OPEN ACCESS INTERNATIONAL JOURNAL OF SCIENCE & ENGINEERING

EXPERIMENTAL EVALUATION OF THE TRANSESTERIFICATION OF CALOPHYLLUM INOPHYLLUM OIL USING DIFFERENT BLENDS

Mr.P.DHANUNJAYA KUMAR[1], Mr.M.RAVINDR[2], Mr.M RAJESH[3]

M.Tech student, Department of Mechanical Engineering ,MVR COLLEGE OF ENGINEERING & TECHNOLOGY, VIJAYAWADA,ANDHRA PRADESH[1]

Asst. Professor, Department of Mechanical Engineering, MVR COLLEGE OF ENGINEERING & TECHNOLOGY VIJAYAWADA,ANDHRA PRADESH[2]

Asst.Professor, Head of the department, Department of Mechanical Engineering, MVR COLLEGE OF ENGINEERING & TECHNOLOGYVIJAYAWADA,ANDHRA PRADESH[3]

[1]dhanu5735@gmail.com,[2]Ravihavi.markatudi@gmail.com,[3]mulpurrajesh@gmail.com

---

Abstract: In the present years, population of vehicles increased enormously which increases the demand of fossil fuel, The availability of conservative fuels decreased continuously, these reasons makes to find the alternative fuels especially biofuels . The use of biodiesel considerably reduced emission and increases the performance of the engine.

Now a days researchers have reported the possibility for the production of biodiesel from non edible oil jatropha curcus , pongamia pinnata etc. There is a best source of raw material that is calophyllum inophyllum oil for biodiesel production. In present study calophyllum inophyllum is used as fuel in C.I engine.

Blends such as CIME10,CIME20,CIME30,CIME100 are taken for the experiment From this blends CIME20 gives good results and for this blend Isobutanol is added as fuel additive with concentration of 10%,15%. The Performance was improved and emissions were reduced by using Isobutanol with CIME20.

∴ ∴ ∴

I INTRODUCTION

HISTORY:

DIESEL ENGINE Developed in the 1890s by inventor Rudolph diesel, the diesel engine has become the engine of choice for power, reliability, and high fuel economy, worldwide. Early experiments vegetable oil fuels included the French government and Dr. Diesel himself, who envisioned that pure vegetable oils could power early diesel engines for agriculture in remote areas of the world, where petroleum was not available at the time. Modern biodiesel fuel, which is made by converting vegetable oils into compounds called fatty acid methyl esters, has its roots in research conducted in the 1930s in Belgium, but today's biodiesel industry was not established in Europe until the late 1980s.

MODREN WORK:

Due to the widespread availability and low cost of petroleum diesel fuel, vegetable oil-based fuels gained little attention, except in times of high oil prices and shortage. World War II and the oil crises of the 1970's saw brief interest in using vegetable oils to fuels diesel engines. Unfortunately, the newer diesel engine designs could not run on traditional vegetable oils, due to the much higher viscosity of vegetable oil compared to petroleum diesel fuel. A way was needed to lower the viscosity of vegetable oils to a point where they could be burned properly in the diesel engine.

SCOPE FOR PRODUCTION OF BIO DIESEL IN INDIA:

Energy scenario in India:

The economic development of any country depends upon the source of energy. India being a developing country requires much higher level of energy to sustain its rate of progress.

The rapid mechanization in agriculture sector and other unorganized small scale industrial sector needs more and more oil and electricity in future. As per the current estimates, oil reserves in India will exhaust in next few years. It is estimated that oil demand and supply almost quadruple during the last quarter century. At present, India is enabling

to produce about one-third of the total petroleum fuels required. However, the remaining being imported which consume major share of foreign exchange earn by the country. The development and promotion of appropriate technology for utilizing.

INTERNALCOMBUSTIONENGINE ALTERNATE FUELS:

In general, two broad types of IC engines are spark ignition (SI) engine and compression ignition (CI) engine which are popular in the society as petrol and diesel engine respectively. SI engine uses fuels with high auto ignition temperature like petrol, alcohol and gaseous fuels. The combustion in this engine is initiated at a single location by a spark and the developed flame then propagates in to the pre-mixed fuel air mixture in a progressive manner. Whereas, in CI engine, fuels with low self- ignition temperature like diesel are used. In this engine, towards the end of compression process, fuel is injected to an environment of hot compressed air having a temperature higher than the self-ignition temperature of the fuel used which initiates combustion at several locations. The fuels of both SI and CI engines are commonly fossil based and have uncertain future because of their limited reserve and environmental impact. Hence to meet the international standard for both fuel consumption and exhaust emission, several proven options are being available starting from expensive engine hardware modification to cheaper alternative fuels. In Indian context, the use of existing IC engines with little or no modifications is a promising and viable solution which can only be possible through the route of alternative fuels. A number of non-traditional liquid and gaseous fuels are being tried in the existing internal combustion engines. The use of alternative fuels in both SI and CI engines are decided on the basis of their combustion characteristics. Some of the results obtained are of encouraging nature and need micro-level critical analysis for its sustainable application. Considering the need of the day, number of diesel engines used in agriculture and public transportation sector are far ahead of that of petrol engines. Therefore, it is more relevant to highlight the common features of diesel alternatives fuels.Non-traditional energy resources is coming up strategically as an emerging solution to the present energy and environmental crises. The planning commission of India has recommended two plant species i.e., Karanja and Jatropha for bio-diesel production and started working on bio-fuel project near about in 200 districts from 18 states in India.

ADVANTAGES & DISADVANTAGES OF BIO-DIESEL:

ADVANTAGES:

1. High energy return and displace petroleum based fuels.
2. Reduces life-cycle Greenhouse emission.
3. Reduces pollution.
4. Improves air quality and positive impact on human health.
5. Utilizing bio diesel where the conventional fuels are not available.

DISADVANTAGES:

1. Conversion of raw oil into bio-diesel is difficult
2. Time taken process.
3. NOx from the emission of bio-diesel is high when compared conventional fuels.
4. Some bio-diesels requires engine modifications.
5. io-diesel having low calorific value & high viscosity.

OBJECTIVES OF PRESENT WORK:

In the present project work the following objectives are met.

- Collecting requirements for the present work based on standard journals.
- Converting raw oil into bio-diesel.
- Make ready the computerized MFVCR engine.
- Conducting base line test using diesel.
- Checking the properties of bio-diesel and compare with the base line values.
- Checking the performance. Combustion and emission analysis of the calophyllum inophyllum bio-diesel with additives

II .LITERATURE REVIEW

The main purpose of this literature review is to provide background information on the issues to be considered in this work and to emphasize the relevance of the present study. An intensive literature survey has been carried out from bio-diesel and its blends in diesel engine.The chapter contain the information we have got from different papers.

In the present years non edible oils are easily obtained because of the availability. In the paper stated that potential calophyllum inophyllum as a most promising feed stock for biodiesel production In this paper, several aspects such as physical and chemical properties of crude Calophyllum inophyllum oil and methyl ester, fatty acid composition, Transesterification blending and engine performance and emissions of Calophyllum inophyllum methyl ester were studied. Overall, Calophyllum inophyllum appears to be an acceptable feedstock for future biodiesel production.

T.M.M. Marso et al. studied the production of biodiesel from calophyllum inophyllum seeds. In this biodiesel production raw oil is prepared and then the viscosity of the oil is reduced by the transesterification process.

Sahid at el studied the use of biodiesel in CI engine by using edible oils such as soybean oil, sunflower oil, cotton seed oil. It can reduce the emission reduced in the engine but it has one limitation for the use edible oil as biodiesel i.e. edible oils are used as the food crops in daily life due to its unavailability non edible oils are used as biodiesel.

Soo-young No studied the scope non edible oils in the present generation. Due to the unavailability of edible oils non edible oils are preferred. Non edible oil such as jatropha, Karanja, linseed, rubber are used as fuels. In this jatropha is used as biodiesel in CI engine and the results were obtained concluded that NOx emissions increased by the use of bio diesel and reduced CO and HC emissions compared to diesel.

B.AshokK.Nanda gopal, D.shakthi Vignesh stated Calophyllum inophyllum is a source of bio-diesel in India. The calophyllum trees in India can reduce the dependency on petroleum products. In present study different types of blends such as B100,B30,B60 are used for engine testing and comparing this results with conventional fuel. The results obtained by the engine shows performance characteristics increased by using calophyllum inophyllum bio-diesel with out any modification.

B.Ashok,k.Nanda gopal in the present study anti oxidant additives are used in calophyllum inophyllum bio-diesel to improve the performance of the engine. Anti oxidant additives such as Ethanox and Butylated hydroxytoluene are added to the calophyllum inophyllum biodiesel in different concentrations. Experimentation conducted then results are compared. Ethanox has better performance compared to the Butylated hydroxytoluene.

In this paper Effect of leaf extract from pongamia pinnataon the oxidation stability, performance and emission characteristics of calophyllum biodiesel from this paper oxidation stability of calophyllum inophyllum biodiesel can improved by adding leaf extract additive to the CIME20.due to the additive concentration emission OF CO and HC slightly increased compared to the diesel .

N. Yilmaz et al studied the effect of butanol additive on the performance and emission characteristics on the diesel engine. Additives are added to the biodiesel to improve the characteristics. Results are concluded that the reduced the NOx emissions and slight increase in the CO and HC emissions by the addition butanol in the concentration of 5% and 10%.

Al-Hasan studied the effect of Isobutanol addition to the diesel engine and the results are concluded that decrease brake thermal efficiency and increase the specific fuel consumption with the addition of Isobutanol compared to diesel engine.

The knowledge we have got from the studying the above papers

- Different sources of production of bio-diesel in India
- How to convert the raw oil into bio-diesel (transesterification)
- Modifications required for engine.
- Different parameters that have been considered while the test is conducting.
- Pollutants from the bio-diesel and base line.
- Improving the performance of the diesel engine by adding additives.

III .PREPERATION OF A BIODIESEL

Preparation of bio diesel involves following process.

1. Collection of seeds from the sources and converting into raw oil.
2. Pre-treatment
3. Acid-test
4. Esterification.
5. Transesterification.
6. Settling & separation
7. Water washing.
8. Post-treatment.

COLLECTION OF SEEDS FROM THE SOURCES AND CONVERTING INTO RAW OIL:

The dry & cleaned calophyllum inophyllum fruits from the different sources are collected sufficiently. By peeling the calophyllum inophyllum dry fruits seeds has been extracted. The seeds are now used for producing raw oil. The seeds are gently cleaned and crushed in an oil mill. In the oil mill the seeds are fed into hopper and crushed by using helical grooves, due to high pressure, the seeds are crushed then raw oil & oil cake are the by products from this sources. The oil recovery was calculated to be near about 27%.We extracted (200 – 250) ml of oil by grinding 1kg of calophyllum inophyllum seeds.

All the crude calophyllum inophyllum oil was having high viscosity value. In order to use straight vegetable oil (SVO) in the engine, viscosity was to be reduced which can be done by heating the above oil. Other problems associated with using it directly in engine include carbon deposits, oil ring sticking, lubricating problem and also formation of deposits in the engine

due to incomplete combustion. In order to reduce viscosity, transesterification process was adopted. Transesterification technique is to convert high FFA and high viscous fluid to low FFA and low viscous fuel, namely calophyllum inophyllum biodiesel. Since the crude calophyllum inophyllum oil acid value was found to be more than 24-29, so acid Esterification and transesterification techniques was adopted.

FIG. .1 CALOPHYLLUM INOPHYLLUM TREE, SEEDS

PRE-TREATMENT:

The pre-treatment involves following processes.

- □ Removing all dust particles by using filter papers.
- □Heating the raw oil up to above the boiling temperature of the water to remove water content
- Keep that oil in an air tight seal bottle.

FIG..2 PRE-TREATMENT

HEATING:

Heating is the process to remove complete water content from the bio-diesel. Water content in the bio-diesel may damage the engine parts and reduces combustion process. so we have to remove all water content.

Equipment required:

- □ Heater with temperature indicator.
- □ Glass beaker.

In the heating process initially the obtained bio-diesel in taken in a glass beaker and placed on a heater. Switch on the heater and heat up to above the boiling temperature of the water to remove water content, and cool down that bio-diesel for 5 hours to get the bio-diesel at ambient temperature

Now the bio-diesel is used in any IC-ENGINE.

IV .PROPERTIES OF PREPARED BIO-DIESEL.

- Calorific value(CV)
- Flash point.
- Fire point
- Cloud point.
- Pour point.
- Cetane number.
- Acid value.
- Density.
- Viscosity.

4.2COMPARING THE PROPERTIES OF BIO-DIESEL WITH BASE LINE VALUES:

SL.NO	PROPERTY	CALOPHYLLUM INOPHYLLUM BIO-DIESEL	Isobutanol	DIESEL
1	CALORIFIC VALUE kJ/kg	38500	33100	41888
2	FLASH POINT(°c)	146	35	93
3	FIRE POINT(°c)	152	-	62-106
4	CLOUD POINT(°c)	7.5	-	-12
5	POUR POINT(°c)	-	-	-20
6	ACID VALUE mg/KOH	-	-	0.36 mg/KOH
7	DENSITY kg/m^3	878	825	849
8	KINETIC VISCOSITY mm^2/s	4.18	2.63	2.6
9	CETANE NUMBER	51.2	25	54.6

TABLE1:PROPERTIES OF A BIODIESEL USING WITH BASE LINE VALUE

Cetane number is a relative measure of the interval between the beginning of injection and auto ignition of the fuel. The higher the cetane number, the shorter the delay interval and the greater its combustibility. Fuels with low Cetane Numbers will result in difficult starting, noise and exhaust

smoke. In general, diesel engines will operate better on fuels with Cetane Number is above.

V .EXPERMENTAL SETUP

Details of test rig and its specifications:

The MFVCR engine test rig is a computer based analysis engine by using different sensors and thermocouples. The sensors are used in the present test rig that are used to find the speed, torque, fuel consumption etc., k-type thermocouples are used in the test rig to measure the temperature at various points.

Engine specifications:

- Engine: 4 stroke computerized variable compression ratio multi fuel direct injection water cooled engine
- Make: TECH-ED
- Basic engine: Kirloskar
- Rated power: 5 HP (DIESEL)
- Rated power: Up to 3 HP (PETROL)
- Bore diameter: 80mm
- Stroke length: 110mm
- Connecting rod length: 234mm
- Swept volume: 551cc
- Compression ratio: 5:1 to 20:1
- Rated speed: 1500 rpm

Initially the baseline test was conducted using diesel at various loads from no load to full load condition in five intervals(0%,25%,50%,75%,100%) . the performance and combustion are observed using engine test software which are loaded in the computer through interface The emission analysis is carried out Airval automation emission analyser and AVL smoke meter The six gas smoke analyser gives the percentage of CO (carbon monoxide) ,NOx (nitrogen oxide), SOx (sulphur oxide), oxygen (O2), carbon dioxide (CO2), HC(hydro carbons) and smoke meter will gives the amount of smoke coming from the engine.

FIG3. EXPERIMENTAL SETUP

SENSORS: The complete VCR engine is completely integrated with sensors to know the different characteristics during running of the engine. Sensor is a electronic device that sense the anything and convert that into electric signal form. The following are the sensors that are used in the present test rig.

- Torque measuring sensor.
- Speed measuring sensor (tachometer).
- Thermocouples.

  Combustion sensor.
  Fuel consumption measuring sensor.

- Water flow measuring sensor.

Torque measuring sensor:

Torque sensor is a electronic device that convert torque with respect to the load application into the digital form by using electric current.

Fig 4:Torque measuring sensor

Speed measuring sensor:

speed sensor is a electronic device that convert speed of the engine into digital form. The speed sensor is placed near the flywheel, based on the fly wheel revolutions it will convert that into digital form. By using this sensor no need any manual speed measuring devices like tachometer etc..

Fig.5: speed measuring sensor

VI .RESULTS AND ANALYSIS:

PERFORMANCE ANALYSIS:

BP v/s LOAD:

The BP v/s load graph will gives the information about the engine condition at different loads with respective to the BP is high at higher loads will ensure the use of that combination fuel the main consideration when working with any fuel BP and load are very more important when working with any fuel BP and load are very much important.

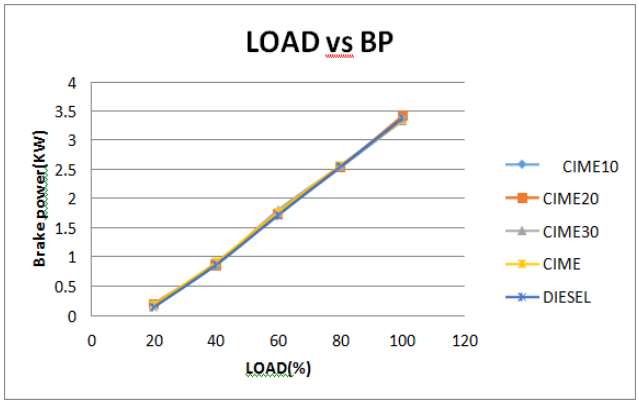

Fig 6:LOAD v/s BP diagram

BP vs SFC:

Specific fuel consumption consideration is mainly for economic purpose at higher loads condition at which fuel will give low SFC value that is used as economic fuel.

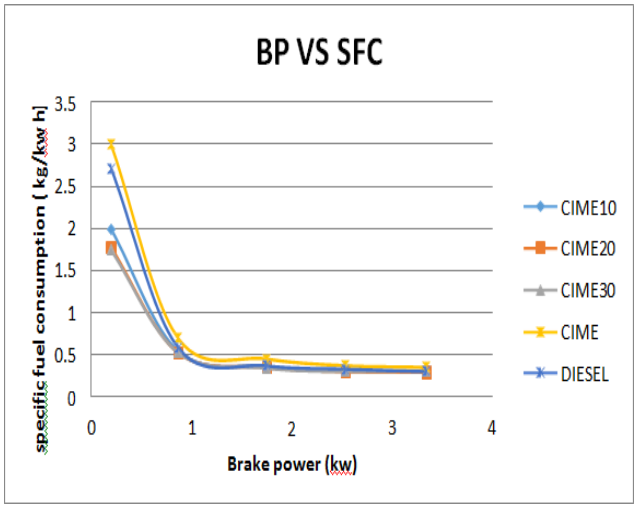

Fig 7:BP v/s SFC diagram

6.1.3BP v/s ηB the:

The performance analysis mainly depends on the BTHE, BP and BSFC. From this diagram we get how the BTHE is varies for different fuel combination with respective to the BP is to be formed at higher BP condition which having higher BTHE that will be considered as efficient fuel.

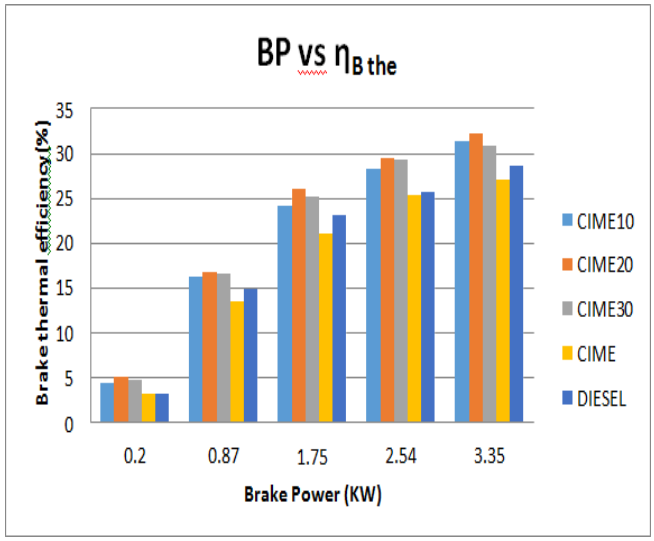

Fig 8 BP v/s ηB the diagram

6.1.4 BP vs ηVol

The plot of volumetric efficiency against BP as shown in fig.6.1.4Comparison of different blends with the diesel. Diesel has the highest volumetric efficiency compared to the blends. From the blends CIME20 has better volumetric efficiency at highest BP.

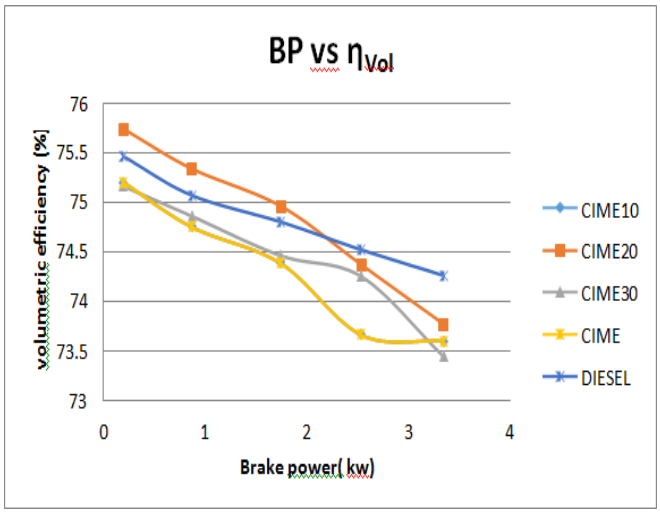

Fig 9: BP vs ηvol

EMISSION ANALYSIS:

Load v/s CO:

CO emissions from the engine occur due to partial oxidation of the fuel mixture. The rate of CO formation is a function of unburned fuel and mixture temperature during combustion. The variation of CO emissions against brake power is shown in Fig10It is observed that CIME20 has low emission of CO, at part load as compared with neat diesel. The CO emission is increased for higher loads.

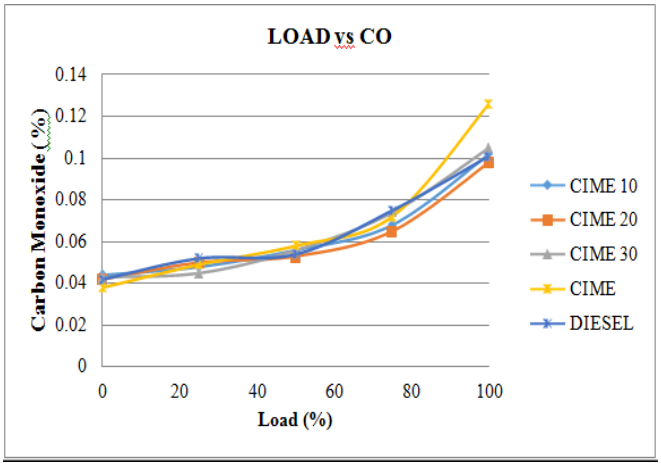

FIG10:Load vs CO diagram

Load v/s HC:

The comparisons of hydrocarbon emissions for straight diesel, biodiesel are shown in Fig.11While compared with base diesel, hydrocarbon emission was found in decreasing Rate in CIME20.From the figure all the parameters has small variations

.At full load condition CIME 20 has low hydrocarbon emission.

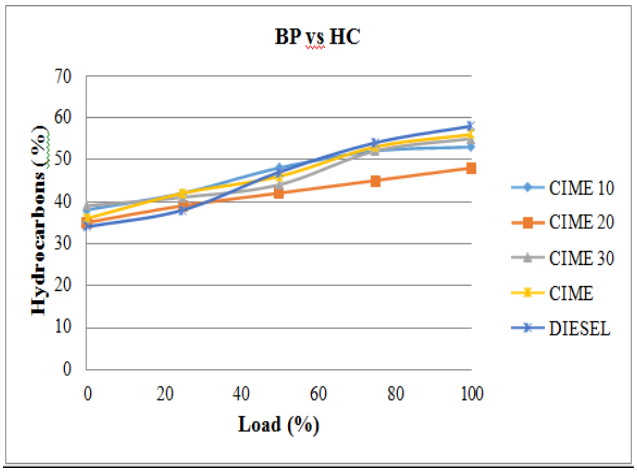

FIG 11:Load v/s HC diagram

Load v/s NOx:

NOX formation rate depends upon in-cylinder gas temperature. NO X forms at high temperature burned gas regions. The comparison of variations of NOx emission with different blends substitution is shown in Fig.8.2.3 There is a reduction was observed in NOx emission up to part load levels. It is evident NOx is increased by increasing the load. This may due to reduction in fresh air in the combustion, which increases the ignition delay resulting into reduced cylinder peak pressure temperature. From the above graph diesel has low emission compared to the other blends.

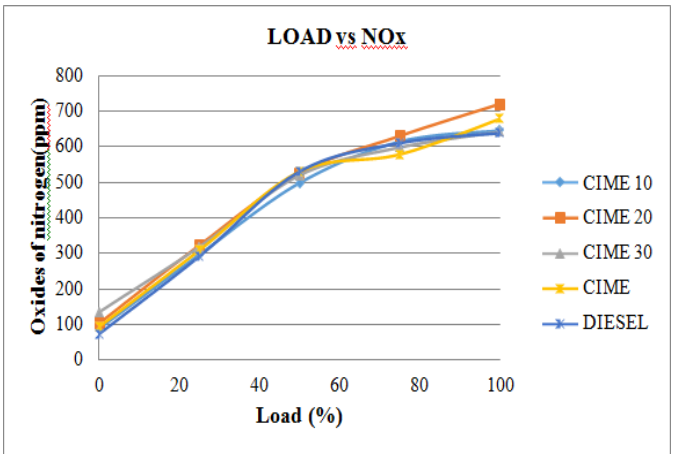

FIG12:Load v/s NOx diagram

CAUSE FOR THE NOx EMISSIONS:

- High temperatures in the combustion chamber.
- Poor injection system.
- Poor engine design and lubrication system.
- Low oxygen levels in the ambient air

VII CONCLUSION

The main objective of the present study was to use the non-edible calophyllum inophyllum oil as biodiesel in CI engine. To reduce the viscosity of neat calophyllum inophyllum, transesterification was done to bring it close to that of conventional diesel. In order to obtain a basis for comparison, Various blends are used such as (B10,B20,B30,B100) from this blends B20 shows best results compared to the diesel. To improve the performance characteristics Isobutanol additive added in the B20 in the concentration of 10% and 15%

Observations:

- CIME20 gives the good performance and emission results in single cylinder
- operation In CIME20 has low emission parameters except NOX compared to diesel engine
- operation. The performance of CIME20 is further increased by adding Isobutanol additive
- Finally we conclude that by observing performance, combustion and emission
- analysis the combination of CIME20+ISO15 gives better results compared to conventional diesel fuel. At full load condition the CIME20+ISO15 will produce maximum B.P. so, this combination is recommendable for the stationary engine.

REFERENCES

1. A.E.Atabani ,Al Dara da Silva Cesar (2014). Performance, combustion and emission characteristics of Calophyllum inophyllum L-A prospective non edible biodiesel feed stock study of bio diesel production ,properties, fatty acid composition , blending and engine performance, Renewable and sustainable energy 37(2014)644-655.

2. H. An, W.M. Yang, A. Maghbouli, J. Li, S.K. Chou, K.J. Chua, cs of biodiesel derived from waste cooking oils, Appl. Energy 112 (2013) 493–499.

3.R.M.Abgu,E.GanapathySundaram,E.Natarajan(2015). Thermal & catalytic slow pyrolysis of calophyllum inophyllum fruit shell, Bio source technology 193(2015)463-468.

4. A.K. Manoharan, B. Ashok, S. Kumarasamy, Numerical prediction of NOx in the exhaust of a CI engine fuelled with biodiesel using in-cylinder combustion pressure based variables (No. 2016-28-0153), SAE Technical Paper, 2016.

5. A. Kulkarni, G. Salvi, M. Gophane, B. Ashok, Performance and emission analysis of diesel engine using blended fuel and study of emulsion, Int. J. Appl. Eng. Res. 8 (19) (2013).

6. O¨ zer Can, ErkanO¨ ztu¨ rk, Hamit Solmaz, Fatih Aksoy, Can C¸ inar, H. Serdar Yu¨ cesu, Combined effects of soybean biodiesel fuel addition and EGR application on the combustion and exhaust emissions in a diesel engine, Appl. Therm. Eng. 95 (2016) 115–124.

7. K. Nanthagopal, B. Ashok, R. Thundil Karuppa Raj, Influence of fuel injection pressures on Calophyllum inophyllum methyl ester fuelled direct injection diesel engine, Energy Convers. Manage. 116 (2016) 165–173.

8. Olubunmia o. Ayodela , falasegum A . Production of bio diesel from calophyllum inophyllum oil using a cellulose derived catalyst, Biomass and Bio energy 70(2014)239-248

9. A.K. Yadav, M.E. Khan, A.M. Dubey, A. Pal, Performance and emission characteristics of a transportation diesel engine operated with non-edible vegetable oils biodiesel, Case Stud. Therm. Eng. 8 (2016) (2016) 236–244.

10. IM Rizwanul Fattah, H.H. Masjuki, M.A. Kalam, M.A. Wakil, A.M. Ashraful, S. Ashraful Shahir, Experimental investigation of performance and regulated emissions of a diesel engine with Calophyllum inophyllum biodiesel blends accompanied by oxidation inhibitors., Energy Convers. Manage. 83 (2014) 232– 240. 71

11. B.Ashok, k. Nanthagopal , D.sakthi Vignesh(2017). Calophyllum inophyllum methyl ester biodiesel blends as an alternative fuel for diesel engine application, Alexandria engg journal available 2017.

12. I.M.Rizwanul Fattah , H.H.Masjuki , M.A.Kalam , M.A.Wakil , A.M.Ashraful , S.A.shahi(2013). Experimental investigation of performance and regulated emissions of a diesel engine with calophyllum inophyllum biodiesel blends accompanied by oxidation, Energy conversion and management 83(2014)232- 240

13. B.Ashok , K. Nantha gopal A.K.Jeevanantham ,Pathikrit Bhowmick , Dhruv Malhotra , Pranjal Agarwal(2017).An assessment of calophyllum inophyllum biodiesel fuelled diesel using novel antioxidant additives 148(2017)935-943

14. B.Ashok , K.Nanth gopal , Rayapati Subbarao , Ajith johny , Aravind mohan, A.Tamilarasu Experimental studies on the effect of metal oxide and anti oxidant additives with calophyllum inophyllum methyl ester in compression ignition engine, Journal of cleaner production 166(2017)474-484

15. B.Ashok , K.Nanth gopal , Ajith johny , Aravind mohan, A.Tamilarasu. Comparative analysis on the effect of zinc oxide and ethanox as additives with biodiesel in C.I engine, energy 140(2017)352-364

16. Nadir Yilmaz , Fransisco M.Vigil, Kyle Benalil, Stephen M. Davis , Antonio Calva. Effect of biodiesel-butanol fuel blends on emissions and performance characteristics of a diesel engine.Fuel135(2014)46- 50.

17. H.M.Mahmudul , Ftwi Y. Hagos , Rizalman Mamat and abdul A. Abdullah. Impact of oxygenated additives to diesel-biodiesel blends in the context of performance and emission characteristics of a CI engine.160(2016)012060.

18. Mohammad Ibrahim Al-Hasan , Muntaser Al-Momany.The effect of Iso- Butanol-Diesel blends on engine performance.200823(4):306-31