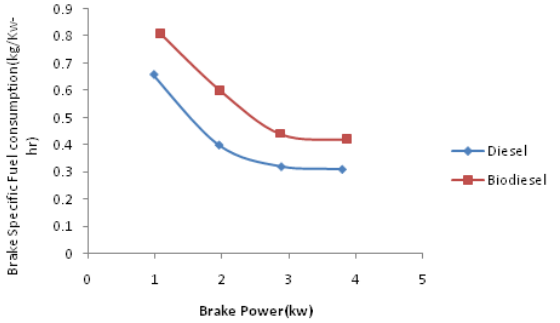
5.1 BTE Vs BP



Graph shows variation in brake thermal efficiency for different fuels. Lower brake thermal efficiency is observed with cotton seed bio diesel due to its higher viscosity and low volatility. Due to higher viscosity, injection of larger droplets causes slow evaporation, poor air- fuel mixing and slow combustion which results in lower thermal efficiency.

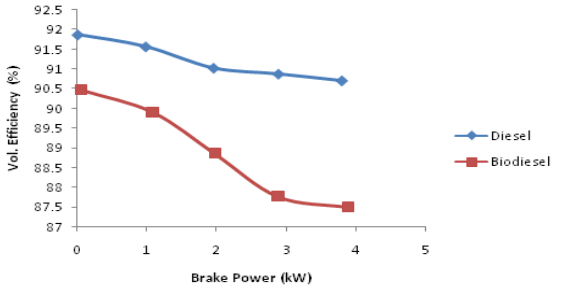
5.2BSFC Vs BP

Graph below shows that variation in brake specific fuel consumption for different fuels. Bio diesel shows higher BSFC due to its lower calorific value, higher viscosity and higher density as compared to diesel. This shows increase in mass of fuel flow of vegetable oils based fuels for obtaining same power as that of diesel.



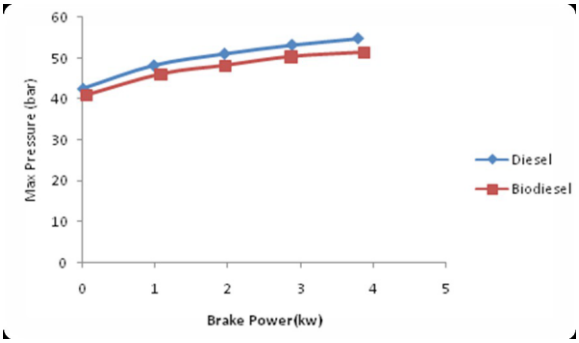
5.3 η_{Vol} Vs BP

Graph of volumetric efficiency vs brake power shows that volumetric efficiency depends on the amount of air sucked during suction stroke which in turn depends on temperature of the residual exhaust gases present in engine.



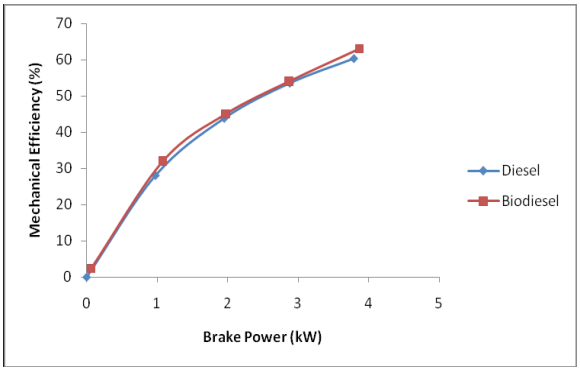
5.4Pmax Vs BP

Graph below shows variation in cylinder pressure with crank angle at full load with BP for different test fuels respectively. The peak cylinder pressure depends on quantity of fuel burnt during pre-mixed phase of combustion. Lowest peak cylinder pressure is observed with bio diesel due to its poor combustion



5.5ηmech Vs BP

Below graph shows variation in mechanical efficiency with brake power. It is observed that with bio diesel mechanical efficiency is higher as compared to diesel due to better lubrication property as compared to diesel.



6. CONCLUSION

The diesel engine performance characteristics were investigated with cotton seed oil as bio diesel and compared with those of diesel. Based on experimental investigations, the following conclusions are made.

a) The calorific value of cotton seed bio fuel is lower than that of diesel.
b) The specific gravity of cotton oil is higher than that of diesel.
c) The cotton seed bio fuel is more viscous compared to diesel.
d) The brake thermal efficiency with cotton seed oil is lower than that of diesel due to its higher viscosity.
e) The mechanical and thermal efficiency is found to be more than that of diesel at high temperature and high load.
f) Finally it can be said that Bio diesel can be used for compression ignition engine for short term operation without changing any engine parameters like IOP, FIT and compression ratio with reasonable good efficiency.

REFERENCES

[1] Md. Nurun Nabi, Md. Mustafizur Rahman, Md. Shamim Akhter; Biodiesel from Cotton seed Oil and its Effect on Engine Performance and Exhaust Emissions; Accepted on 14th November 2008.
[2] Umer Rashid, Farooq Anwar, Gerhard Knothe; "Evaluation of Biodiesel obtained from Cotton Seed Oil"; September 2009, Vol.90 (9), 1157-1163.
[3] Chen Jinsi; Wang Xiangyang; Hu Enzhu; Xu Yufu; Hu Xianguo; Pan Lijun; Jiang Shaotong; " Biodiesel Production by Transesterification of Cottonseed Oil with Ethanol using Tetrahydrofuran as a Co solvent" 2011 International Conference on Materials for Renewable Energy and Environment, 288-293.