Experimental Investigation on the Effect of Nano Fluids on the Performance and Emission Characteristics of a Biodiesel Based Diesel Engine

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Abstract— Diesel engine plays a vital role in the automobile and heavy duty applications due to its reliability a high performance, even though diesel has many advantages it has its own drawback as it is a renewable source will deplete soon. The depletion of fossil fuel must be resolved by finding a better replacement for diesel without affecting the performance of the engine. So we produce lemon grass oil as a biofuel for an alternative source but in viscosity was a problem to used was in diesel engine, so we go for the transesterification process which reduces the viscosity dramatically. Once preparing lemongrass biodiesel add the nanoparticles through sonification process. By adding nanoparticles to the biodiesel to enhance the heat transfer rate. Such a biodiesel can be used in single cylinder direct injection diesel engine with compression ratio 16.5 carry out the performance and emission characteristics.

Key words: Biodiesel, Nanoparticles, Performance and Emission Characteristics

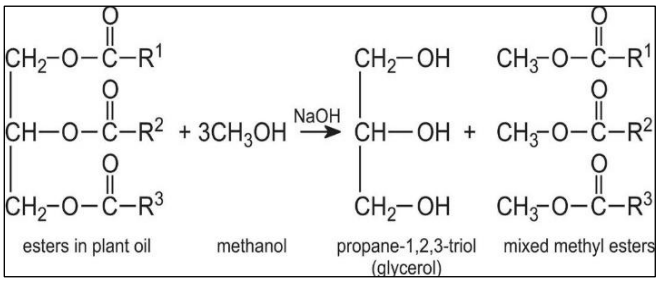
I. INTRODUCTION

The diesel fuels have an important role in the industry economy of any country. Compared to the rest of the world, India demand for diesel fuels is aroundly six times that of gasoline fuels and its stands at one third of total petroleum products consumption in the country. India lacks fossil energy resources and imports almost half to total petroleum products was approximately 110 million and unreliable external energy supply had been a burden to the national economy.

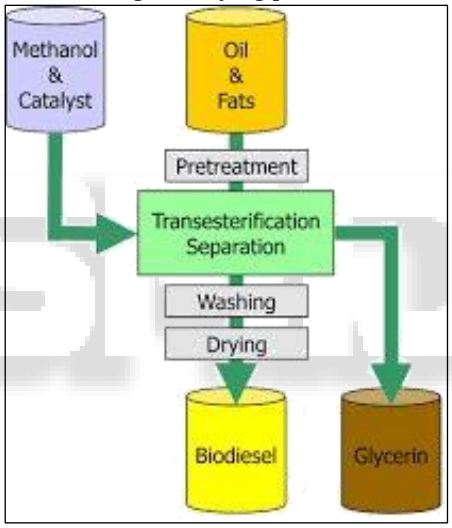
Increased environmental concerns, tougher vehicle`s emission norms, increasing prices and uncertainties concerning petroleum availability necessitate the search for a viable alternative fuel, which is more environment friendly. Vegetable oils have comparable energy density and cetane number as that of mineral diesel. The idea of using vegetable oils and other waste oil as fuel for diesel engine is not new. When Rudolf Diesel first invented the diesel engine, he demonstrates it at the 1900 world exhibition in Paris, employing peanut oil [1].

II. EXPERIMENTAL PROCEDURE

The viscosity of lemon grass oil will be reducing through transesterification process. Lemon grass is a plant species contain esters directly mixed with methanol addition NAOH act as catalyst to form glycerol and mixed methyl ester, basically lemon grass is a plant oil which contain high viscosity compared to the diesel and reduce its viscosity through transesterification process. The NAOH catalyst and the methanol forms a good chemical bonding and its breaks through the process by stirring at 40-50°C.



The completion of transesterification process glycerin collected separately and biodiesel getting after the completion of washing and drying process.



The plant oil measure and pour into the reaction vessel. Mixture 25% by volume of plant oil and 3.25g/liter of plant oil and sodium hydroxide; then heat the plant oil to 40-50°c. Pour the sodium hydroxide into plant oil while stirring and allow the solution to settle down at least 8 hours. Finally, separate the glycerin from biodiesel. In transesterification, sodium hydroxide and methanol are mixed to create sodium methoxide ($Na+CH_3OH$) mixed in with the plant oil this strong polar bonded chemical breaks the trans fatty acid into glycerin and ester chain.

III. PROPERTIES OF DIESEL AND BIODIESEL

Fuel property	Diesel	Biodiesel
Cetane number	51	44
Density	0.832kg/l (or) 832kg/m³	0.942kg/l (or) 942kg/m³
Flash point	52-96˚C	50-115˚C

Fire point	Usually 10˚C greater than flash point	Usually 10˚C greater than flash point
Viscosity	2.5-3.5mm²/s at 40 ˚C	2.1-4.1mm²/s at 40 ˚C
Calorific value	45.5MJ/kg	37.6MJ/kg

IV. TESTING ENGINE PROCEDURE

SPECIFICATION	DETAILS
No.of cylinder	1
Make and model	Kirloskar and AV-1
Compression ratio	16.5
Bore and Stroke	80*110mm
Maximum speed	1500rpm
Maximum bhp	5@1500rpm
Injection pressure	200bar
Engine capacity	553cc
Type of cooling	Water cooled
Type of loading	Eddy current Dynamometer

V. NANOPARTICLE

The nanoparticle directly adds lemongrass biodiesel through sonification process with 30 min. The nanoparticles which can be used in this project is Al_2O_3, TiO_2. To enhance the heat transfer rate in a combustion stroke in an engine the nanoparticle will be added and to reduce the emission to atmosphere.

VI. RESULTS AND EVALUATION

The following sections illustrates the results obtained from the performance and emission characteristics of the Biodiesel based CI engine. The total fuel consumption is same for diesel and raw lemongrass at particular load condition. Once add the nanoparticle the fuel consumption for a per hour is high compared to diesel.

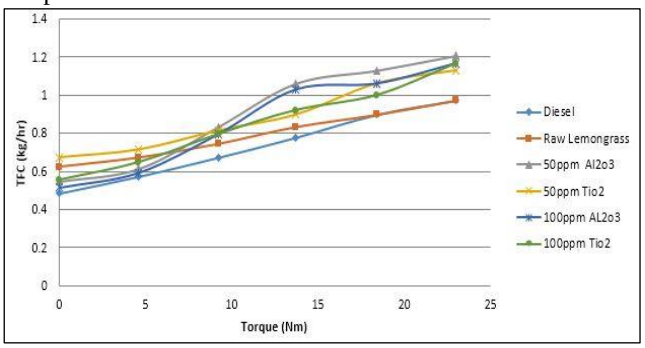


Fig. 1: Torque vs TFC

VII. SPECIFIC FUEL CONSUMPTION

The specific fuel consumption is higher for the diesel lemongrass blends than neat diesel at all the Torque. This is due to lower calorific value of the diesel lemongrass blends than neat diesel; more quantity of fuel is consumed to maintain engine speed constant. The lowest SFC is observed as 0.2692kg/kW.hr for the raw lemongrass whereas it is 0.2690kg//kW.hr for neat diesel at the torque of 23Nm.

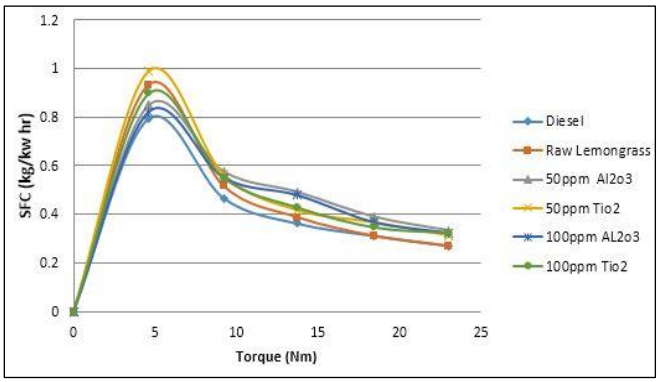


Fig. 2: Torque vs SFC

VIII. THERMAL EFFICIENCY

The brake thermal efficiency of the neat diesel is higher then all the fuel blends. The highest brake thermal efficiency is observed as 30.75% for neat diesel whereas it is 26.47% for the lemongrass with 50ppmTio2 blend under the same Torque of 23Nm.

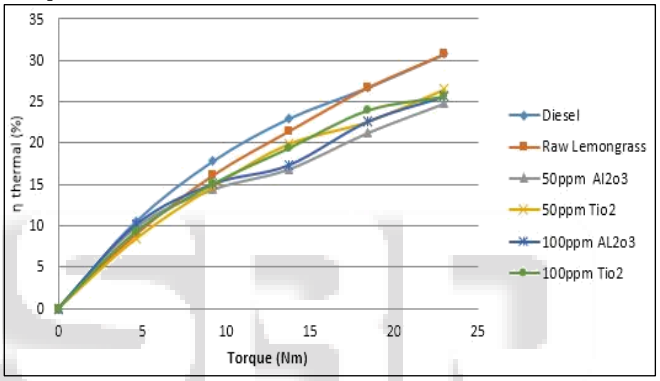


Fig. 3: Torque vs thermal efficiency

IX. CARBON MONOXIDE EMISSION

The carbon monoxide emission decreases with the use of biodiesel lemongrass blends than neat diesel. The lowest CO is observed as 17% for lemongrass whereas it is 96% for neat diesel at the torque of 23Nm. The addition of titanium oxide further decreases the CO emission when comparing with neat diesel.

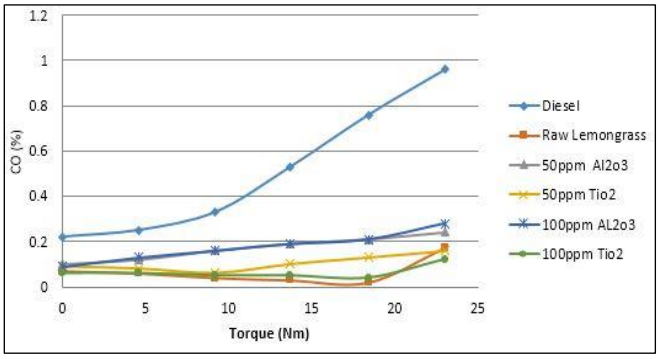


Fig4. Torque vs co

X. HYDRO CARBON EMISSION

The hydro carbon emission decreases with the use of biodiesel lemongrass blends than neat diesel. The lowest HC is observed as 69ppm for lemongrass whereas it is 148ppm

for neat diesel at the torque of 23Nm. The addition of titanium oxide further decreases the HC emission when comparing with neat diesel.

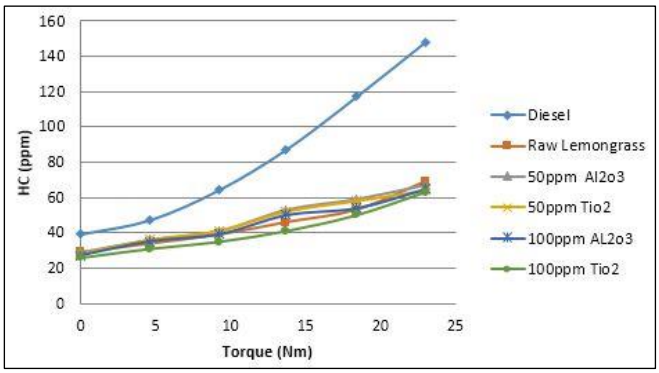


Fig. 5: Torque vs HC

XI. NITROGEN OXIDE EMISSION

The nitrogen oxide emission decreases with the use of biodiesel lemongrass blends than neat diesel. The lowest NO is observed as 680ppm for lemongrass whereas it is 710ppm for neat diesel at the torque of 23Nm.

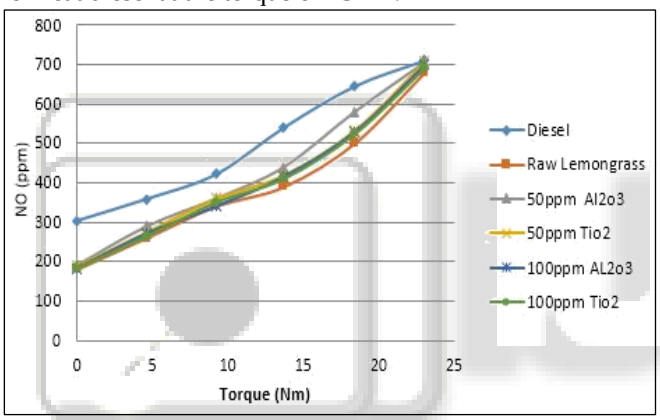


Fig. 6: Torque vs NO

XII. CARBODIOXIDE EMISSION

The carbon dioxide emission decreases with the use of biodiesel lemongrass blends than neat diesel. The lowest CO2 is observed as 6.2% for lemongrass with 50ppm of AL2o3 whereas it is 6.5% for neat diesel at the torque of 23Nm.

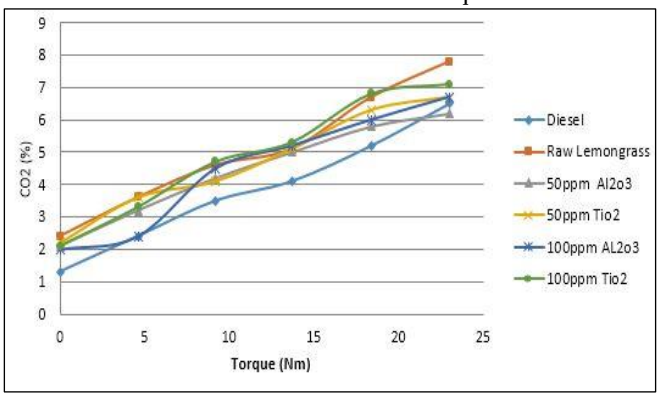


Fig7. Torque vs CO_2

XIII. SMOKE EMISSION

The smoke emission increases with the use of biodiesel lemongrass blends than neat diesel. The lowest CO is observed as 58% for lemongrass whereas it is 38% for neat diesel at the torque of 23Nm. The addition of titanium oxide decreases the smoke emission when comparing with neat diesel.

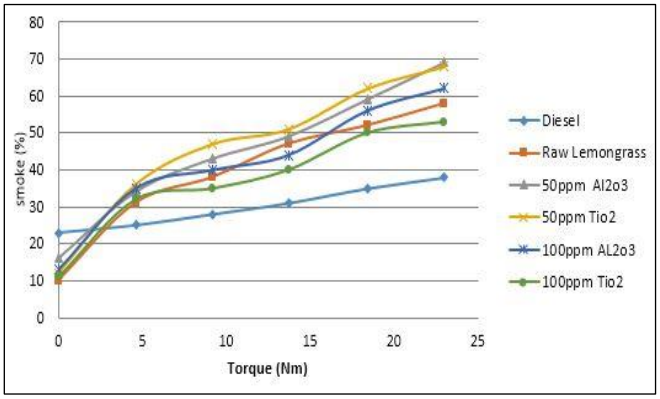


Fig. 8: Torque vs smoke

REFERENCES

[1] Alan Williams, the future of diesel engine vehicles, proceeding of bicentenary celebration college of engineering Gundy, 1991.
[2] Avinash, A Alagumalai, The Combustion characteristics of Lemongrass oil in partial premixed charge compression ignition engine. Elsevier-Alexandria Engineering Journal 2015. http://dx.doi.org/10.1016/j.aej.2015.03.021
[3] R. Sathiyamoorthi and G. Sankaranarayanan. Experimental investigation of performance, combustion and emission characteristics of neat Lemongrass oil in DI Diesel Engine. Int. Journal of current Engineering and Technology. Special Issue 3, April 2014.
[4] V. Venugopal and DR.D. Madhu. Experimental investigation of performance and emission characteristics of Lemongrass as a Biodiesel. IOSR-JMCE Vol.11, Issue 4, Ver II July-Aug 2014.
[5] S. Prabhakar and C. Jagdeesh Vikram. Performance test for Lemongrass oil in single cylinder diesel engine. ARPN Journal of Engineering and Applied Sciences. Vol.8, No.6, June 2013.
[6] G. Balaji and M. Cheralathan. Experimental investigation of antioxidant effect on oxidation stability and emission in a methyl ester of neem oil fueled DI Diesel Engine. Elsevier-Renewable Energy. http://dx.doi.org/10.1016/j.renene.2014.09.019
[7] Senthil Ramalingam and Silambarasan Rajendran. Effect of operating parameters and antioxidant additives with biodiesel to improve the performance and reducing the emission in a CI Engine. Elsevier-Renewable and Sustainable Energy Review. http://dx.doi.org/10.1016/j.rser.2017.08.026
[8] E. Griffin Shay. Diesel fuel from vegetable oil: Status and opportunities. Biomass and Bioenergy. Vol.4, No.4, pp.227-242,1993.

[9] Pravinkumar D Patil and Masoomraja Z Mull. Review on different sources for the production of Biodiesel. IJLTEMAS. Vol.6, Issue 7, July 2017.
[10] P. Mohamed Shameer and K. Ramesh. Assessment on the consequences of injection pressure on the combustion characteristics of Sustainable Biodiesel Fueled Engine. Elsevier-Renewable and Sustainable Energy Review 81 (2018) 45-61. http://dx.doi.org/10.1016/j.rser.2017.07.048

