EXPERIMENTAL INVESTIGATION OF CI ENGINE FUELLED WITH WASTE COOKING OIL AS BIODIESEL USING PYROGALLOL AS ANTIOXIDANT

[1]D.Niharika, [2]Dr.B.Durga Prasad, [3]Dr.M.P.Rangaiah
[1]PG Research Scholar, [2]Professor, [3]Lecturer
[1]Department of Mechanical Engineering,
[1]JNTUA College of Engineering,Ananthapuramu,AndhraPradesh,India.

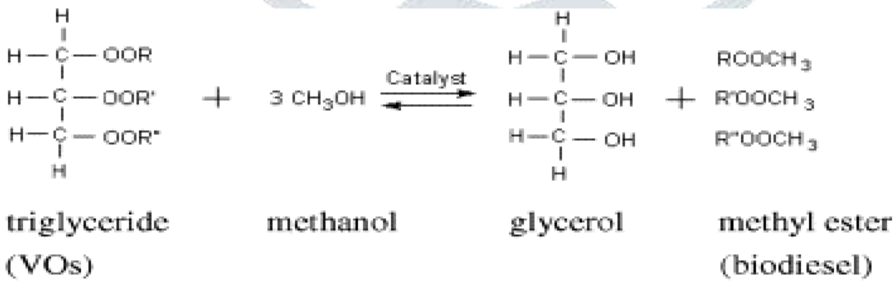
Abstract : In current conditions,vitality is considered as a basic factor for financial development,social advancement and human welfare.To meet the consistently rising demand for energy,biodiesel an alternative fuel got from vegetable oils,animal fats is winding up progressively prominent in creating nations.Among which biodiesel derived from waste vegetable oil has effectively demonstrated as potential alternative for diesel engine.Anyway more research is to be done on alternative fuels using additives.

In this experiment investigation is done on single cylinder compression ignition engine using waste cooking oil biodiesel prepared by transesterification process with an additive pyrogallol[$C_6H_6O_3$].Pyrogallol as an antioxidant provides oxidation stability to the biodiesel.The performance and emission tests are done at different loading conditions.Tests are done using different blends namely B10,B15,B20,B10A,B15A,B20A.By the addition of pyrogallol to the biodiesel brake thermal efficiency came nearer to that of pure diesel performance.Emissions are also very less for all blends when compared to pure diesel.

***Index terms*- CI Engine,transesterification,waste cooking oil,pyrogallol**

I. INTRODUCTION

Due to diminishing fossil fuels values are climbing up and natural concerns are driving the researchers to develop alternative fuel.Now a days cooked oils from restaurants are reused as biodiesel rather than throwing away which causes enivironmentalpollution.This method of conversion into alternative fuel benefits us both environmentally and economically.The waste cooked oil can be converted into biodiesel by several methods.The most common method is by using transesterificationprocess.In this process the oil is chemically treated with alcohol namely methanol/ethanol in presence of the catalyst for yielding a fatty acid alkyl ester and glycerol(collected from the bottom).



Mixes of biodiesel are presently well embraced and picking up in market. Biodiesel is a fuel contained mono-alkyl esters of long-chain unsaturated fats got from vegetable oils or creature fats that meets the necessities of ASTM D 6751. In any case, a few extraordinary attributes of biodiesel, otherwise called fatty acid methyl esters (FAME), or B100, may cause some operatabilityissues.Viscosity,thermal and oxidation strength are the most noteworthy issues confronting researchers on biodiesel mixes.

Additive:

Biodiesel is viewed as an inexhaustible substitute for fossil diesel, however its poor oxidative steadiness is a deterrent to its total acknowledgment by diesel engine producers. The biodiesel is less volatile when contrasted with the diesel. Regardless it is unprotective to the to oxidation degradation because of auto-oxidation within the sight of oxygen, which ruins its use across the boardutilize.Addition of antioxidant is the only solution for this problem. Various investigations have demonstrated the significant increment in engine NOx with biodiesel fuel. Antioxidant addition may influence the engine emissions and in addition the performance of the engine.

Although biodiesel consists of natural antioxidants they are subjected to loss during refining process. At higher temperatures the antioxidants present in the biodiesel becomes invisible at fast rate, diminishes the stability. Addition of pyrogallol to the biodiesel results in the decrease of viscosity.

II. LITERATURE REVIEW

- Shiv Kumar et al. [1] expalined that India is deficient in edible oils, the non-edible oils like Mahua, Simarouba, Jatropha, Neem, etc., are to be increased in India for the production of biodiesel,in his journal" Sustainability of biodiesel production as vehicular fuel in Indian perspective", Renewable and Sustainable Energy Reviews" 25 (2013), pp.251-259.
- A.E. Atabani , A.S. Silitonga, I.A. Badruddin , T.M. Mahlia , H.H. Masjuki, S. Mekhilef[2] explained that properties of biodiesel are nearer to that of fossil diesel in"A comprehensive review on biodiesel as an alternative energy resource and its characteristics", Renewable and Sustainable Energy Reviews. 16 (2012), pp.2070 – 2093.
- L.C. Meher, D. Vidya Sagar, S.N. Naik[3] explained about the method of biodiesel production in"Technical aspects of biodiesel production by trans-esterification"a review, Renewable and Sustainable Energy Reviews. 10 (2006), pp.248–268.
- J. Xue, Grift T. E, A. C Hansen[4] states that there will be change on performance and emissions of engine while biodiesel is used."Effect of biodiesel on engine performances and emissions". Renewable and Sustainable Energy Reviews. 15 (2011), pp.1098– 1116.
- S. Balaji, Natesan Kapilan, R.Saravanan[5] studied the effect of antioxidant properties on biodiesel oxidation stability in" Influence of Propyl Gallate Antioxidant on Performance and Emissions of a CI Fuelled with Neem Oil Biodiesel", Journal of Biofuels.7 (2016), pp. 62-70.
- Orkun Ozener , Levent Yuksek, Alp Tekin Ergenc, Muammer Ozkan[6] states that there is a reduction in cost when biodiesel is used as fuel in" Effects of soybean biodiesel on a DI diesel engine performance, emission and combustion characteristics", Fuel (2012) 10.081.

III. EXPERIMENTAL SETUP AND MATERIALS

Materials:

The biodiesel used in the experiment is derived from waste cooked palm oil which is collected from restaurant.Firstly the oil is filtered foe the removal of solid particles and then its is heated upto certain temperature for the removal of water content or moisture.In further step the oil is converted to biodiesel using transesterificationprocess.The prehetaed oil is added mixed with potassium methoxide which is obtained by dissolving potassium hydroxide catalyst in methanol.The mixture obtained is stirred in a magnetic stirrer for 2 hours at 55◦C.Then it is allowed to settle for three hours.After three hours we can observe the esters are formed on the top and glycerol is settled at the bottom.those esters are cleaned with water for the removal of impurities.Fossil diesel is blended with biodiesel in different percentages.To this final biodiesel yield antioxidant pyrogallol is added in the concentration of 1000ppm to the final biodiesel blend.

fig1.biodiesel

fig 2.antioxidant(pyrogallol)

Engine Setup:

Present experiment is done on four stroke single cylinder water cooled diesel engine.The engine is coupled with rope brake dynamometer arrangement to absorb the mechanical power produced by the engine.Necessary weights and spring balance are included to apply load on the break drum.Suitable water cooling arrangement for the brake drum is provided for engine cooling.A fuel measuring system consisting of a fuel tank mounted on a stand,burette and three way cock is provided.

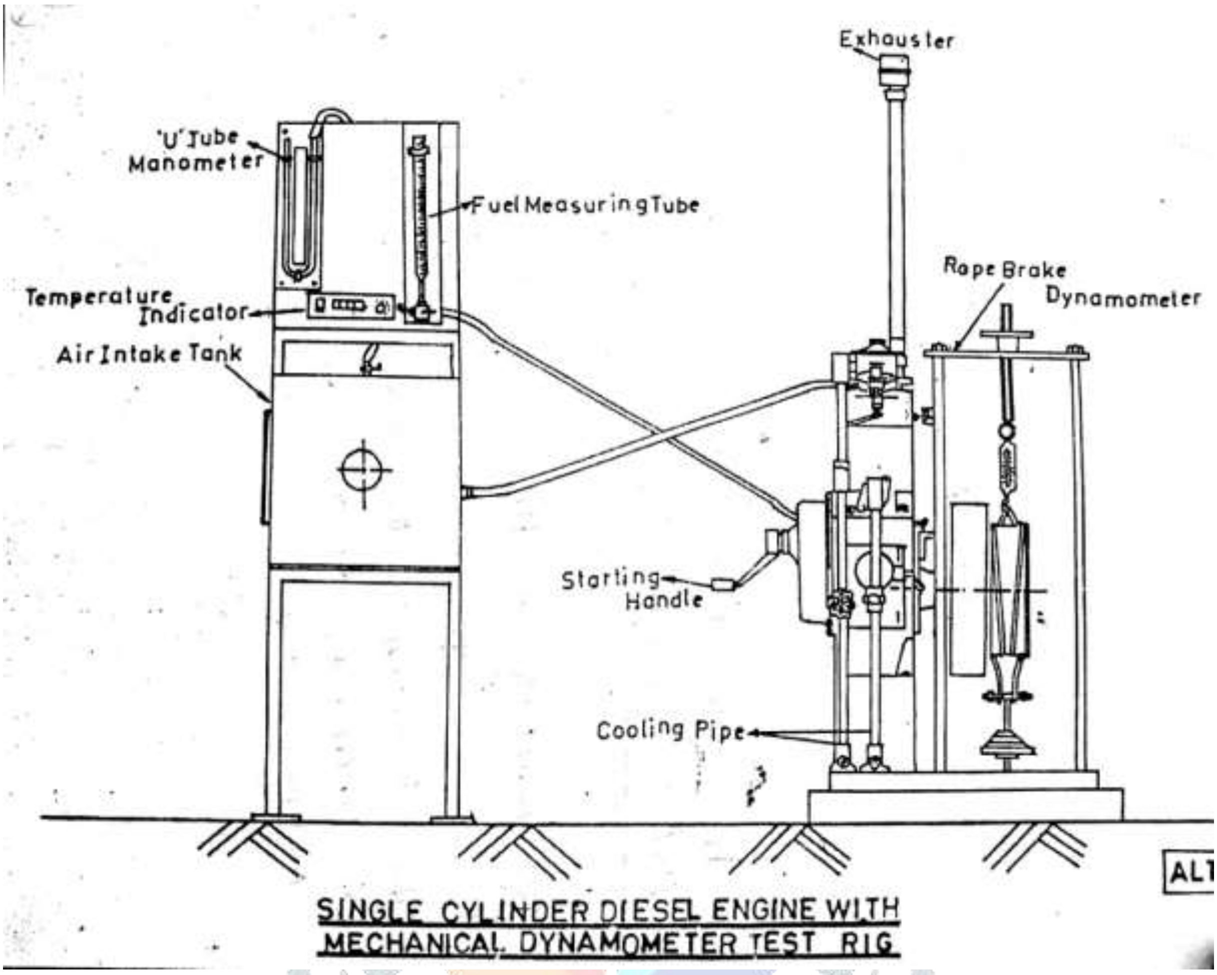


fig3.line diagram of kirloskar engine

TABLE 1

Specifications of diesel engine

Feature	Details
Make	Kirloskar Model AV
Bore(Dia)	80mm
Stroke(L)	110mm
R.P.M	1500
B.H.P	5HP(3.72Kw)
Compression Ratio	16.5:1
Diameter of the Orifice	30mm
Diameter of the rope	0.015m
Cooling type	Water cooling

Test Procedure:

Fuel level and the lubricating oil levels are checked before starting the engine.After that the three way cock is opened so that the fuel will flow to the engine.Cooling water is supplied to the engine through inlet pipe.Engine is started to run at rated speed and allowed to warm up for 5 minutes.Load the engine by adding the required weights to the hanger.Time taken for 10cc of fuel consumption,load on the engine,manaometerreading,speed at different loads were noted.Emission test was done using AVL DIGAS-444 five gas analyser.

Fig4: AVL DIGAS-444 five gas analyser.

IV. RESULTS AND DISCUSSION

Engine Performance:

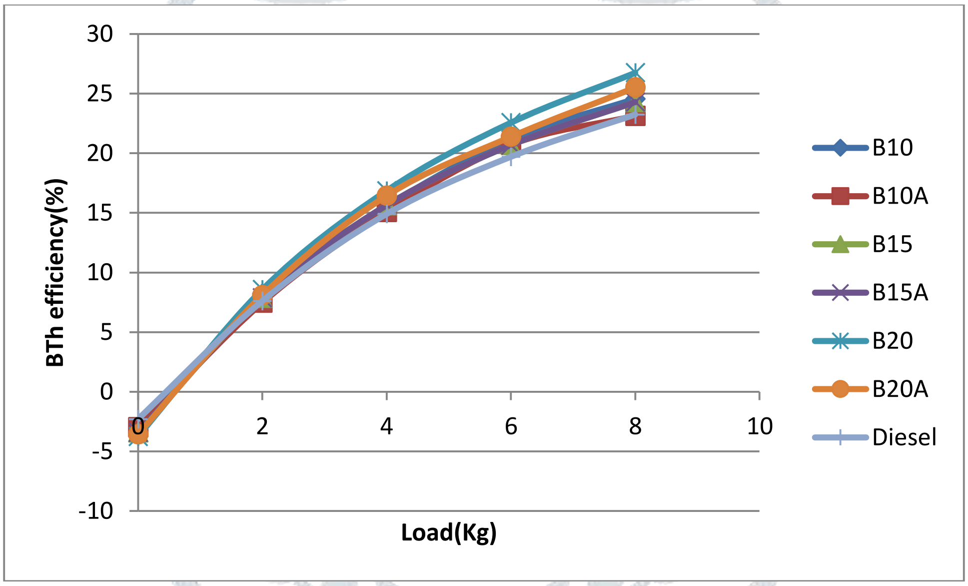


Fig 5:Variation of brake thermal efficiency with load for different blends

From the above graph we can clearly observe that brake thermal thermal efficiency of the engine is higher than the diesel for every blend used.Highest efficiency(26.74%) was found at 8kg load for B20 blend when compared to all other blends of biodiesel.By using B10 and B10A the efficiencies are 1.34% and 0.10% higher than that of diesel respectively at half load.When comes to B15 and B15A they are 2.7% and 1.044% higher than pure diesel.From the above observation it is clear that pyrogallol brought the biodiesel efficiency of engine nearer to that of diesel efficiency.The efficiency of the engine is increased due to the increase of cetane number of biodiesel.Due to the increase in anti knock characteristics the efficiency is increased.

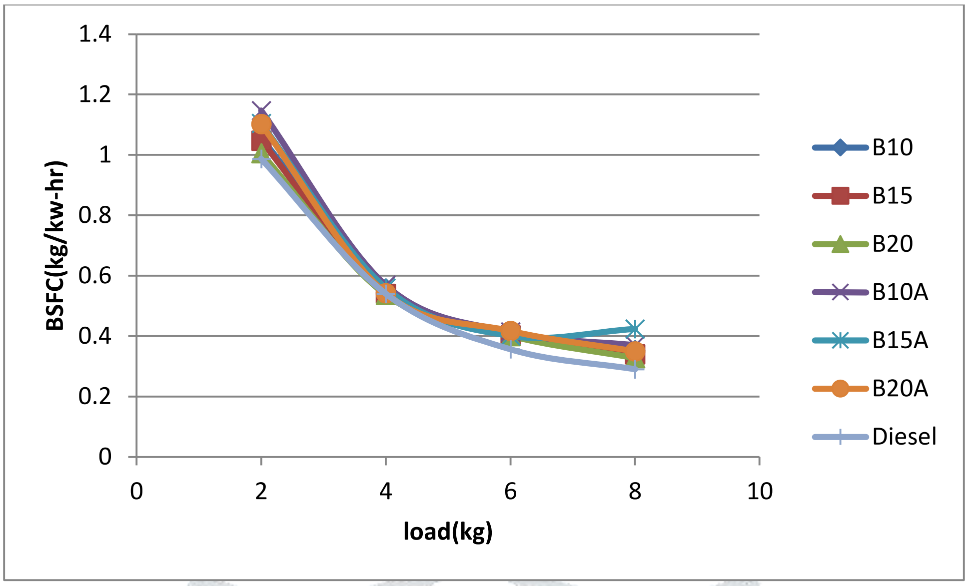


Fig 6: Variation of BSFC with load for different blends

Brake specific fuel consumption for diesel was less when compared to biodiesel because the calorific value/heating value of the biodiesel and biodiesel with additive were less so the fuel consumption was found to be more than that of diesel.At initial stages the fuel consumption will be high for the engine to start gradually it will decrease for higher loads.Biodiesel consumption is more when compared with blend with additive.There is a decrease in BSFC by 0.395% when B20 is used and 0.045% when B20Ais fuelled in the engine.

Engine emissions:

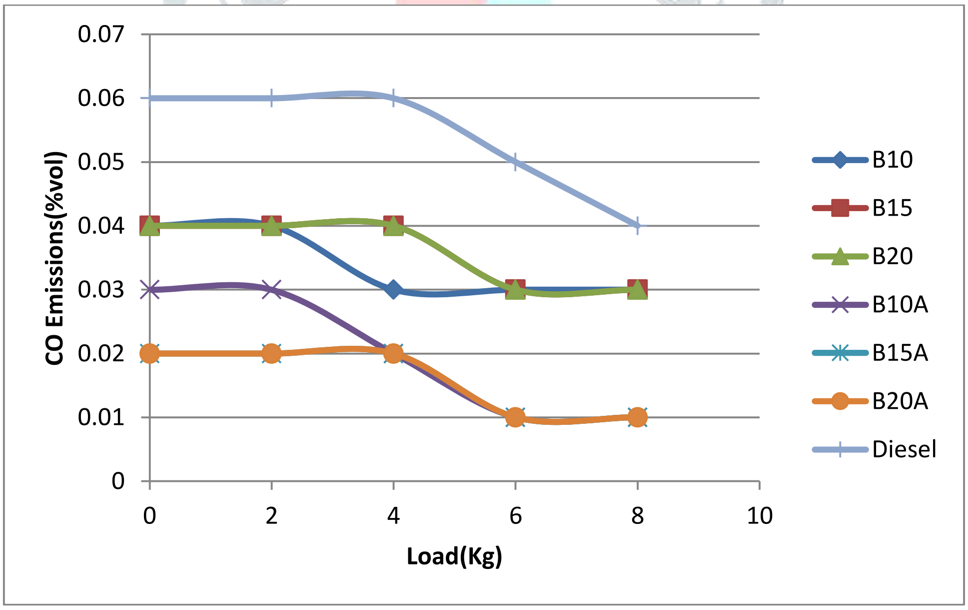


Fig 7.Variation of CO emissions with load for different blends used and Diesel

Normally, In Diesel engines CO emissions are more upto certain load and reduces gradually but that too is more than the permissible limits. When Bio-Diesel is used CO emissions can be reduced upto some extent . From the graph, it is clear that by using Pyrogallol additive the CO content was reduced more and is in permissible limit.During the usage of biodiesel at 8kg(50%) load CO emissions are reduced from 0.04%vol for diesel to 0.03%vol,where as by addition of Pyrogallol they are reduced to 0.01%vol.At no load case we can see the emmisions are high with diesel 0.06%vol,when comes to biodiesel the are 0.04%vol and 0.01%vol when additive is added.

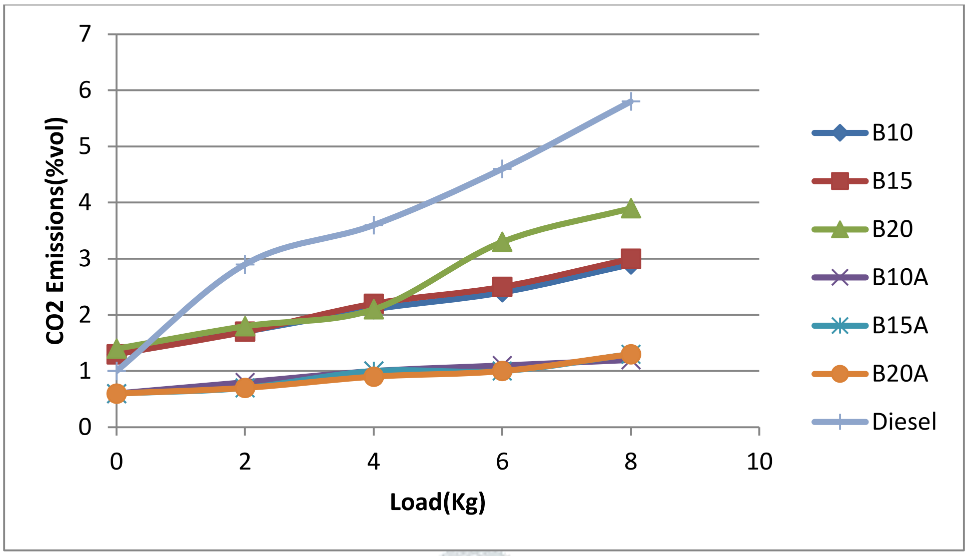


Fig 8.Variation of CO_2 emissions with load for different blends used and Diesel

Regarding CO_2 emissions Diesel engine produces more under higher loads When Bio-Diesel is used it has reduced to some extent but when additive Pyrogallol is used we can observe more reduction in levels of CO_2.This is happened because of less oxidation due to the presence of pyrogallol.At 8kg(50%) load we can see that the CO_2 emissions are very high i.e.,5.8%vol,by using biodiesel it is reduced to 2.9%vol for B10 blend and after addition of antioxidant it reduced to 1.2%vol.

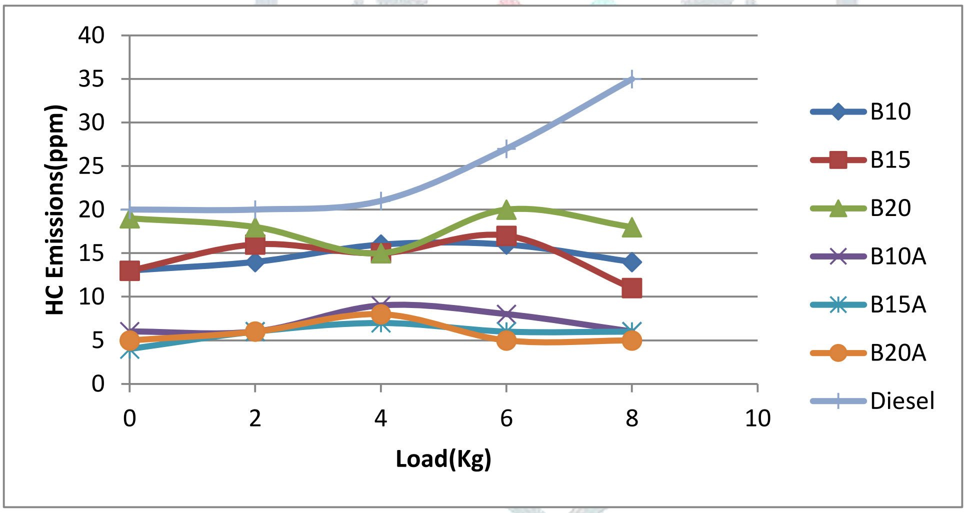


Fig 9.Variation of HC emissions with load for different blends and Diesel

HC Emissions are usually more in Diesel engine at higher loads. But when Bio-Diesel blends are used it is high at zero loads and it reduced gradually.Similarly when Bio-Diesel along with Pyrogalol was used HC emissions reduced to great extent.At maximum load used HC emissions for pure diesel was 35ppm they are reduced to 14ppm,11ppm,18ppm by using B10,B15,B20 blends respectively.When it comes to additive blend they are reduced to 6ppm,6ppm,5ppm for B10A,B15A,B20A blends respectively.

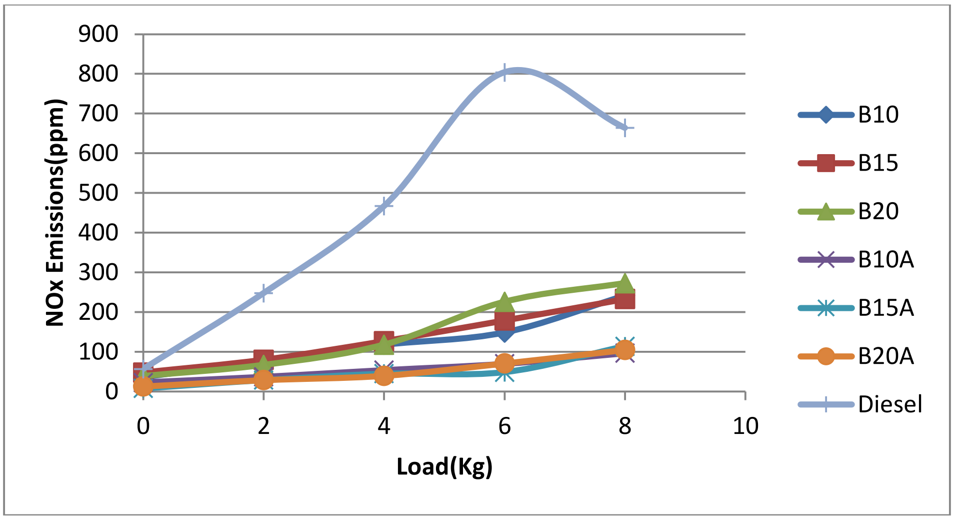


Fig 10.Variation of NOx emissions with load for different blends and Diesel

From the figure10, NO_x emissions were high for Diesel because of higher temperatures at higher loads.But when Pyrogalol along with Bio-Diesel used as a fuel it reduced to a greater extent at higher loads even.At higher load i.e.,8Kg when diesel is used NO_x emissions are 664ppm,which are reduced to 242ppm,233ppm,273ppm for blends B10,B15,B20 respectively.Where as by addition of pyrogallol there is a drastic decrease in NO_x emissions to 97pm,114ppm,105ppm for B10A,B15A,B20A blends.

V.CONCLUSION

From the above experimental investigation it is clear that the efficiency of the engine increased for the blends of biodiesel and also the efficency came nearer to that of diesel when antioxidant is added.Highest Brake thermal efficiency was found for B20 which is 3.5% high compared to diesel at same conditions of load i.e at 8kg load. The Exhaust emissions i.e.,CO,CO_2,HC,NOx are very less for both the cases,far more less when pyrogallol is added because of increased percentage of oxygen.CO,CO_2,HC,NOx emissions are 33.4%,50%,49.62%,64.90% reduced respectively when biodiesel blend is used.In the case of Additive blends they are reduced by 66.66%,77.51%,85.71%,58.36% respectively.So it is clear that pyrogallol usage has a most prominent effect on the decrease of engine emissions

VI.REFERENCES

1.AminTalebian-Kiakalaieh, Nor AishahSaidina Amin, HosseinMazaheri. A review on novel processes of biodiesel production from waste cooking oil, Applied Energy, Applied Energy 104 (2013) 683–710, Page 1-20.

2. H. An, W.M. Yang , A. Maghbouli, J. Li, S.K. Chou, K.J. Chua.,2013. Performance, combustion and emission characteristics of biodiesel derived from waste cooking oils, Applied Energy 112, p.497.

3.MohdHafizil Mat Yasin, RizalmanMamat, Ahmad FitriYusop, Rafidah Rahim, Amir Aziz and LiyanaAmer Shah. Fuel Physical Characteristics of Biodiesel Blend Fuels with Alcohol as Additives, Malaysian Technical Universities Conference on Engineering & Technology 2012, MUCET 2012, Procedia Engineering, Volume 53, 2013, Pages 701–706.

4. A. Monyem, J. H Gerpen van, the effect of biodiesel oxidation on engine performance and emissions, Biomass and Bioenergy. 20 (2001), pp.317 – 325.

5.Erolİleri ,GünnurKoçar ,Experimental investigation of the effect of antioxidant additives on NOx emissions of a diesel engine using biodiesel, Fuel. 125 (2014), pp. 44-49.

6. S. Balaji, NatesanKapilan, R.Saravanan, Influence of Propyl Gallate Antioxidant on Performance and Emissions of a CI Fuelled with Neem Oil Biodiesel, Journal of Biofuels.7 (2016), pp. 62-70.

7.Shiv Kumar Lohan; S.T. Ram, M. Mukesh Ali, S Arya, Sustainability of biodiesel production as vehicular fuel in Indian perspective, Renewable and Sustainable Energy Reviews. 25 (2013), pp.251-259.

8. A.E. Atabani , A.S. Silitonga, I.A. Badruddin , T.M. Mahlia , H.H. Masjuki, S. Mekhilef, A comprehensive review on biodiesel as an alternative energy resource and its characteristics, Renewable and Sustainable Energy Reviews. 16 (2012), pp.2070 – 2093.

9.Conceição MM, Dantas MB, Rosenhaim R, FernandesJr VJ, Santos IMG, Souza AG. Evaluation of the oxidative induction time of the ethylic castor biodiesel. J. Therm. Anal. Calorim.2009; 97:643–6.

10. Walter W. Focke, Isbe van der Westhuizen, A.B. LofteGrobler, Khomotso T. Nshoane, Judy K. Reddy, Adriaan S. Luyt. The effect of synthetic antioxidants on the oxidative stability of biodiesel, Fuel 94 (2012) 227-233.