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EXPERIMENTAL STUDY OF PERFORMANCE AND EMISSION BEHAVIOR OF A DIRECT INJECTION DIESEL ENGINE

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ABSTRACT

Ever increasing rate in the manufacturing of automotive vehicles and the significance of lowering the pollutions in nature trigger several researches to find the alternative answer. Biodiesel has been taken into consideration a vital gasoline for diesel engine view point. In the existing observe a single Cylinder diesel engine was run absolutely on non-petroleum fuels blends. In this regard Jatropha methyl ester (JME) and waste transformer oil (WTO) had been determined on as a fuel for the alternative of diesel. Diesel engines which includes gas direct injection method is used. The WTO at low percentages (10-40% at regular durations of 10% on a extent basis), was combined with diesel, to get the fuel blends for the research. The performance and emission terms were compared, analyzed and offered in this text.

KEYWORDS: Biodiesel, Diesel Engine, Waste to Energy, Efficiency.

1. INTRODUCTION

Fast depletion of fossil fuels and increasing number of automobile populace, And their adverse effect at the environment effects in urgent want of possibility fuels for meeting the sustainable energy call for with minimum environmental impact [1]. Therefore, there may be a necessity to discover suitable possibility fuels for diesel engines which may be less steeply-priced and eco-friendly. Biomass is a excellent supply for deriving distinctive shape of possibility fuels. Biomass is available in the shape of agriculture residue, vegetable seeds, animal waste, crop residue, food waste, business waste, municipal waste and lots of others [2]. Biomass is an natural rely and is renewable over the years. There are techniques typically followed to derive possibility fuels from biomass belongings which might be; (i) Biochemical method (ii) Thermo-chemical approach. In biochemical approach, fermentation and anaerobic digestion are used to convert a number of the biomass wastes into alcohol and biogas respectively. Biomass sources together with crop residue, cow dung, pig manure, spent wash and many others. Are converted into biogas thru anaerobic digestion. If the biomass supply is properly transformed into an possibility gas mainly for diesel engine, then the call for diesel fuel can be substantially reduced [3-5].

Energy consumption is developing exponentially because of rapid improvement within the population, industrialization and boom in range of automobile car. Nowadays, the petroleum fuels play a essential characteristic inside the mobility, business sectors, and agricultural sectors. Meanwhile, the availability of petroleum assets is restricted in nature, to be had in constrained area and they will be getting depleted every day [6-10] Furthermore, problems associated with the surroundings are the maximum essential results of consumption of extra petroleum fuels. The trouble of electricity safety and surroundings troubles made worldwide places and researchers to search for trade manner of renewable similarly to surroundings-great fuels. The maximum promising and economically possible alternative fuels which can be a alternative of petroleum fuels are biofuels [11-13]. Various sectors are searching out opportunity fuels due to the power disaster and the concern of society for depleting earth's non-renewable assets. Among severa researchers from all over the global commenced out out offering numerous strategies to apply vegetable oils in inner combustion engines.

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These methods embody pyrolysis, micro-emulsification, direct mixing with diesel, trans esterification. And so on. [14-15].

Engine take a look at [16] have turn out to be carried out using Putranjiva, Jatropha and Karanja oils in a Ricardo variable compression ignition engine to analyze and compare the outcomes of ordinary overall performance and emission homes. It have grow to be determined that the non-healthful to be eaten oil of Jatropha gave the excellent performance and emissions consequences at all of the load conditions in evaluation with one of a kind vegetable oils. Saravanan et al [17] have investigated the feasibility take a look at of crude rice bran oil as a diesel opportunity in a compression ignition engine with none changes. They pronounced that thermal standard performance of the engine with rice bran oil is barely lesser than diesel, however added approximately higher emission trends. Naga Prasad et al. [18] investigated the compression ignition engine with neat castor oil and its blends with diesel and determined that the general performance characteristics are reduced to the ones of diesel. But additionally they placed that the emission traits are increased on the rated load in comparison to those of diesel. Also, they observed that 25% of neat Castor oil blended with 75% of diesel is the nicely-appropriate combination for Diesel engine without heating and/or without enforcing any engine modifications. Deepanraj et al., [19] studied the overall performance characteristics of aunmarried cylinder direct injection diesel engine with palm oil biodiesel and its blends. From their outcomes, they mentioned that the proper thermal efficiencies were acquired, and the fine gasoline consumption and exhaust gas temperatures were higher than the results obtained with diesel fuel. Many investigations were completed on the usage of biodiesel derived from exceptional feed inventory in diesel engine [20-22]. From the ones paintings it may be referred to that the selection of biodiesel is very important. The biodiesel derived from non-secure to eat feed inventory is constantly a higher preference due to food protection trouble because use of safe to consume oil as feed stock of biodiesel will affect this problem severely. The one-of-a-kind non-fit for human intake feed stock used for production of biodiesel is Jatrophacurcas, karanja, tobacco seed, rice bran, mahua, neem, rubber Plant, castor, linseed, and microalgae [23-24], and so on. In this bankruptcy software of biodiesel derived via Jatropha oil is described. The bio-diesel consequently produced is blended with waste transformer oil at one-of-a-type extent proportions and examined in diesel engines.

2. FUEL PREPARATION

In the existing take a look at fuel become produced with the aid of transesterification method. The esterification manner involves the reaction of a triglyceride (fat/oil) with alcohol inside the presence of an alkaline catalyst collectively with sodium hydroxide. A triglyceride has a glycerine molecule as its base with three lengthy fatty acids connected. The alcohol reacts with the fatty acids to shape a mono-alkyl ester, or biodiesel, and crude glycerol, used within the splendor, pharmaceutical, meals and painting industries. The alcohol used is usually each methanol, which produces methyl esters, or ethanol, with ethyl esters. The base carried out for methyl ester is potassium or sodium hydroxide, however for ethyl ester the previous base is more appropriate. The esterification response is laid low with the chemical shape of the alcohol, the acid and the acid catalyst.

The gift observe is aimed to analysis the impact of waste transformer oil (WTO) combined with Jatropha Methyl Ester (JME) in four special chances as test fuels, at the performance and emission traits of a diesel engine. The WTO at low chances (10-forty% at everyday intervals of 10% on a quantity foundation), changed into combined with diesel, to get the gas blends for the research. The designations of the test fuels and their compositions used on this look at are given under.

Table 1: Designations of the test fuels

Fuel	JME (by volume)	WTO (by volume)	Diesel (by volume)
diesel	-	-	100%
JME	100%	-	-
B10	90%	10%	-
B20	80%	20%	-
B30	70%	30%	-
B40	60%	40%	-

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3. EXPERIMENTATION

The test was done on a single cylinder, four stroke, clearly aspirated, air cooled, DI diesel engine which has a maximum energy out of four. Four kW. The take a look at engine specifications are provided in Table 1. For loading on the take a look at engine an eddy modern dynamometer is coupled to engine with the assist of load cellular. The engine is interfaced to a manipulate panel, that's related to a computer. The inputs received from one-of-a-kind gadgets are interfaced to a laptop via an analog and digital converter card PCI-1050 that is mounted on the motherboard. A statistics acquisition device (DAS) integrated with a computer obtained facts from exclusive devices which is then processed and displayed on the reveal.

Table 2: Engine specifications

Manufacturer	Kirloskar
Model	TAF 1
Engine type	Single cylinder, four stroke, constant speed, air cooled, direct injection, CI engine
Rated power (kW)	4.4
Speed (rpm)	1500 (constant)
Bore (mm)	87.5
Stroke (mm)	110
Piston type	Bowl-in-piston
Displacement volume (cm^3)	661
Compression ratio	17.5
Nozzle Opening pressure (bar)	200
Start of fuel injection	23 ˚CA bTDC (for diesel)
Start of fuel injection	24.5 ˚CA bTDC (for JMETPO20)
Dynamometer	Eddy current
Injection type	Pump-line-nozzle injection system
Nozzle type	Multi hole
No. of holes	3

4. RESULTS AND DISCUSSION

This section discusses the results of the performance and emission parameters obtained from the test engine run on diesel, JME and different JME-WTO blends.

4.1 Brake Thermal Efficiency

The brake thermal overall performance gives information concerning how green the electricity within the gasoline became transformed in to energy output [25]. Figure 1 gives the power overall performance of the diesel and unique check fuel blends derived engine beneath certainly one of a kind loading situations. It can be seen that beneath the equal load, the extra efficiency is for diesel operated engine. In addition, the engine power accelerated linearly with the load for all the take a look at fuels. As the load increases the warm temperature generated in the cylinder increases, and consequently, the brake thermal overall performance increases. At complete load the diesel gave maximum brake thermal performance as compared to all of the test fuels used inside the present check. This may be pertained to the better calorific value of the diesel gas in contrast among all take a look at fuel used.

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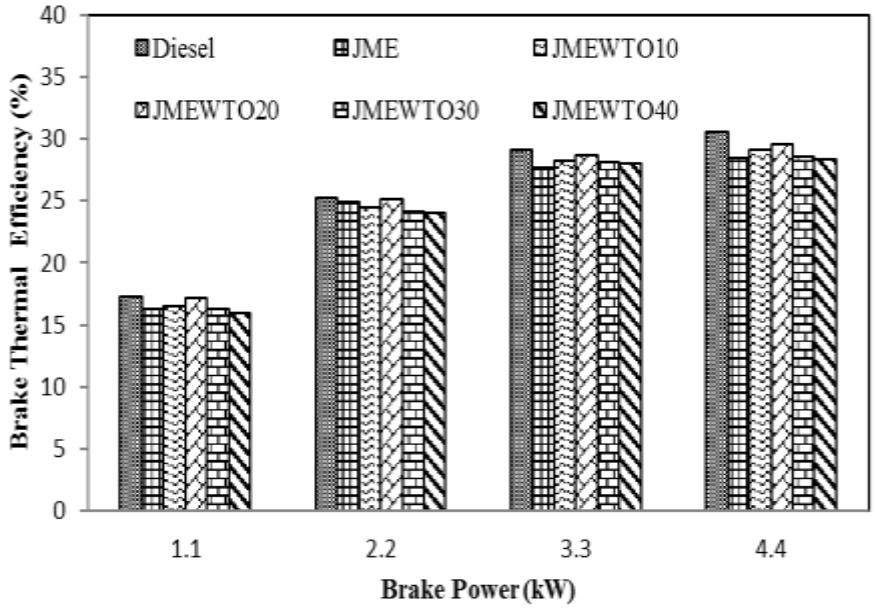

Figure 1: Variation of brake thermal efficiency with brake power

The negative atomization of test fuels because of the higher viscosity may also be one of the reasons for decrease brake thermal performance than that of diesel. Among blends B20 produces highest brake thermal efficiency.

4.2 Carbon Monoxide Emission

The carbon monoxide (CO) emission tendencies of the engine run on diesel and one of a type take a look at gas blends is furnished in Fig. 2. It is understood that the rate of CO emission is a characteristic of the unburned gas availability and aggregate temperature, which controls the fee of fuel decomposition and oxidation. In the presence of enough oxygen, the CO emission is transformed into carbon dioxide emission [26]. The fee of CO emission at complete load for the diesel, JME, B10, B10, B15 and B20 aggregate become observed to be 0.044, 0.0.5, 0.037, 0.04, 0.046 and 0.052%. The CO emission for the JME, B10 and B20 is marginally lower than the ones of diesel gasoline. This may be due to the reality that JME carries excess oxygen which helps for higher combustion. When the proportion of tire derived gasoline will growth beyond 10%, the CO emission increases significantly. This can be due presence of fragrant content material material which ends up in incomplete combustion, and might cause better CO emission [27].

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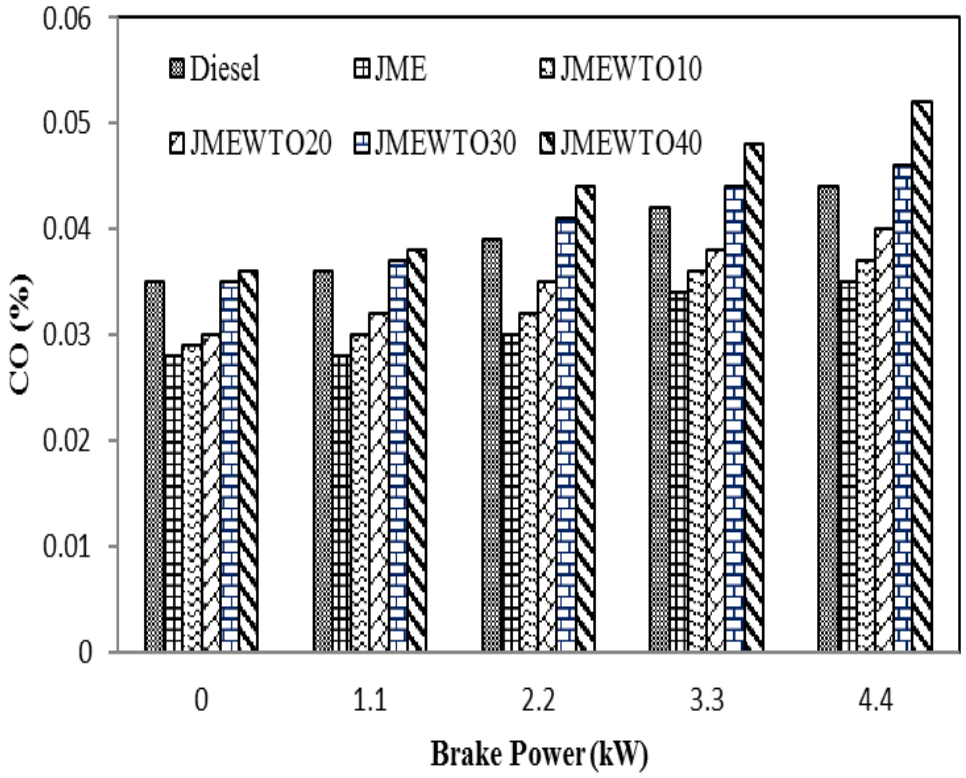

Figure 2: Variation of carbon monoxide emission with brake power

1.3 Hydrocarbon Emission

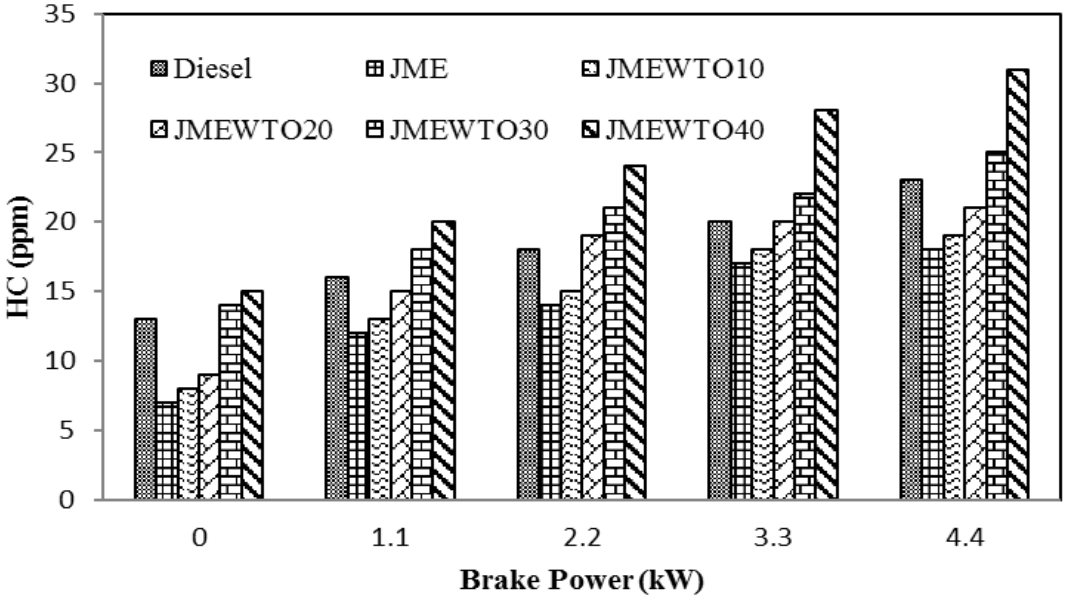

Figure 3: Variation of the unburnt hydrocarbon emission with brake power

The version of hydrocarbon (HC) emission for diesel, JME and special take a look at gasoline blends is shown in Fig. 3. It is located that hydrocarbon emission will increase with the boom in percentage of WTO within the

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JME-WTO blends. The HC emission is lowest for JME and it was about 18 ppm at complete load operation. This can be because of oxygen molecule found in biodiesel [28]. The most rate of HC emission became received with B20 combo and modified into observed to be 31 ppm. But the addition of the tire derived liquid percentage effects in higher HC emission. This is because of the reality that TPO has higher fragrant content material fabric, and consequently can also bring about incomplete combustion and extra HC emission for B15 and B20 in comparison to the opposite take a look at fuels used in this have a take a look at. The HC values for diesel, JME, B10, B20, B30 and B40 are 23, 18, 19, 21,25 and 31 ppm are at entire load.

4.4 Nitric Oxide Emission

The nitric oxide (NO) emission traits of the diesel and distinctive check fuel blends derived engine at one-of-a-kind load situations are supplied in Fig. 4. It can be seen that the NO emission awareness improved with the load for the entire take a look at fuels.

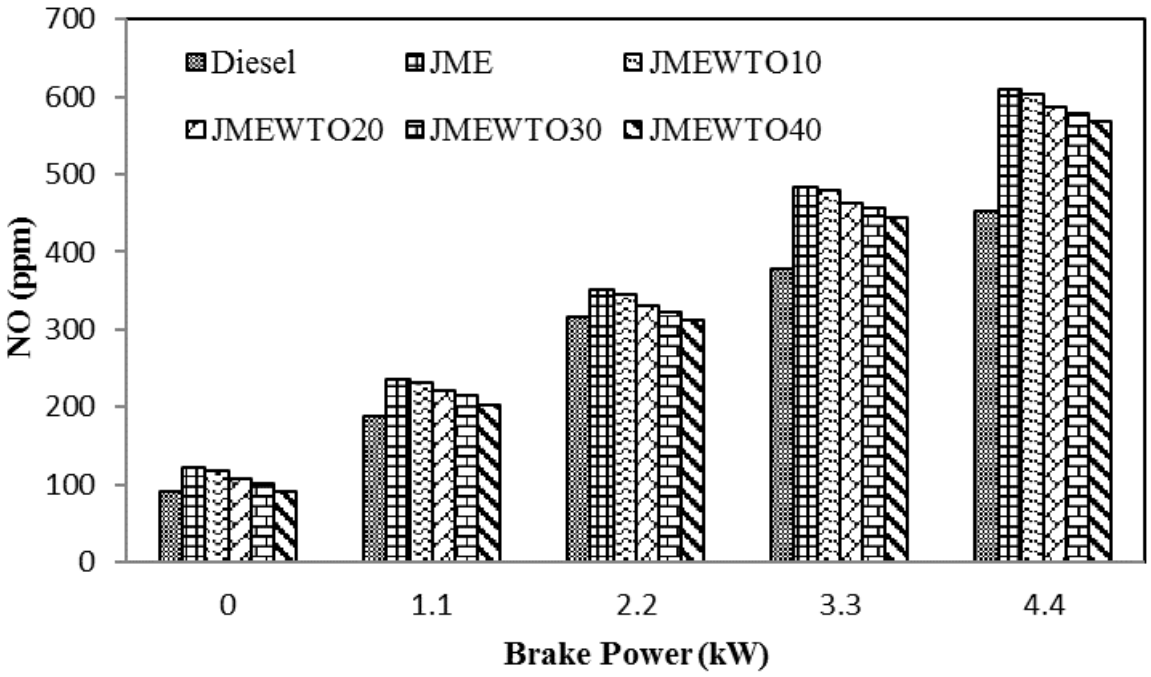

Figure 4: Variation of the nitric oxide emission with brake power

This is because of the fact that, because with growing load, the temperature prevailing inside the combustion chamber will boom [29-30]. The NO emission shape engine exhaust is pretty depending on oxygen focus and combustion temperature. The JME has approximately 11% oxygen molecule that is the primary motive of higher NO emission for this gasoline in assessment to all extraordinary check gas used on this have a observe. While growing the WTO percent in the blend, the NO emission decreases, because of decrease warm temperature launch fees than that of JME. The values of NO emission for diesel, JME, B10, B20, B30, and B40 are by approximately 452, 614, 589, 564, 549, and 532 ppm respectively, at full load operation.

5. CONCLUSIONS

A single cylinder, 4 stroke, evidently aspirated, air cooled, DI diesel engine become operated effectively using JME-WTO blends. The following conclusions are made primarily based at the experimental results.

- The brake thermal efficiency of the engine became highest for the diesel and among one-of-a-kind combo B10 gave better brake thermal efficiency. At full load, the brake thermal performance is sort of the same, i.e., 29.9% and 30.8% for B20 and diesel respectively, at complete load.
- The CO and HC emissions have been decrease through approximately 9%, 19% respectively for B20, in comparison to diesel at full load.

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- Nitric oxide emission turned into better by way of about 21% for B20 in evaluation with diesel at full load.
- On the entire it's miles concluded, that the B20 combination can be used as gas in a diesel engine immediately, with none engine amendment. The B20 offers the surest end result, as compared to the alternative blends. The effects from the experiments show that B20 mixture is good alternative for diesel gasoline.

REFERENCES

[1] International Energy Agency. Energy and Air Pollution. 2016. Doi: 10.1021/ac00256a010.
[2] BP Energy Outlook - 2016 version. 2016.
[3] IPCC 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the 5thAssessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland: 2014.
[4] Wu, H. W., Wang, R. H., Ou, D. J., Chen, Y. C., & Chen, T. Y. (2011). Reduction of smoke and nitrogen oxides of a partial HCCI engine the use of premixed fuel and ethanol with air. Applied Energy, 88(11), 3882-3890.
[5] Vehicular Pollution - water, consequences, environmental, pollution, impact, EPA, chemicals, poisonous, human, electricity, assets, use, existence, fitness, oil 2016. Http://www.Pollutionissues.Com/Ve-Z/Vehicular-Pollution.Html (accessed August 29, 2016).
[6] Dieselnet. EU Emission Standards for Passenger Cars n.D. Https://www.Dieselnet.Com/requirements/ecu/ld.Hypertext Preprocessor (accessed July 6, 2018).
[7] Kumar, M. S., Ramesh, A., &Nagalingam, B. (2001).Investigations on the usage of Jatropha oil and its methyl ester as a gas in a compression ignition engine. Journal of the Institute of Energy, 74 (498), 24-28.
[8] Kumar, M. S., Ramesh, A., & Nagalingam, B. (2003).An experimental comparison of strategies to use methanol and Jatropha oil in a compression ignition engine. Biomass and bioenergy, 25(3), 309-318.
[9] Sahoo, P. K., Naik, S. N., & Das, L. M. (2005). Studies on biodiesel production era from jatrophacurcas and its performance in a CI engine. Journal of Agricultural Engineering, 42(2), 14-20.
[10] Mandpe, S., Kadlaskar, S., Degen, W., &Keppeler, S. (2005). On avenue trying out of advanced commonplace rail diesel vehicles with biodiesel from the Jatrophacurcas plant (No. 2005-26-356). SAE Technical Paper.
[11] Mahanta, P., Mishra, S., &Kushwah, Y. (2006). A comparative have a look at of pongamiapinnata and jatrophacurcus oil as diesel alternative. International Energy Journal, 7(1).
[12] Sivaprakasam, S., & Saravanan, C. G. (2007). Optimization of the transesterification system for biodiesel production and use of biodiesel in a compression ignition engine. Energy & Fuels, 21(5), 2998-3003.
[13] Lakshmi NarayanaRao, G., Durga Prasad, B., Sampath, S., & Rajagopal, K. (2007). Combustion evaluation of diesel engine fueled with jatropha oil methyl ester-diesel blends. International Journal of Green Energy, 4(6), 645-658.
[14] Sher E. Handbook of air pollution from inner combustion engines: pollutant formation and manipulate. Academic Press; 1998 Mar 20.
[15] Chiaramonti D, Oasmaa A, Solantausta Y. Power era using fast pyrolysis liquids from biomass. Renewable and sustainable electricity evaluations. 2007 Aug 31;11(6):1056-86.
[16] Mohan D, Pittman CU, Steele PH. Pyrolysis of timber/biomass for bio-oil: a essential evaluation. Energy & fuels. 2006 May 17;20(3):848-89.
[17] Chen Y, Cheng JJ, Creamer KS. Inhibition of anaerobic digestion technique: a overview. Bioresource generation. 2008 Jul 31;99(10):4044-64.
[18] Ladisch MR, Lin KW, Voloch M, Tsao GT. Process concerns in the enzymatic hydrolysis of biomass. Enzyme and Microbial technology. 1983 Mar 1;5(2):82-102.
[19] Verma P, Zare A, Jafari M, Bodisco TA, Rainey T, Ristovski ZD, Brown RJ. Diesel engine performance and emissions with fuels derived from waste tyres. Scientific reports. 2018 Feb 6;8(1):2457.
[20] Siva M, Onenc S, Uçar S, Yanik J. Influence of oily wastes at the pyrolysis of scrap tire. Energy conversion and management.2013 Nov 1; 75:474-81.

ISSN: 2277-9655
Impact Factor: 5.164
CODEN: IJESS7

[21] Duan P, Jin B, Xu Y, Wang F. Co-pyrolysis of microalgae and waste rubber tire in supercritical ethanol. Chemical Engineering Journal.2015 Jun 1; 269:262-71.
[22] Dincer K. Lower emissions from biodiesel combustion. Energy Sources, Part A. 2008 Mar 27;30(10):963-8.
[23] Sigar CP, Soni SL, Mathur J, Sharma D. Performance and emission traits of vegetable oil as diesel fuel extender. Energy Sources, Part A: Recovery, Utilization, and Environmental Effects. 2008 Dec 2;31(2):139-48.
[24] Balat M, Balat M, Kırtay E, Balat H. Main routes for the thermo-conversion of biomass into fuels and chemical compounds. Part 1: Pyrolysis systems. Energy Conversion and Management. 2009 Dec 1;50(12):3147-57.
[25] Jull C, Redondo PC, Vapnek J. Recent trends inside the law and coverage of bioenergy production, merchandising and use. Food & Agriculture Org.; 2007.
[26] Kannan M, Karthikeyan R, Deepanraj B, Baskaran R. Feasibility and overall performance look at of turpentine fueled DI diesel engine operated below HCCI combustion mode. Journal of Mechanical Science and Technology. 2014 Feb 1; 28(2):729-37.
[27] Prakash R, Singh RK, Murugan S. An experimental research on a diesel engine fueled by biodiesel and its emulsions with timber pyrolysis oil.International magazine of green energy. 2012 Nov 1;9(8):749-65.
[28] Lima DG, Soares VC, Ribeiro EB, Carvalho DA, Cardoso ÉC, Rassi FC, Mundim KC, Rubim JC, Suarez PA. Diesel-like gas obtained through pyrolysis of vegetable oils. Journal of Analytical and Applied Pyrolysis. 2004 Jun 1;71(2):987-96.
[29] Demirbaş A. Biodiesel fuels from vegetable oils through catalytic and non-catalytic supercritical alcohol transesterifications and different methods: a survey. Energy conversion and Management. 2003 Aug 1;44(13):2093-109.
[30] Schuchardt U, Sercheli R, Vargas RM. Transesterification of vegetable oils: a review. Journal of the Brazilian Chemical Society. 1998 May;9(3):199-210.