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Performance analysis on 4 stroke Internal Combustion engine with EGR by using mahuva oil blends

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ABSTRACT

As a renewable and alternative fuel for compression ignition engines, biodiesel instead of diesel has been increasingly fuelled. In the recent 10 years many researchers investigated the effects on engine performances and emissions which are the harmful in diesel engine. Around the world researched are devoted to reduce such emissions with different ways like fuel modification, combustion chamber design and treating the exhaust gas, etc., In this connection the hunt for the suitable alternative fuels for diesel engine initiated.

The paper focused on effective utilization of fuel blend in DI diesel engine operating at different exhaust gas recirculation. In this work an effort was made to compare the performance characteristics of the diesel engine fuelled with pure diesel, pure Mahuva biodiesel and the blend of diesel-biodiesel-ethanol (ternary fuel blends). It was observed that the performance of the diesel engine with ternary fuel blends is as par with pure diesel. The experiments were conducted on single cylinder direct injection diesel engine at constant speed 1500 rpm. The engine was run without EGR, and 5% EGR. The blends are considered that with 5% , 10% of blend for EGR and without EGR. The results obtained were compared with that of pure diesel fuel.

KEYWORDS: IC engine, mahuva oil, EGR, Blends, Performance and emission analysis

1. INTRODUCTION

Fossil fuel consumption is steadily rising in industrial as well as in transportation sector as a result of population growth in addition to improvements in the standard of living. The continually depleting resources of fossil fuel and the highly toxic emissions which are produced due to these fuels have largely hastened the need for alternate fuels for internal combustion (IC) engines. Several fuels have been tried for running internal combustion engines. These include straight vegetable oil, biodiesel, alcohol, natural gas and hydrogen. Hydrogen has been found to have several properties which are essential for a green alternate fuel to be used in IC engines. Its high auto ignition temperature and low ignition energy coupled with its various other combustive properties help in enhancing engine performance. The high diffusivity of hydrogen which is about four times that of gasoline improves the

mixing process of fuel and air. As the burning velocity rises the actual indicator diagram is nearer to the ideal diagram and the thermodynamic efficiency increases.

2. BROAD CLASSIFICATION OF BIOFUELS

Classification based on Generation (Suc-classification of the secondary biofuels) According to this classification, the biofuels have been kept in four groups based on the source materials. They are: first generation, second generation, third generation and fourth biofuels

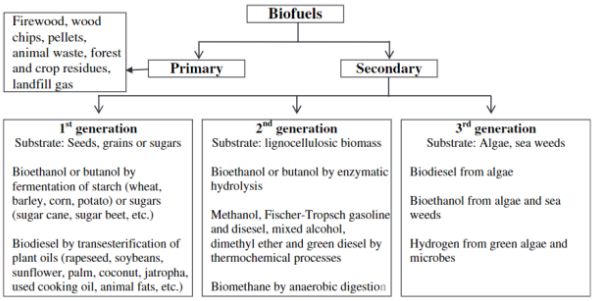

Figure-1: Broad classification of biofuels

3. EXPERIMENTAL SETUP AND METHODOLOGY

3.1 Production of Mahuva oil

Mahua oil is extracted from mahua seed by mechanical expeller. First the dry fruits were collected in a drum, and the kernels were separated. Later the kernels were dried and then fed into the oil extraction machine. The oil obtained by pressing is collected in a drum. Then filtration is done to remove the unwanted particles left in the extruded oil in order to obtain the pure vegetable oil.

The oils obtained from expeller were used for biodiesel production. Degumming process was carried out for Neem and Polanga oil to nullify the gum effect.. Then the oils were analysed for determination of their acid values by titrating against a known strength of KOH solution.

The methods adopted for degumming were treating the crude mahua oil first with immobilized phospholipase and then extracting the phospholipase-treated crude oil with pure water. 1% phosphoric acid was added to 1200 ml of crude neem/polanga oil. The mixture was heated and stirred at 900 C. Then the mixture underwent settling for 24 hours resulting in gum free mahua oil.

Fig 2: mahuva oil from seeds

It is semi-evergreen herbage indigenous to IndiaMahua oil has around 20% FFAs and has a yield of 181,000 metric tons per year in India.

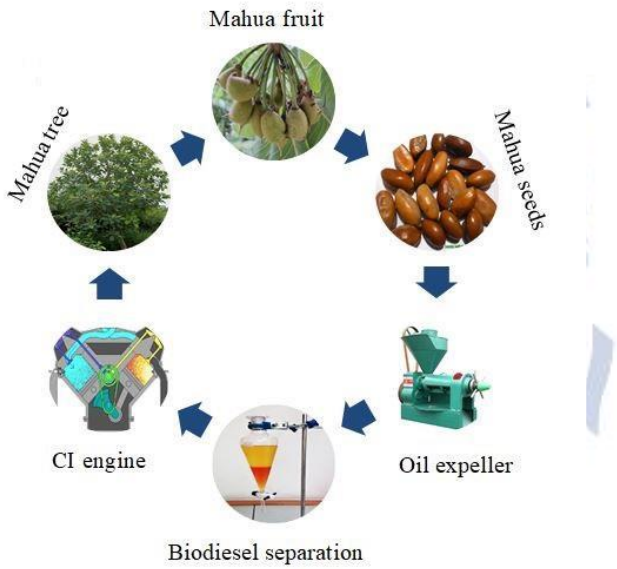

Fig. 3: .Life cycle analysis of mahua oil biodiesel

The unprocessed yet filtered rawmahua oil is greenish yellow in color. The fatty acid profile determines the quality and effectiveness of fats and oils. According to the fatty acid profile of mahua oil, the main fatty acids are palmitic acid, stearic acid, oleic acid, and linoleic acid. Table 2 indicated mahua oil contains a high concentration of saturated along with mono-unsaturated fatty acids.

Oils and fats can be processed into bio-diesel in at least four ways transesterification, dilution, micro-emulsions, and pyrolysis. The standard method is transesterification. It is a chemical process that forms fatty acid alkyl esters and glycerine, which is catalyzed by oil or fat and an alcohol.

3.1 Exhaust gas recirculation

Diesel engines have inherently high thermal efficiencies, resulting from their high compression ratio and fuel lean operation. The high compression ratio produces the high temperatures required to achieve auto-ignition, and the resulting high expansion ratio makes the engine discharge less thermal energy in the exhaust. The extra oxygen in the cylinders is necessary to facilitate complete combustion and to compensate for non-homogeneity in the fuel distribution. However, high flame temperatures predominate because locally stoichiometric air–fuel ratios prevail in such heterogeneous combustion processes . Consequently, Diesel engine combustion generates large amounts of NOx because of the high flame temperature in the presence of abundant oxygen and nitrogen

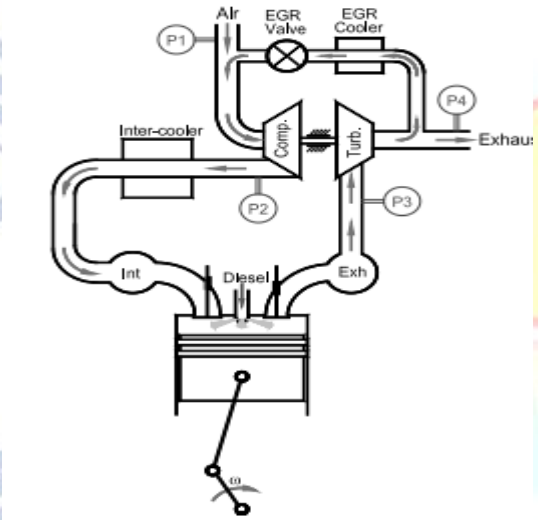

Fig 4:Exhaust gas recirculation

3.2 DIFFERENT TYPES OF BLENDS

The different types of blended bio fuels used in these projects are

1. B0 : 100% PURE DIESEL
2. B5 : 5% MAHUVA OIL &95% DIESEL
3. B10 : 10% MAHUVA OIL& 90% DIESEL
4. B15 : 15% MAHUVA OIL & 85% DIESEL

Table 1: Properties of blends

S.No	Blend	Viscosity(Stokes)	CV (Kj/kg)	Flash Point(^{0} C)	Fire Point(^{0} C)	Density ^{0} 45 C (Kg/m^3)
1	B0	2.65	46000	55	61	640
2	B5	2.98	45125	69	74	655
3	B10	3.45	44150	71	76	671
4	B15	4.12	43750	83	88	684
5	MAHUVA OIL	27.63	37450	212	227	915

3.3 Test rig specification

Table 2 : Specifications of the engine and the dynamometer

Description	Specifications
Engine	
Make	Mahindra and Mahindra
Engine Capacity (cc)	625
Type	Automotive (Multi-speed)
Compression Ratio	18:1
Power	9 HP @ 3000 rpm
Torque	30 NM @ 1800 rpm
Dynamometer	
Maker	Technomech
Type	Eddy current
Max. Power (in BHP)	10
Load measurement method	Strain Gauge
Cooling	Water

Figure 5: 4 stroke 1- cylinder diesel engine WITH EGR

4 RESULTS AND ANALYSIS

4.1 PERFORMANCE PARAMETERS

4.1.1 EGR VS BREAK POWER AT Torque of 24Nm

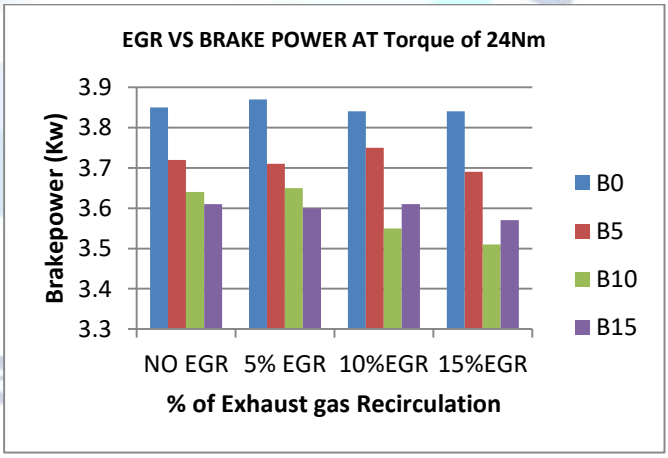

Fig 6: variation of brake power with EGR

4.1.2 EGR VS BRAKE THERMAL EFFICIENCY AT Torque of 24Nm

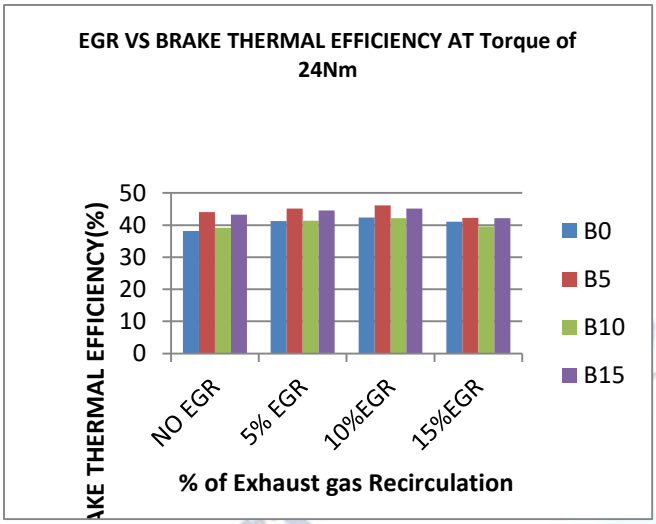

Fig 7: variation of BTE with EGR

4.1.3 EGR VS EXHAUST GAS TEMPERATURE AT Torque of 24Nm

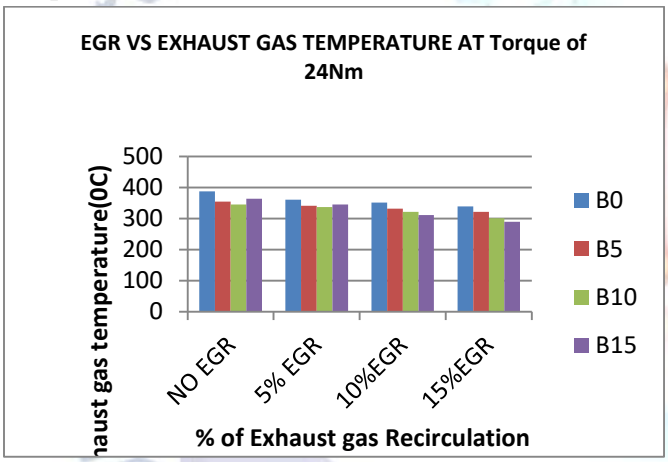

Fig 8: variation of EGT with EGR

4.1.4 EGR VS Brake Specific fuel consumption (Kg/Kw Hr) AT Torque of 24Nm

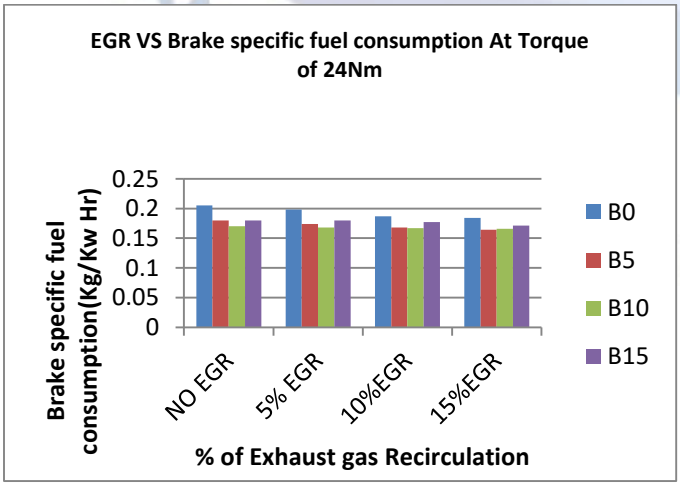

Fig 9: variation of BSFC with EGR

4.1.5 EGR VS Brake mean effective pressure (bar) AT Torque of 24Nm

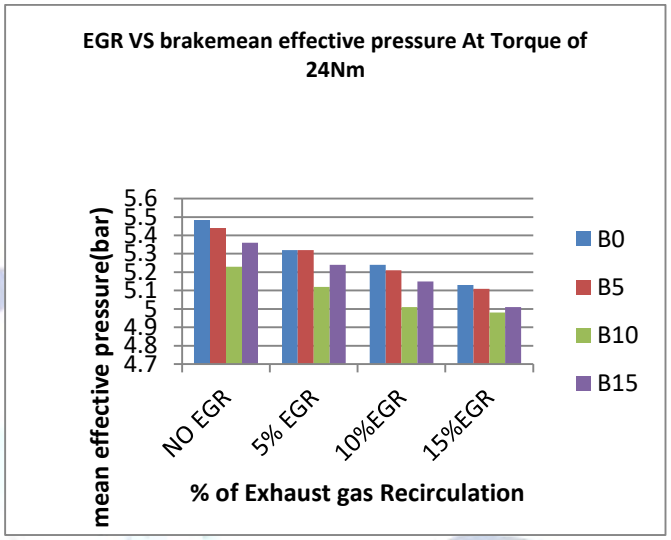

Fig 10: variation of BMEP with EGR

4.1.6 EGR VS Volumetric efficiency (%)AT Torque of 24Nm

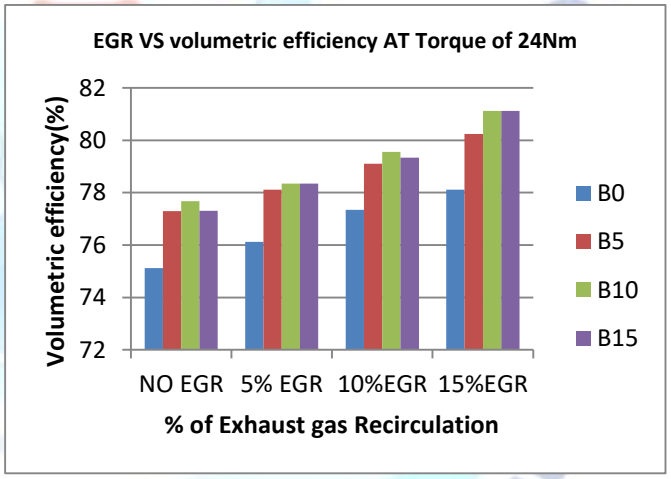

Fig 11: variation of Volumetric Efficiency with EGR

4.2 EMISSION ANALYSIS

4.2.1 EGR VS Hydrocarbon At Torque of 24Nm

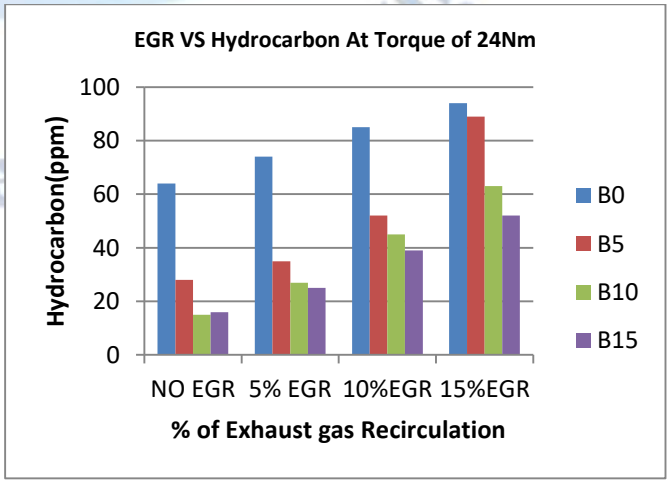

Fig 12: variation of HC with EGR

4.2.2EGR VS NITROGEN OXIDE EMISSION (ppm) At Torque of 24Nm

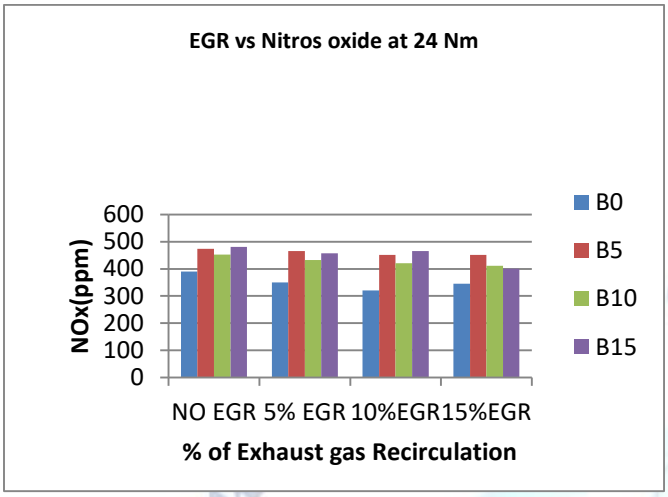

Fig 13: variation of NOx with EGR

4.2.3 EGR VS CARBON DI OXIDE (%)At Torque of 24Nm

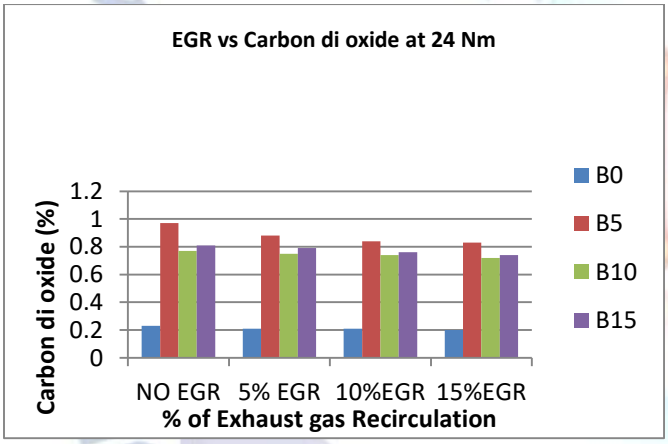

Fig 14: variation of CO_2 with EGR

4.2.4 EGR VS CARBON MONOXIDE (%)At Torque of 24Nm

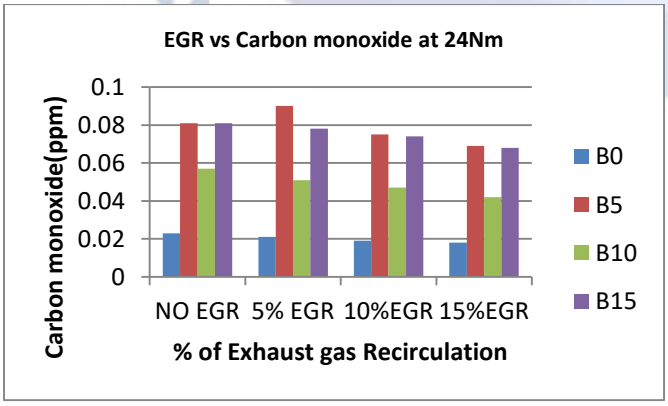

Fig 15: variation of CO with EGR

5. CONCLUSION

The experimental results shown in this paper thatengine performance and emissions of all blends whererun on the diesel engine and compared with standarddiesel fuel

1. Smooth working of engine is observed with mahua oil by blending with diesel without any modifications.
2. Percentage increase in mahua oil increases the viscosity of diesel.
3. Increase in percentage of mahua oil changes the properties of blends.
4. Slight increase in brake thermal efficiency and decrease in specific fuel consumption is observed in the case of mahua oil compared to that of diesel at different EGR.
5. Mahua oil and its blends can be used directly without any major engine modification. **NOx for various EGR rates.**
6. **CO for various EGR rates.**. The brake thermal efficiency decreases with a corresponding increase in the percentage of Mahua oil blend.
7. Mximum torque of 24 Nm and 10% Mahua oil blend is found to be optimum condition considering the SFC and BT efficiency.

NOx emissions are higher for Mahua oil and its blends. As the percentage of blend increases, the NOx emission rates are also higher. Three EGR flow rates are used to reduce the NOx emissions. 10% EGR flow rate is found to be optimum for the 10% Mahua oil blend 24Nm considering the emission of NOx and BT efficiency.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] Shaik Chand Mabhu Subhani, S.Koteswara Rao , P.Durga Neeharika, Dr. K. Srinivasa rao, N.Vijay kumar, "An experimental investigation of performance, combustion and emission characteristics of diesel engine fueled with bio diesel and its blends", International Journal of Engineering, Science and Mathematics, UGC, Vol. 6 Issue 8, December 2017 (Special Issue).

[2] Shaik chand mabhu subhani et al. "Experimental investigation on a diesel engine performance and emission characteristics with exhaust gas recirculation(egr) system fuelled with cotton seed oil and tyre oil biodiesel" The International journal of analytical and experimental modal analysis, UGC CARE, Volume XII, Issue VIII, August/2020

[3] A ˘gbulut, Ü.; Karagöz, M.; Sarıdemir, S.; Öztürk, A. Impact of various metal-oxide based nanoparticles and biodiesel blends on the combustion, performance, emission, vibration and noise characteristics of a CI engine. Fuel 2020, 270, 117521.

[4] Asokan, M.A.; Prabu, S.S.; Bade, P.K.K.; Nekkanti, V.M.; Gutta, S.S.G. Performance, combustion and emission characteristics of juliflora biodiesel fuelled DI diesel engine. Energy 2019, 173, 883–892

[5] Andrea, T. D., Henshaw, P. F., Ting, D. S. K., "Formation and restraint of toxic emissions in hydrogen-gasoline mixture fuelled engine", International Journal of Hydrogen Energy, 23, 1998, pp. 971-975.

[6] Li, J., Guo, L., Du, T., "Effects of hydrogen addition on cycleby-cycle variations in a lean burn natural gas spark-ignition engine", International Journal of Hydrogen Energy, 33, 2008, pp. 823-831

[7] Bhojraj N. Kale1, Dr.S.V.Prayagi " Performance analysis of cottonseed oil methyl ester for compression ignition engines" international journal of emerging technology and advanced engineering website: www.ijetae.com (issn 2250-2459, volume 2, issue 8, august 2012)

[8] JinangM.Patel, Krunal J.Patel,VatsalV.Patel and Kalpesh V.Vaghela " performance studies of tire pyrolysis oil blends with diesel fuel"international journal of engineering and advanced technology (ijeat) issn: 2249 – 8958, volume-3, issue-2, December 2013

[9] Ashish Jawalkar, Kalyan Mahantesh, M Jagadish "performance and emission characteristics of mahua and linseed biodiesel operated at varying injection pressures on CI engine" international journal of modern engineering research (ijmer), 2, page 1142-1149, 2012.

[10] Sk.Mohammad Younus, V.Ranjith Kumar, DR.Y.V.Hanumantha Rao" Performance and emissions characteristics of diesel engine fueled with tyre pyrolysis oil&diesel blends with additives" international journal of engineering science invention issn (online): 2319 – 6734, issn (print): 2319 – 6726 www.ijesi.org volume 2 issue 5 ǁ may. 2013 ǁ pp.32-37

[11] Alp TekinErgenc¸, LeventY¨Uksek, Orkun ¨Ozener " Performance, emission, and heat release analyses of a direct injection dieselengine running on diesel and soybean ester blends"turkish j eng env sci(2013) 37: 23 – 32

[12] K.Naveen,T.Parameshwaran Pillai, AzhagiriPon "Experimental investigation of variableCompression ratio diesel engine usingziziphus jujuba oil" international journal of innovative research in science, engineering and technologyvolume 3, special issue 3, march 2014,issn (online) : 2319 – 8753 issn (print) : 2347 – 6710

[13] Miqdam Tariq Chaichan, Prof. Dr. Sabah Tarik Ahmed "Evaluation of performance and emissions characteristics for compression ignition engine operated with disposal yellow grease" the international journal of engineering and science (ijes) ||volume|| 2 ||issue|| 2 ||pages|| 111-122 ||2013|| issn: 2319 – 1813 isbn: 2319 – 1805

[14] Shaik chand mabhu subhani et al "Structural and Thermal Analysis of Brake Drum" International Journal for Modern Trends in Science and Technology, UGC, VOL-VI, ISSUE-XII, DEC 2020

[15] Shaik chand mabhu subhani et al "Static and Model Analysis on Pneumatic Suspension by using Ansys Software" International Journal for Modern Trends in Science and Technology, UGC, VOL-VI, ISSUE-XII, DEC 2020

[16] Shaik chand mabhu subhani et al "The analysis on concentric pipe heat exchanger" Emerging trends in mechanical engineering and industrial automation (ICETMEIA), JULY 2021, ISBN NO:98-93-91420-02-4.

[17] Shaik chand mabhu subhani et al "A review on parameters of composite materials" Emerging trends in mechanical engineering and industrial automation (ICETMEIA), JULY 2021, ISBN NO:98-93-91420-02-4.

[18] Shaik chand mabhu subhani et al "The Systematic Comparision on Analysis of Parallel Flow and Counter Flow Heat Exchanger by Using CFD and Practical Methods" International Journal for Modern Trends in Science and Technology, UGC, VOL-VII, ISSUE-XI, Nov 2021