Performance and Emission Characteristics of Diesel Engine Fuelled with Biodiesel of Mahua Oil & Diesel Blends with Additives.

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ABSTRACT

In the present work, biodiesel was produced from Mahua oil through esterification followed by transesterification .kinetic studies of optimize the preparation of Mahua oil Methyl Ester(MOME) were carried out varying different parameters like methanol / oil molar ratio, % of excess alcohol, Reaction time, temperature and concentration of acid catalyst .the result show that 4% H2SO4,0.30% v/v alcohol ratio, 1hr reaction time and 65(degree)c temperature are the optimum conditions for esterification. Optimum conditions for the production of bio diesel from oil are 2% sodium Methoxide, 0.20%v/v alcohol/oil ratio, 1hr reaction time, 65(degree)c temperature and 150% v/v excess alcohol the optimum conditions for tranesterification. The various fuel properties of MOME were compared with ASTM and DIN standards. The fuel properties were to be comparable with that of diesel fuel. Mahua tree is found in abundance in most parts of India and from its chemical composition it is found that the oil is almost similar to that of other Non edible oils. It is concluded that the Mahua oil is also a potential raw material for biodiesel.

Inflation in fuel price and unprecedented shortage of its supply have promoted the interest in development of the alternative sources for petroleum fuels. In this present work, investigations were carried out to study the performance, emission and combustion characteristics of mahua Methyl ester. The results were compared with diesel fuel, and the selected mahua methyl ester fuel blends. For this experiment a single cylinder, four stroke, water cooled diesel engine was used. Initially the engine was run methyl esters added by volume basis and the readings were taken. Tests were carried out over entire range of engine operation at varying conditions of load. The engine performance parameters such as specific consumption, break thermal efficiency, exhaust gas emissions are reduced with increase biodiesel concentration. The experimental results provide that the use of biodiesel in compression ignition engine is a viable alternative to diesel. Additives to add the mahua oil Diethyl ether(DEE),Ethanol used it decrease to NOX,PM and slight changes from CO,HC.

Keywords:-Mahuaoil, Bio0diesel, Ethanol, Diethyl ether, Emission Characteristics.

I. INTRODUCTION

Due to recent energy crises and dwindling reserves of crude oil the demand for alternate liquid fuels particularly the diesel is increasing. Bio-fuels are being given serious consideration as potential sources of energy in the future, particularly in developing countries like India. The use edible oil to produce biodiesel in India is not feasible in view of big gap in demand and supply of such oil. As India is deficient in edible oils some developmental works have been carried out by government of India for producing bio diesel from nontraditional oil jatraopha, karnaja, neem, undi, sal, etc. bio diesel from mahua seed is important because most of the states of India are tribal where is found abundantly. Mahua seed contain 30-40 percent fatty oil called mahua oil. The mahua tree starts bearing seeds from seventh year of planting. Mahua seed oil is a common ingredient of hydrogenated fat of India. It is obtained from the seed kernels and is pale yellow, semi solid fat at room temperature. It is also used manufacture of various products such as a soap of glycerin, crude mahua oil generally contains high % free fatty acid and conversion of FFA to bio diesel is very important .properties of bio diesel depends esterification. From the chemical composition it is found that mahua oil is almost similar to that of other non-edible oils. It is prime reason behind selecting mahua oil as the raw material for bio diesel production .four well known processes are used reduce the viscosity, namely, dilation, pyrolysis, micro emulsion and transesterification however is the current method of choice for study, which results in a fuel similar to diesel. transesterification .Transesterification how ever is the current method of choice for study , which results in a fuel diesel .transesterification is the current method of choice for study ,which results in similar to diesel .transesterification is are action between a triglyceride and alcohol present in the in alkali

catalyst to produce glycerol and ester. The modulator weight of ester molecules is one-third of oil and of low viscosity. However higher ratio of alcohol to oils is generally employed to obtain bio diesel of low viscosity and high conversion. Alkali-catalyzed transesterification is very fast compared to acid catalyzed. Methanol or ethanol is widely used for transesterification. In this study, mahua oil methyl ester was prepared by using alkali catalyst of sodium methoxide by transesterification process.
Trans-esterification conversion completed of oil contains higher amount of FFA in which case it will form soap with alkaline catalyst. The soap can prevent separation of the bio diesel from glycerin. Crude mahua oil contains about 30%FFA, which is far beyond the 1% level. The production of FFA <1% is best esterification followed by transesterification. In the transesterification reaction excess of methanol is used to cause fast reaction and high degree conversion. The transesterification requires an alkali catalyst such as NaOH, or KOH which are preferred due to their low cost and large availability . although the ester is the major product ,desired recovery of glycerol is important as industrial uses. In the study, mahua oil methyl ester was prepared by using alkali catalyst as sodium methoxide. The problem with processing these low cost oil fats is that they after contain large amount free fatty acids that cannot be converted to bio diesel using alkaline catalyst. Therefore, two step esterification process is required for these feedstock's. Initially the FFA of these can be converted to fatty acid methyl esters an acid catalyzed pretreatment and second step transesterification completed by using alkaline catalyst to complete the reaction. If the oil has high free fatty acid content more water, acid catalyzed transesterification is suitable. The stochiometric ratio for transesterification requires three moles of alcohol and one mole of glycerol. Reaction time is controlling factor in determining yield of methyl esters. It has been observed that during the transesterification reaction, the reactants initially form a two phase liquid system. The mixing effect has been found to play a significant role in the slow rate of reaction. As phase separation cases, mixing becomes insignificant. The effect of mixing of kinetics of the transesterification process forms the basis for process scale up and design. In this present work experimental investigations have been carried out the different properties of mahua oil. Bio diesel (Mahua oil Methyl Ester) prepared from mahua oil through transesterification process. Different properties of the mahua oil and its methyl ester are determined. Kinetic studies to optimize the preparation of Mahua oil Methyl Easter(MOME) were carried out varying the different parameters like methanol/oil molar ratio,% of excess alcohol, reaction time, temperature and concentration of acid catalyst.

$$\%FFA = \frac{(Vx\ Normality\ of\ KOH\ x\ 56.1)}{(Mass\ of\ oil)}$$

Where V: volume of 0.1 mole K O H run down

1.1. ESTERIFICATION:

The products were cooled. The remaining product was analyzed for 500ml of Mahua oil free from contaminants and water was taken in the three-necked round-bottomed flask. Heat was supplied to the setup. Measured amount of sulphuric acid and methanol were added to the oil. Heat was supplied and stirred continuously maintaining a steady temperature. Reaction time was conducted for 1.5 hours. Intermittently samples were collected at regular intervals and acid value was determined. After the confirmation of complete reduction of acid value to 0.1 - 0.5, the heating was stopped acid value and it was found that the acid value varied from 0.1 to 0.5. This oil sample was further treated for Trans - esterification step to obtain methyl esters.

Fig:1.1. esterification process for Biodiesel

1.2. TRANSESTERIFICATION:

A known amount of oil was charged to a three-necked round-bottomed flask. Solution of

Properties of Biodiesel	Diesel fuel	B100(MOME)
Kineticmatic viscosity at 40°c(Cst)	4.1	4.97
Calorific value (Kj/Kg)	46000	39250
Density(Kg/m³)	0.8344	0.8810
Flash point (°c)	55	157
Fire point(°c)	65	203

known amount of catalyst sodium methoxide was prepared in methanol. The solution and the rest required amount of methanol was added to the oil sample. After proper closing of the flask it was put on mantle heater. The system was maintained airtight to prevent the loss of alcohol i.e. around 70° Celsius to speed up the reaction recommended reaction times varied from 1 to 2 hours. Excess alcohol was normally used to ensure total conversion of the oil to its esters. The formation of methyl ester is checked by using Thin Layer Chromatography (TLC) technique. Coated silica gel glass plates are spotted with Mahua oil and the product sample. The spotted samples are developed in the solvent system in glass chamber using solvent. The completion of Trans – esterification is found by spraying the developed plate with iodine. This procedure is followed for all the samples collected at regular interval of time to check the formation of methyl ester. After the confirmation of completion of methyl ester formation, the heating was stopped and the products were cooled and transferred to a separating funnel. The ester layer containing mainly methyl ester and methanol and the glycerol layer containing mainly glycerol and methanol were separated. The methyl ester was washed and dried under vacuum to remove traces of moisture.

Fig:1.2.Transesterification process for Biodiesel

1.3.Properties of Biodiesel:

Table:1.3.Properties of mahua oli

II. ENGINE AND EXPERIMENTAL SETUP

2.1. Description Of The Test Rig:

The setup consists of single cylinder, four strokes, water-cooled diesel engine coupled to eddy current dynamometer with the help of flexible rubber coupling is mounted on a centrally balanced base frame made of ms channels. The set up has stand alone fully powder coated panel box consisting of air box, fuel tank, manometer, fuel measuring unit digital indicators and transmitter for measuring various parameters. It is also provided with necessary sensors with transmitters for combustion pressure and crank angle measurements. All these signals are interfaced to computer through signal conditioner and signal converter for computerization. The engine is arranged with pre heated setup with thermo stator arrangement, as the process is fully arranged with computerized setup. As the thermo stator is arranged it automatically prefixes the inlet temperature of bio-diesel entering into engine.

Fig: 2.1: Experimental Setup of eddy current dynamometer

2.2. Test rig specification:

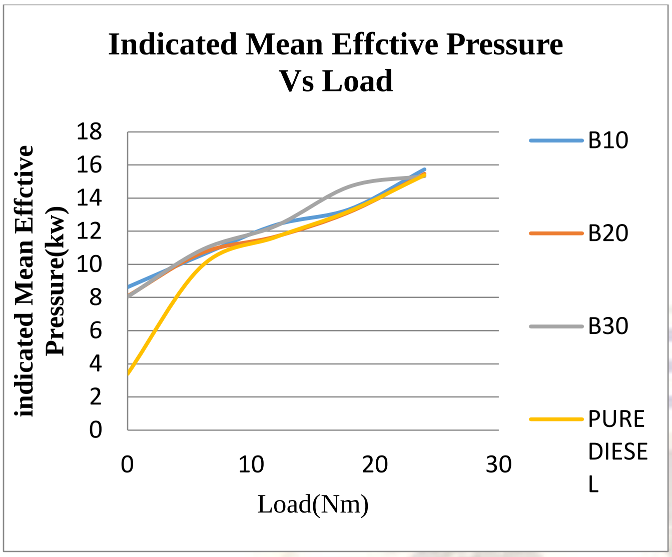
- ENGINE: 4 stroke 1 cylinder water cooled diesel engine
- Make: kirloskar
- Rated power: 3.7KW (5HP)
- Bore diameter: 80mm
- Stroke length: 110mm
- Connecting rod length: 234mm
- Swept volume: 562cc\
- Compression ratio:16.5:1
- Rated speed: 1500 rpm
- DYNAMOMETER: eddy current dynamometer
- Make: POWER MAG
- Rated torque:2.4kg-m
- Arm length: 150mm

III. RESULTS AND DISCUSSION

3.1. Indicated mean effective pressure:

The variation of indicated mean effective pressure with load is shown in fig.1.the plot it is reveals that as the the load increases the indicated mean effective pressure increases. At full load condition the IMEP obtained are 15.9 kw,15.7 kw,15.6 kw and 15.5 kw for B10,B20,B30 and pure diesel respectively. The IMEP of mahua oil blend

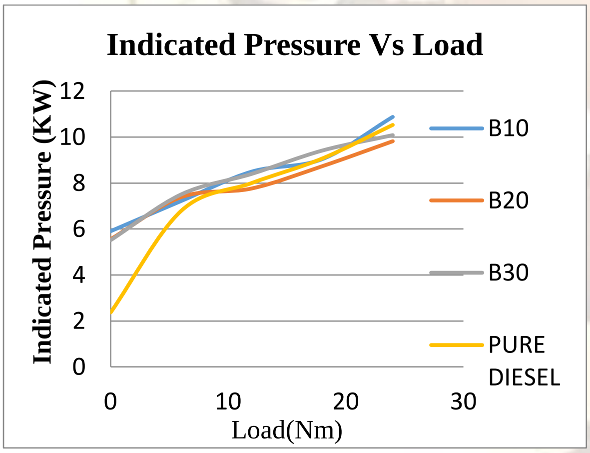
B10 increased when compared to the diesel at full load condition.



Graph:3.1. Indicated mean effective pressure vs load

3.2. Indicated Power(IP):

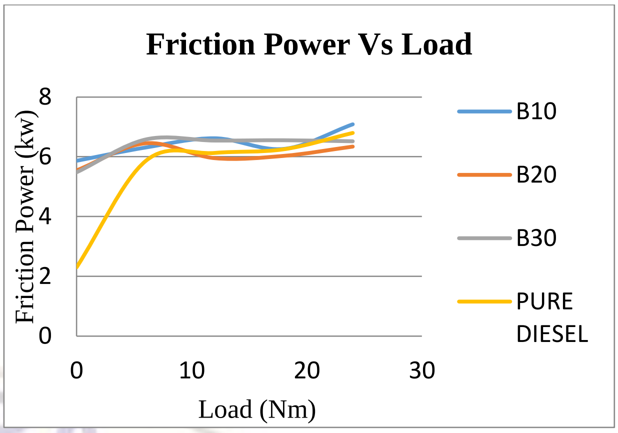
The variation of indicated power with load is shown in fig.:3.2.the plot it is reveals that as the the load increases the indicated power increases. At full load condition the indicated power obtained are 10.8 kw,9.8 kw,10 kw and 10.4 kw for B10,B20,B30 and pure diesel respectively. The indicated power of mahua oil blend **10 in**creased when compared to the pure diesel at full load condition.



Graph:3.2. Indicated pressure vs load

3.3.Friction Power:-

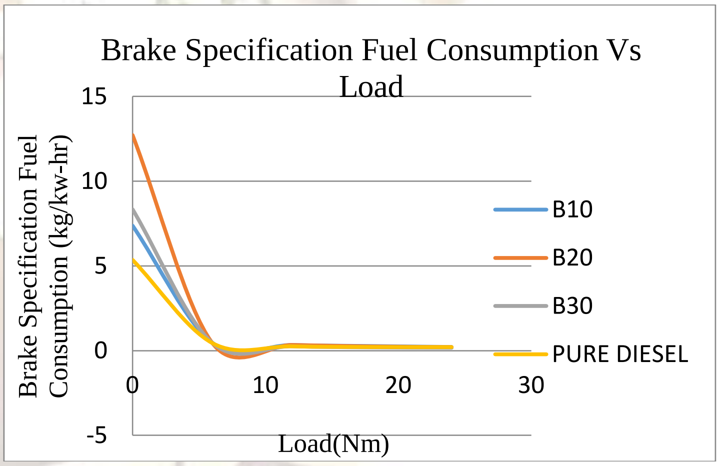
The variation of friction power with loac is shown in fig.3.the plot it is reveals that as the thi load increases the friction power increases. At ful load condition the friction power obtained are 7.: kw,6.2 kw,6.4 kw and 6.8 kw for B10,B20,B30 anc pure diesel respectively. The friction power o mahua oil blend 10 increased when compared to the pure diesel at full load condition.



Graph:3.2.Friction Power vs load

3.4.Specific Fuel Consumption (SFC):

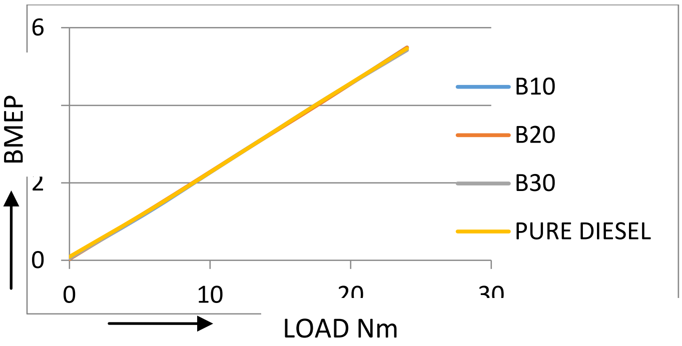
The variation of brake specific fuel consumption with load is shown in fig.4.the plot it is reveals that as the the load increases the fuel consumption decreases. At full load condition the BSFC obtained are 0.45kg/kw-hr, 0.42, kg/kw-hr,0.38,kg/kw-hr and 0.42kg/kw-hr for B10,B20,B30 and pure diesel respectively. The BSFC of mahua oil blend B30 decreased when compared to the diesel at full load condition.



Graph:3.4. Brake Specification fuel consumption vs load

3.5.Brake Mean Effective Pressure:-

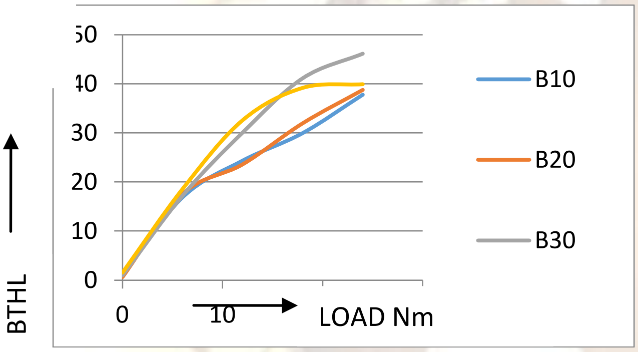
The variation of brake mean effective pressure with load is shown in fig..the plot it is reveals that as the the load increases the brake mean effective pressure increases. At full load condition the **B**MEP obtained are 5.7 kw,5.75 kw,5.6 kw and 5.7 kw for B10,B20,B30 and pure diesel respectively. The BMEP of mahua oil blend B10 increased when compared to the diesel at full load condition.



Graph:3.5. Brake Mean Effective pressure vs load

3.6.Brake Thermal Efficiency:-

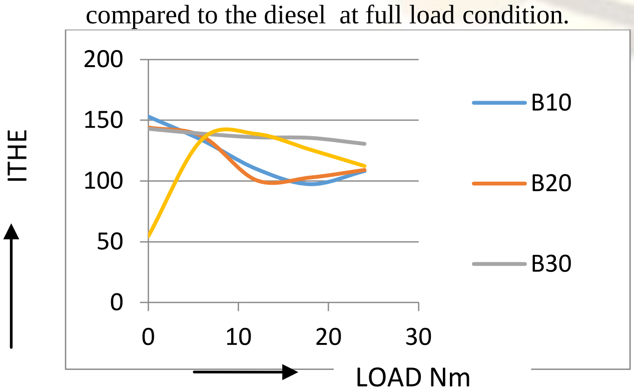
The variation of brake thermal efficiency with load is shown in fig..the plot it is reveals that as the the load increases the brake thermal efficiency increases. At full load condition the BTEH obtained are 37%,39%,46% and 49.5%for B10,B20,B30 and pure diesel respectively. The BTEH of mahua oil blend B30 increased when compared to the diesel at full load condition.



Graph:3.6. Brake Mean Effective pressure vs load

3.7.Indicated Thermal Efficiency:-

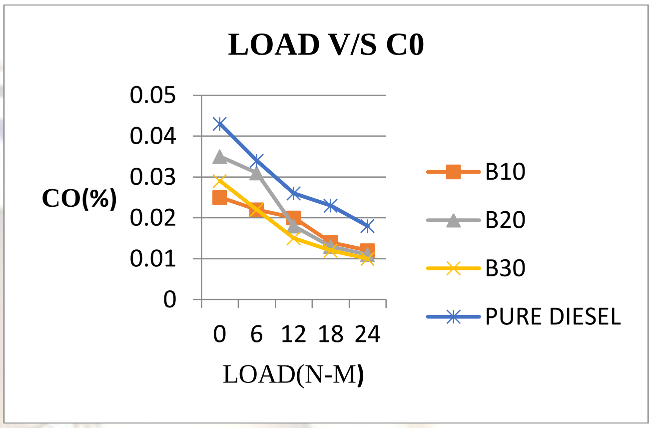
The variation of indicated thermal efficiency with load is shown in fig..the plot it is reveals that as the the load increases the indicated thermal efficiency increases. At full load condition the ITEH obtained are 37%,39%,46% and 49.5%for B10,B20,B30 and pure diesel respectively. The BTEH of mahua oil blend B30 increased when compared to the diesel at full load condition.



Graph:3.6. Brake Mean Effective pressure vs load

3.8.Carbon Monoxide (CO):

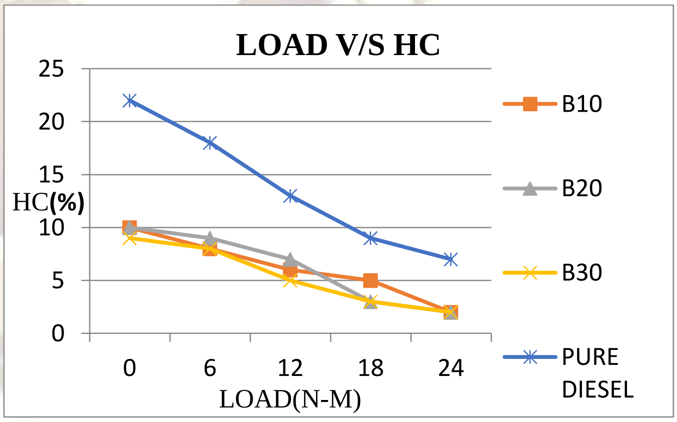
The variation of CO emission with load is shown in fig..the plot it is reveals that as the the load increases the CO emission decreases. At full load condition the CO emissions obtained are 0.018%, 0.012, 0.011 & 0.01 are diesel,B10,B20&B30 respectively. The CO emission of mahua oil blend B30 decreased when compared to the diesel at full load condition.



Graph:3.8. Compare CO emission with Diesel

3.9.Unburned Hydrocarbon (HC):

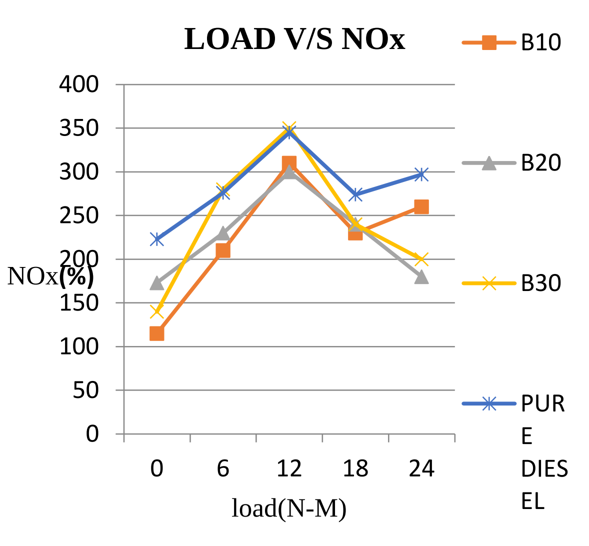
The variation of HC emission with brake power is shown in fig.6.the plot it is reveals that as the the load increases the HC emission decreases. At full load condition the HC emissions obtained are 7ppm,2ppm,2ppm&2ppm are diesel,B10,B20,B30 respectively. The HC emission of mahua oil blend **B30** decreased when compared to the diesel at full load condition.



Graph:3.9. Compare HC emission with Diesel

3.9.OXIDES OF NITROGEN (NOx):

The variation of NOx emission with brake power is shown in fig.6.the plot it is reveals that as the the load increases the NOx emission decreases. At full load condition the NOx emissions obtained are 297ppm,260ppm 180ppm & 200ppm respectively. The NOx emission of mahua oil blend B20 decreased when compared to the other blends at full load condition



Graph:3.9. Compare Nox emission with Diesel

IV. CONCLUSION

The conclusions derived from present experimental investigation to evaluate to performance and emission characterististics on four stroke single cylinder diesel engine fueled with diesel,mahua oil blenas with ethonal and diethyal ether as summarized as follows

I. The biodiesel process of mahua oil estirification,transterification,process arebetter improved it.
II. Brake thermal efficiency increased with all blends when compared to the conventional diesel fuel.
III. CO, HC and NOx Emission are decresed significantely with the blend when compared with diesel.
IV. The brake specific fuel consumption is decresed with the blends when compared to diesel.
V. From the above analysis the blend B 20 Shows the better performance comparared to other blends.

REFERENCE

[1] Y.C.Sharma and bhaskar singh,"A Y.C.Sharma and bhaskar singh,"A hybrid feed stock for a very efficient preparation of biodiesel",fuel processing teachnology, vol.91,pp.1267-1273,2010.
[2] Cjlkilc s.ayden, r.behcet ,H.Aydin, "biodisel fuel from safflower oil and its application in a diesel engine", fuel processing technology, vol.92,pp.356-362,2011.
[3] methanol", fuel, vol 80,pp.225-231,2001Issn (0975-7384) JCPRC.
[4] Phuan s, vedaraman n, Biomass and Bioenergy.2005; 28:87-93.
[5] Hideki f,Akihiko K, hideo N, journal of bioscience and bioengineering.2001; 92 (5): 405-416.
[6] A.S.Ramadhas,S.Jayaraj, C.muraleedharan, "biodiesel production from high FFA rubber seed oil",fuel,vol.84,pp.335-340,2005
[7] Indian streams research journal volume 2, issue7,aug 2012 ISSN:-2230-7850
[8] J.Chem.pharm. Res.,2011,3(2):39-49 ISSN No:0975-7384 CODEN(USA):JCPRC5
[9] International journal of engineering sciences & emerging technologies, Feb.2013. ISSN:2231-6604 VOL 4, Issue 2,pp:96-104 IJESET