Experimental Investigation on Performance and Exhaust Emission Characteristics of Diesel Engine using Eesame Blends with Diesel and Additive

Yarram Emima, Muthuluru Rajesh, Kuchipudi Srinivasa Rao

Abstract: The modern world needs are increasing as the days are going so as to overcome the needs of the human beings science is improving day to day. Many researchers have worked successfully in generating energy from various alternate sources, including solar and biological sources such as conversion of energy from sunlight to electricity and conversion of some renewable agricultural substances into fuel. This work considers the Trans esterification of sesame oil and to measure the viscosity, flash point, fire point, density and gross calorific value of the pure sesame oil after Tran's esterification. Then mixing of blends with diesel taking three samples SB10 (10% sesame oil+90% diesel) and SB20 %(20%sesame oil+80% diesel) and SB40 %(40%sesame oil+60% diesel). Choosing SB10 and SB20 as beset by result obtaining by performing emissions and performance test on biodiesel blends. But the SB40 gives low performance and higher emissions. Now adding additive to SB40 for better results and comparing the experimental values of biodiesel blends SB40+5% Ethyl Hexyl Nitrate with diesel.

Index Terms: Biodiesel, Ethyl Hexyl Nitrate, Fossil Fuel, Sesame oil.

I. INTRODUCTION

Biodiesel is an opportunity gasoline which includes the alkyl ester of fatty acids from vegetable oils or animal fats. Vegetable oils are made out of numerous oil seed crops (edible and non edible oils), e.g., sesame oil, rapeseed oil, linseed oil, rice bran oil, soybean oil, and many others etc., [1]. Diesel engine pollutants consist of carbon monoxide (CO), carbon dioxide (CO2), sulfur oxide (Sox), nitrogen oxide (Nox) and particulate matter (PM) [2]. Biofuels are alternative fuels and lot of research was done on the development of these fuels. [3-4].Vegetable oils contain several advantages as follows:

They are renewable energy because oil-producing vegetables can be used for renewable, the heat producing rate is similar to diesel, and its emission (CO, HC, Nox and PM) rate is comparatively low [4-7-11], and they do not have sulphur content, they can be used in the engine [11-13] as simple or uninterrupted. These essential benefits have guided many research and advance learning on vegetable oils. But some studies found high nose emissions [10-11], number of researchers found a slight drop in Knox emissions while consuming biodiesel mixtures [14-16]. In the form of fuel, if vegetable oils do not apply major modifications on the engines, they can cause abatement in fumes outflow rates [12-15-17]. The major troublesome of abusing vegetable oils like fuel in diesel motors is interrelated adjacent viscosity [15-18-19]. The greater consistency diesel motor prompts pursue - on inconveniences; blockage of fuel lines and channels, and low fuel atomization, combustion is partly and deposits severely on the engine, trumpet formation and injects on the piston ring, formation of gum and lubricating oil thickening [3-14-16-20-22]. In solving these problems to excessive viscosity of vegetable oils, the subsequent general techniques are accepted: mixing in small proportions by ordinary diesel fuel, micro-emulsification through methanol or ethanol, then dissolving them to convert into biodiesel fuel [15-16-22-23]. The way toward mixing requires the advantages of developing the utilization of vegetable oils with peripheral fuel agreement and engine change [16]. In this manner, blending of diesel by vegetable oils with clear extents diminishes consistency as a result, the alternative fuels are used in the diesel engines. The major purpose in this work is to investigate the diesel fuel mixed with sesame oil and diesel fuel as fuel in a diesel engine and to characterize engine execution and upgraded fumes outflow qualities. In this work, the diesel fuel is blended with sesame oil at 10%, 20%, 40% ratios on capacity base immediately to decrease the viscosity of blended fuel.

The investigated results are related by the ordinary diesel fuels. In this work used three blends with the proportions of 10%, 20%, 40%, comparing these there blends the, blend 40% gives the less performance. For this reason we added the 5% additive (ethyl hexyl nitrate) to 40% blend. Then comparing the results.

II. MATERIALS ANDMETHODS

A. Preparation of sesame oil methyl ester:

Initially, 200 ml methanol and 6-5Gm KOH were mixed in the correct proportions of the measured quantity Measure 1Lt of sesame crude oil using measuring cylinder and pour it in a flask and it was heated up to a temperature of 65-75^{0}C.When the oil was

Revised Manuscript Received on June 01, 2019.
Emima Yarram, Department of Mechanical Engineering, VRSEC Vijayawada, Andhra Pradesh, India.
Rajesh Muthuluru, Assistant Professor, Department Mechanical Engineering, VRSEC Vijayawada, Andhra Pradesh, India.
[3]**Srinivasa Rao Kuchipudi**, Assistant Professor, Department of Mechanical Engineering, VRSEC Vijayawada, Andhra Pradesh, India

reached to 75^0C the water particles will evaporate. After that, the oil was cold to 50-55^0C.Methanol and KOH were mixed with sesame oil continuously stirring at a constant temperature of 55^0 Continue heating till 1-2 hours make sure that the temperature remains constant. Pour the oil separation funnel and keep it for at least 6 hours, which permits glycerin to settle down; hence it is denser than biodiesel. Remove the glycerin from the separating funnel. It is taken to be in a conical flask. Now wash the biodiesel obtained with water so as to remove the chemicals. Finally, we have obtained pure sesame biodiesel, which, if free from all chemicals and any water, we added in the process.

Fig A. Tran's esterification Process of biodiesel

B. Blends Preparation:

Blends were prepared in several proportions of sesame oil and diesel SB10, SB20 and SB40 the classified properties of testing fuels alike density, viscosity, and calorific value, flash and fire point were determined. The biodiesel and diesel properties are given below in Table1. The density of the mixed blends (i.e.SB10, SB20 and SB40) showed an ordinarily in respect to a rise in blends proportion.

Fig B. Different blends

C. Ethyl hexyl nitrate:

Ethyl hexyl nitrate is a cetane promoter in diesel. Cetane number on diesel fuel is a measure of its ignition quality. High cetane numbers provide diesel fuel, several important engine performance and environmental benefits. The chemical compound within the ethyl category with the formula ($C8H17O3$). It's a colorless, extremely volatile ignitable liquid. It is normally used as a solvent. Ethyl hexyl nitrate contains a more cetane range of 85-96 and is employed as a beginning fluid, combines with fossil fuel distillates for hydrocarbon and diesel engines as a result of its high volatility and low flash purpose.

Table I. Properties of fuels

Parameters	Diesel	SB10	SB20	SB40
Kinematic viscosity @40°C in cst	2.7	3.28	3.65	4.34
Flash point(°C)	54°C	68°C	89°C	96°C
Fire point(°C)	65°C	73°C	92°C	120°C
Gross calorific value kj/kg	42,500	41326	40,336	38,752
Density in kg/m³	840	852	856	875

D. Experimental Setup:

Fig C. Experimental Setup

Table 2. Engine Specifications

S. No.	Details	Specifications
1	Power	3.7KW
2	Speed	1500 RPM
3	Compression Ratio	12:1 to 20:1
4	Stroke Length	56 mm
5	Cylinder Bore	80 mm
6	No. of Cylinders	1
7	Stroke type	4
8	Cooling Type	Water
9	Speed Type	Constant

A Computerized single cylinder, four stroke, water cooled, diesel engine. Variable compression ratio (VCR) diesel engine was used to study the performance, and emission analysis. The Specifications are shown above table 2.

III. RESULTS AND DISCUSSION

The Brake thermal efficiency, Specific fuel consumption, and exhaust gas emissions were studied on the variable compression ratio(VCR) for water cooled diesel engine using diesel fuel 90%, 80%,60% and the blends are 10%, 20%, 40% of sesame oil and the compression ratio of 18:1 with additive and without additive. 18:1 has been presented with varying loads. Three blends characteristics have been equated by diesel to understand the result of each parameter. In this study, the performance parameters such as brake thermal efficiency, specific fuel consumption and emissions such as oxides of nitrogen, carbon monoxide, and hydro carbons were determined.

A. Brake Thermal Efficiency:

The character of change of brake thermal efficiency (BTE) through percentage capacity for different sesame biodiesel mixtures with the compression of 18:1 shown in below Figures D, E.

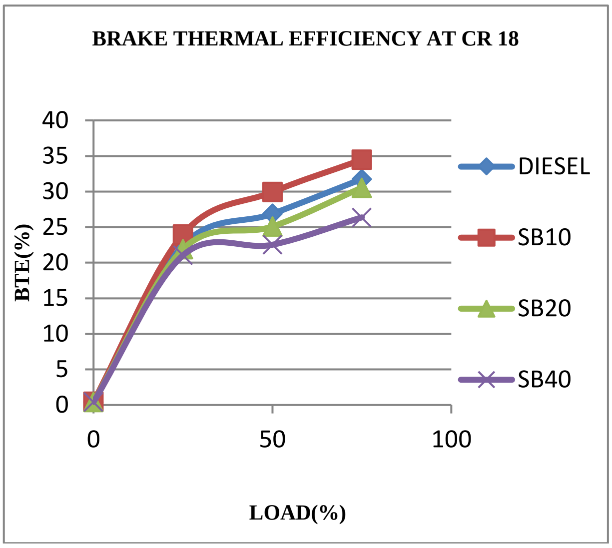

Fig D. Load vs. Brake thermal efficiency

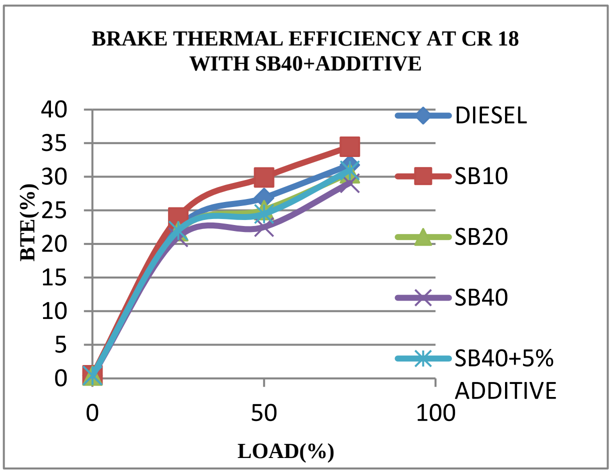

Fig E. Load vs. BTE *with* SB40+5%additive

The brake thermal efficiency of SB10 is more than diesel. From the graph it is clear that the brake thermal efficiency has increased with more compression ratio of 18:1. Even the viscosity of biodiesel blend SB10 is less than diesel. This proves that SB10 biodiesel blend gives improved brake thermal efficiency than diesel.

B. Brake Specific Fuel Consumption

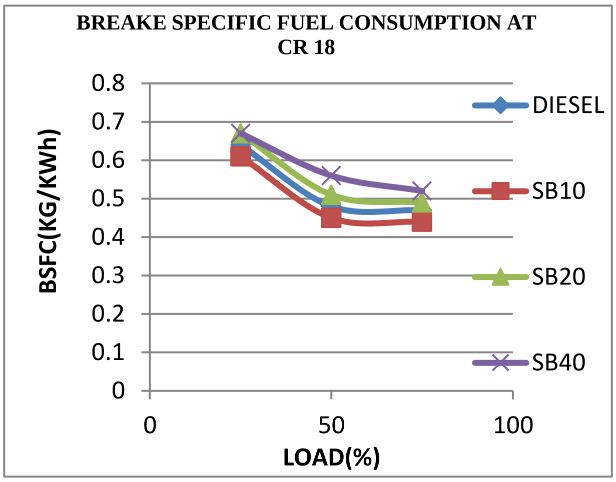

Fig F. Load vs. Specific fuel consumption

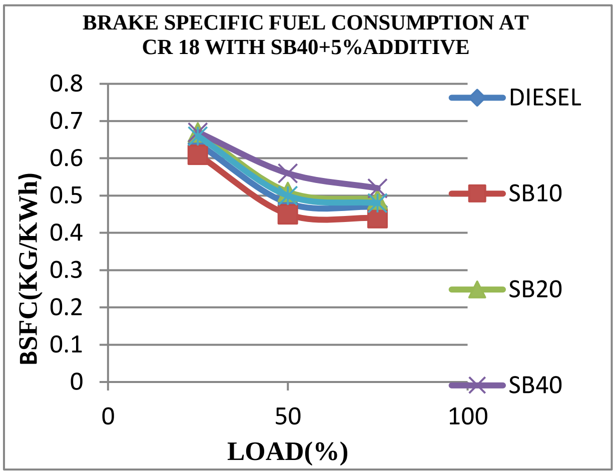

Fig G. Load vs. SFC with SB40+5%additive

The specific fuel consumption (BSFC) difference by compression ratio for various sesame biodiesel blends is shown in Figure F, G. If load increases the Specific fuel consumption slightly reduces for the sesame biodiesel blends. As the compression ratio increases the Specific fuel consumption (BSFC) decreases. The BSFC of SB10 and SB20 is lower than diesel. From the graphs F, G. It is evident that the BSFC has decreased with higher the compression ratio of 18:1. Even the calorific values of bio diesel blends are less than diesel. The blend SB40 has high BSFC. For this reason to reduce the BSFC of SB40, used to added 5% ethyl hexyl nitrate to SB40.

C. Exhaust emissions:

Sesame blends creates significantly low CO emissions than diesel fuel. Wang et al. [16] it has additionally been said that at the reality of just the engine total limit, the emissions CO of vegetable oils/diesel fuel blends remain less in contrast with diesel fuel. At low engine speeds the CO emissions remain high. In polluted air the Nox emissions are very important [14]. With the increase in the speed of the engine, there was a decrease in Nox emissions. This is mainly increment in unpredictable productivity and gas stream speed inside the engine chamber beneath the engine higher velocities which prompts blending quicker and a little start delay between the fuel and the air. Within the test range, it can be seen that

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

Nox emissions from a mixture of sesame oil and diesel fuel is less than sesame blends. The decrease in Knox emission is probably due to the small calorific value of the mixture [16].

a. Carbon monoxide emissions:

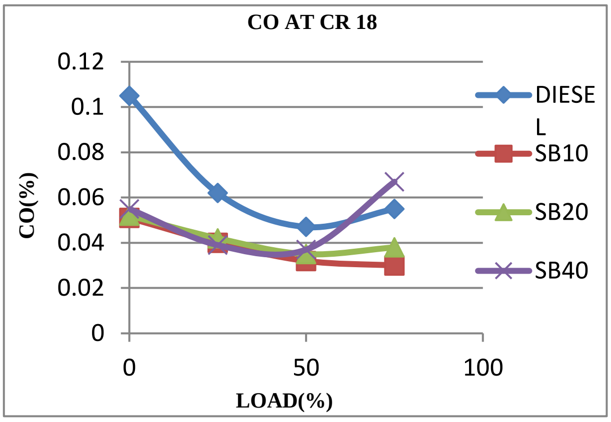

Fig H. Load vs. carbon monoxide

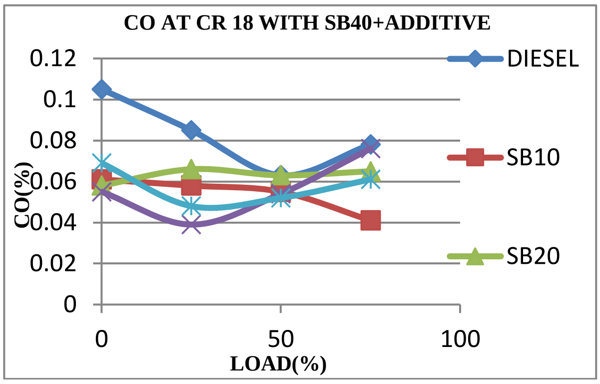

Fig I. Load vs. carbon monoxide withSB40+5%additive

From the load vs. co graphs with additive and without additive the carbon monoxide of mixtures are reduced than the diesel, except blend SB40.The SB40 has higher carbon monoxides then the SB10, SB20 and diesel. The sesame biodiesel SB10 has and SB20 having lower carbon monoxide. For this reason to overcome the co emissions, adding of additive to the SB40.After adding additive to the SB40, the co-emissions are reduced.

b. Hydrocarbon emissions:

This is one of the toxic products of burning due to inadequate combustion of hydrocarbons (HC) [25]. The emission of sugars and smoke in diesel engines is the main problem. Although smoke emissions were seen blindly and were significantly more than diesel fuel. An important soot formed in the combustion chamber was also detected. Long-term engine tests require exhaust valves especially on different proportion of sesame oil. However smoke emissions were detected blindly and were significantly higher than diesel fuel. Due to the low temperature of the mixture, the exhaust gas mixture is less than the diesel fuel. Sesame oil has adverse effects on combustion of high flash point, fire point, calorific value but low viscosity and density compared to the diesel fuel from table 1.

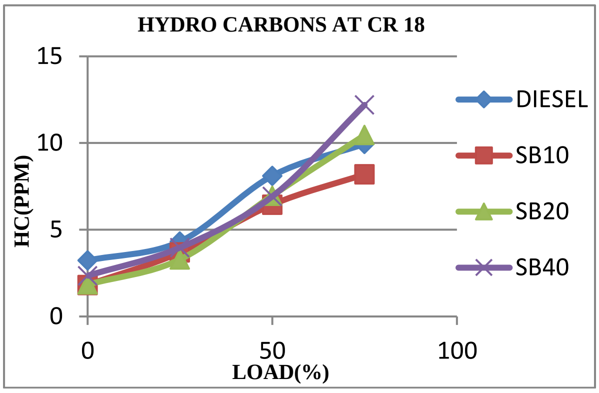

Fig J. Load vs. Hydrocarbons

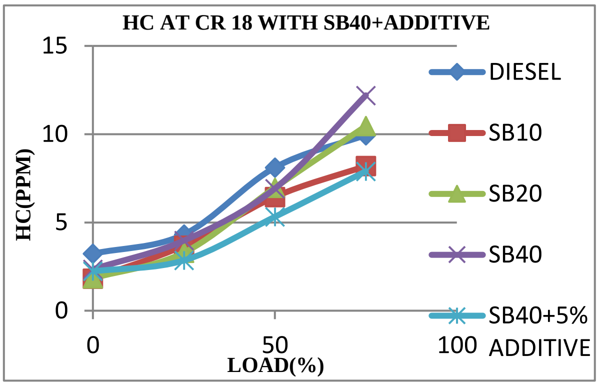

Fig K. Load vs. Hydrocarbons with SB40+5%additive

C. Nitrogen oxide emissions:

It was seen from the graph L, M that as the load increases nitrogen oxide increases. Nitrogen oxide emissions of SB10, SB20 and SB40 exceeds diesel in all load conditions. From the graph, it is clear that nitrogen oxide decreases with an increase in the compression of 18: 1 [14]. Nox emissions decreased by increase in engine speed. Nox emissions are probably created the small calorific value of the mixture [16]. The temperature in the cylinder is lower, automatically the Nox should be reduced. At high combustion temperatures, the Nox emissions greater than before with engine load. This shows that the significant reason aimed at the emission of Nox is the local stoichiometry of the combustion temperature then the mixture in the engine cylinder. From fig L, M it can be understood that inside the capacity of testing, Nox emissions are lesser when mixing with sesame blends than that of diesel fuel. Due to the smaller calorific value of the mixture the Nox emissions are probably decreased [16].

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

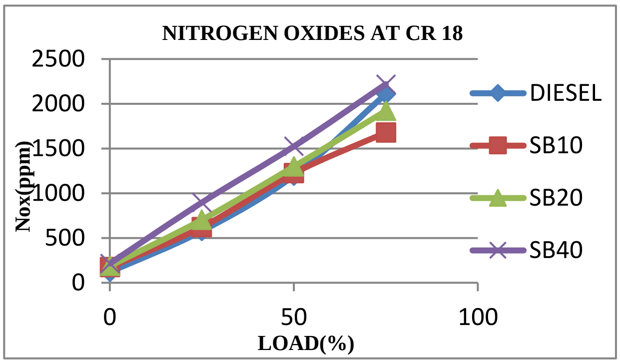

Fig L. Load vs. Nitrogen oxides

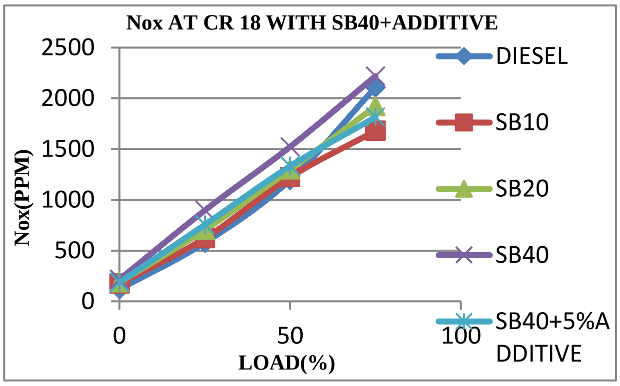

Fig M. Load vs. Nitrogen oxide with SB40+5%additive

When adding the additive to SB40 with 5% ethyl hexyl nitrate, the emissions nitrogen oxides are reduced. So the efficiency of the SB40 increased shown above fig M. This proves that the Nox gases are reduced by using the biodiesel.

IV. CONCLUSION

In this examination, the impacts of sesame oil and diesel fuel blend are examined experimental as an alternative fuel on engine performance and fumes gas discharges. In light of the trial aftereffects of this investigation, the accompanying ends can be taken:

1. A blend of sesame oil and diesel fuel can be used directly in the diesel engines in the form of fuel without any modification.
2. However, the power produced by mixing sesame oil and diesel fuel is near to conventional diesel fuel, but fuel utilization of the mixture is greater than normal diesel fuel. It is responsible for the low heating system value of the mixture compared to normal diesel fuel.
3. It is seen that compared to ordinary diesel fuel, the mixture reduces the low CO value and slightly reduces the Nox value.
4. The price of sesame oil is generally increasing and the formation of sesame yield created on hand texture (not mechanical) is due to its small crop besides inadequate planting regions to grow. Thus, sesame oil today cannot play by diesel fuel or extra plant oils. When it is estimated that the production of increasing sesame will be high, if vegetable oils are used in diesel engines
5. In this work the blends SB10 and SB20 gives good performance and lower emission characteristics. But SB40 gives lower performance and higher emissions.
6. To overcome these problems used to added 5% ethyl hexyl nitrate with SB40.After adding the additive, the performance has increased and emissions are reduced.
7. It is observed that dissipate excretion of sesame blends with diesel fuel is less than normal diesel fuel. Then sesame blends can be utilized as an alternative fuel in the wake of natural contamination.
8. Unique grades of sesame oil blends and diesel gas combinations can exist in diesel engines and additionally improvement in gas characteristics had been investigated.

REFERENCES

1. Agarwal D, Agarwal AK (2007) Performance and emissions characteristics of Jatropha oil (preheated and blends) in a direct injection compression ignition engine. Appl Therm Eng. 27:2314–2323Perugia, Ital.
2. Corsini A., Giovannoni V., Nardecchia S., Rispoli F., Sciulli F., Venturini P., Performance of a common-rail Diesel engine fuelled with rapeseed and waste cooking oils. In Proceedings of ECOS 2012
3. B.L. Salvi, N.L. Panwar, Biodiesel resources and production technologies- a review. Renew. Sustain. Energy Rev. 16, 3680–3689.
4. B.K. Barnwal, M.P. Sharma, Prospects of biodiesel production from vegetable oils in India. Renew. Sustain. Energy Rev. 9, 363–378 (2005) (2012). doi:10.1016/j.rser.2012.03.050
5. Selim MYE, Radwan MS, Elfeky SMS. Combustion of jojoba methyl ester in an indirect injection diesel engine. Renew Energy 2003; 28: 1401–20. [6 Szybist JP, Boehmon AL, Taylor JD, Mccormick RL. Evaluation of formulation strategies to eliminate biodiesel NOx effect. Fuel Process Techno 2005; 86:1109–26.
6. Agarwal D, Sinha S, Agarwal AK. Experimental investigation of control of NOx emissions in biodiesel-fuelled compression ignition engine. Renew Energy 2006; 31:2356–69.
7. Nabi N, Akhter S, Shahadat MZ. Improvement of engine emissions with conventional diesel fuel and diesel–biodiesel blends. Bio resource Technol 2006; 97(3):372–8.
8. Kalligeros S, Zannikos F, Stournas S, Lois E, Anastopoulos G, Teas C, et al. An investigation of using biodiesel/marine diesel blends on the performance of a stationary diesel engine. Biomass Bioenergy 2003; 24:141–9.
9. Canakci M. Combustion characteristics of a turbocharged DI compression ignition engine fuelled with petroleum diesel fuels and biodiesel. Bio resource Technol 2007; 98(6):1167–75.
10. Dorado MP, Ballesteros EA, Arnal JM, Gomez J, Lopez FJ. Exhaust emissions from a diesel engine fuelled with transesterified waste olive oil. Fuel 2003; 82(11):1311–5.
11. Rakopoulos CD, Antonopoulos KA, Rakopoulos DC, Hountalas DT, Giakoumis EG. Comparative performance and emissions study of a direct injection diesel engine using blends of diesel fuel with vegetable oils or bio-diesels of various origins. Energy Convers Manage 2006; 47:3272–87.12.
12. Wang YD, Al-Shemmeri T, Eames P, McMullan J, Hewitt N, Huang Y, et al. An experimental investigation of the performance and gaseous exhaust emissions of a diesel engine using blends of a vegetable oil. Appl Therm Eng. 2006; 26:1684–91.
13. He Y, Bao YD. Study on rapeseed oil as alternative fuel for a single- cylinder diesel engine. Renew Energy 2003; 28:1447–53.
14. Nwafor OMI. Emission characteristics of diesel engine running on vegetable oil with elevated fuel inlet temperature. Biomass Bioenergy 2004; 27:507–11.
15. Demirbas A. Biodiesel production via non-catalytic SCF method and biodiesel fuel characteristics. Energy Convers Manage 2006; 47(15/16): 2271–82.
16. Yu¨cel HL. The use of the mixtures of cotton oil and diesel fuel as alternative fuel. In: Proceedings of the fourth national clean energy symposium, I˙stanbul, 2002. p. 945–52 [in Turkish].

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication

17. Pugazhvadivu M, Jeyachandran K. Investigations on the perfor-mance exhaust emissions of diesel engine using preheated waste frying oil as fuel. Renew Energy 2005; 30:2189–202.
18. Huzayyin AS, Bawady AH, Rady MA, Dawood A. Experimental evaluation of diesel engine performance and emission using blends of jojoba oil and diesel fuel. Energy Convers Manage 2004; 45: 2093–112.19.
19. Georing CE, Schwab B, Daughrt MJ, Pryde EH, Heakin AJ. Fuel properties of eleven vegetable oils. Trans Am Soc Automot Eng 1982:1472–83. (0001-2351/82/2506-1472S02.00).
20. Yu¨cesu HS, Altın R, C- etinkaya S. Dizel motorlarında alternative yakıt olarak bitkisel yag˘kullanımının deneysel incelenmesi. Turk J Eng Environ Sci 2001; 25:39–49.
21. Agarwal AK. Biofuels (alcohols and biodiesel) applications as fuels for internal combustion engines. Prog Energy Combust Sci 2007; 33(3):233–310.
22. Demirbas A. Biodiesel production via non-catalytic SCF method and biodiesel fuel characteristics. Energy Convers
23.] Humke AL, Barsic NJ. Performance and emissions characteristics of a naturally aspirated diesel engine with vegetable oil fuels—(Part 2). Soc Automot Eng 1982; 810955:2925–35.
24. Yu¨cel HL. The use of the mixtures of cotton oil and diesel fuel as alternative fuel. In: Proceedings of the fourth national clean energy symposium, I˙stanbul, 2002. p. 945–52 [in Turkish].
25. Pugazhvadivu M, Jeyachandran K. Investigations on the perfor-mance exhaust emissions of diesel engine using preheated waste frying oil as fuel. Renew Energy 2005; 30:2189–202.