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INVESTIGATION ON PERFORMANCE AND EMISSION CHARACTERISTICS OF DIESEL ENGINE WITH THE BLENDS OF ROSEMARY OIL WITH MAGNESIUM OXIDE

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ABSTRACT

This study presents the experimental results on performance and emission characteristics of diesel engine with blends of rosemary oil and nano-additive (MgO). These results were run on an unmodified diesel engine. The tests were conducted with total of six blends. B15, B30, B45 are the three blends that have been tested. The other three blends are nothing but the same blends with nano-additive (MgO). The fuel are tested in Kirloskar TV-1 (4-stroke, single cylinder engine) and analysed in AVL smokemeter. Performance characteristics like brake power, thermal efficiencies etc were recorded. Emission levels of CO, CO_2, HC, NO_x are taken and compared. Efficiency for sample 3 (B15 with additive) was observed to be nearly 35% more than that of diesel at brake power of 2.5kW but after that the diesel curve has a steep slope whereas sample 3 has a gradual rise. Specific fuel consumption for pure diesel is low, then comes sample 3 which has a slightly lower fuel consumption at higher brake power. CO emissions for sample 3 have found to be about 10% lower than that of diesel. HC emissions for sample 4 have a great decrease of 50% when compared to pure diesel. In CO_2 emissions sample 2 and in NO_X emissions sample 5 had significantly good results.

Keywords: VCR engine, nano catalyst, transesterification, emission.

Nomenclature

SFC = Specific Fuel Consumption
BTHE = Brake Thermal Efficiency
CO = Carbon Monoxide
CO_2 = Carbon Dioxide,
HC = Hydro Carbon
MgO = Magnesium oxide
VCR = Variable compression engine
NOx = Nitric Oxide
MgO = Magnesium oxide
bTDC = Before Top Dead Centre

1. INTRODUCTION

The rapid increase of transportation vehicles in the world has led to the lavish usage of petroleum fuels. Countries economy is suffered due to heavy usage of fossil fuels (1-3). Presently, Government is having a tough challenge on their hands to overcome the import of crude petroleum from the other petroleum oil producing countries. On the other hand the environmental pollutions from the transportation systems are becoming a great threat (4, 5). Hence governments in the world have been focusing on the utilization of renewable energy sources. Edible and non-edible crops are used for the preparation of alternate source of energy which has become common in many researchers. The diesel engines are more efficient than the other standard engine; if any engine is said to be reliable then it should develop more BTE, less SFC and less emissions (6-8). The Exhaust gases from the diesel engines have become a serious problem to the researchers. Hence there is a great need to find the solution for reduction of emission from the automobile engines. Among the pollutants, Nitrogen oxide (NOx) and smokes are more harmful to human being. It gives respiratory diseases like lung cancer, bronchitis, etc (9).

Many researchers have concluded or inferred the following from their works that NOx increases due to high combustion temperature with lean burn condition (10). Hence, individual fuels combustion temperature is responsible to produce NOx emission. The bsfc for the tested bio fuels was found slightly higher than that for DF. These increased fuel consumptions for blend fuels are because they contain oxygen content in the fuels, which result in the lower heating value (11). The oxygenated compounds available in the blends improve the fuel oxidation reducing HC emissions. When the oxygen content of fuel blend is increased, it requires less oxygen for combustion. However, oxygen content of fuel is the main reason for more complete combustion and HC emission reduction.

2. EXPERIMENTAL SETUP

The setup consists of single cylinder, four stroke, VCR (Variable Compression Ratio) Electric start Diesel engine connected to eddy current type dynamometer for loading, AVL gas analyzer, AVL smoke meter (Figure-1). The setup enables study of engine performance with EGR for brake power, indicated power, frictional power, BMEP, IMEP, brake thermal efficiency, indicated thermal efficiency, Mechanical efficiency, volumetric efficiency, specific fuel consumption, A/F ratio, heat balance and emission characteristics like CO, HC, NO_X, CO_2.The Table-1 Represent the Engine specification details.

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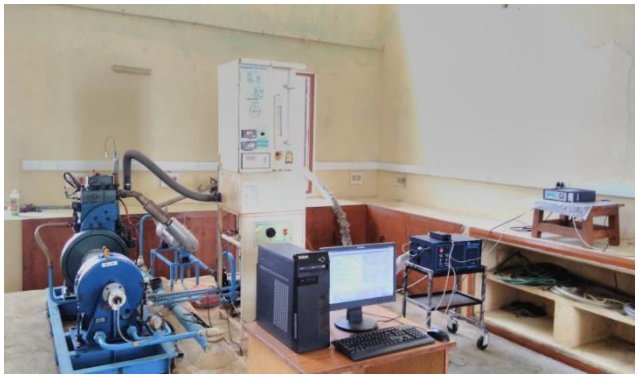

Figure-1. Engine set up.

Table-1. Engine specifications.

Engine setup	VCR (Variable compression Ratio) engine setup
No of strokes	4
Rated power	3.5 @1500 RPM
Cylinder Diameter	87.5 mm
Stroke Length	110 mm
Compression ratio	12 to 18:1

3. RESULT AND COMPARISON

The investigations obtained at different load conditions 25%, 50%, 75% and 100% for all the blends of rosemary oil were analysed. Based on the results, the following observations are discussed:

3.1. Performance investigation

3.1.1. Brake Power (BP) Vs Brake Thermal Efficiency (BTE)

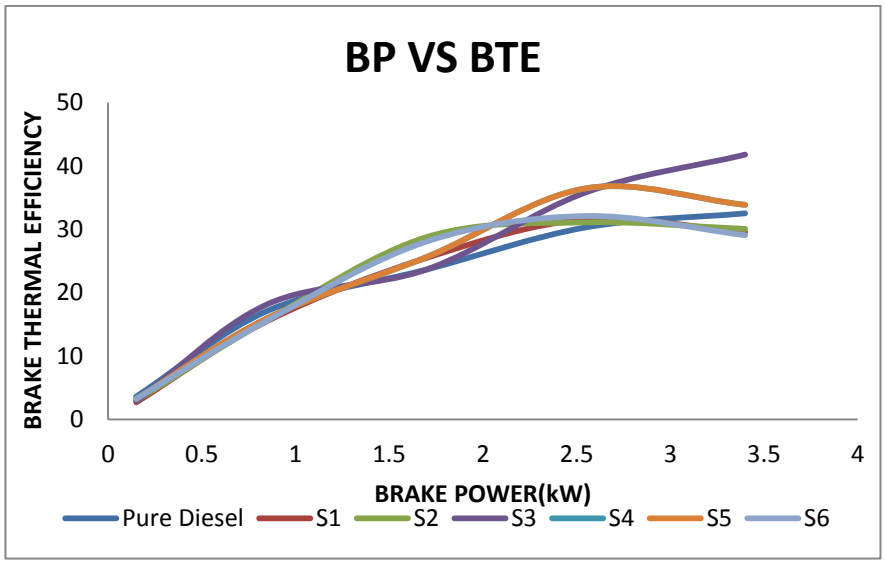

Figure-2. BP VS BTE.

When the fuel undergoes proper combustion, thermal energy produced is efficiently converted into mechanical energy. In the above BP Vs BTE graph sample 3(B15 with additive) has high efficiency till the brake power of 2.5KW. S3 is 35% more efficient than pure diesel. From Figure-2, Graph of diesel has a steep slope which indicates the increase in efficiency at higher brake power. When testing B15 with additive (S3), the percentage of thermal energy converted to mechanical energy is high compared to other blends because of blend with high calorific value and nano-additive (MgO) added with blend gives more oxygen to the fuel makes it to give complete combustion. This makes the S3 more efficient.

3.1.2. Brake Power (BP) Vs Specific Fuel Consumption (SFC)

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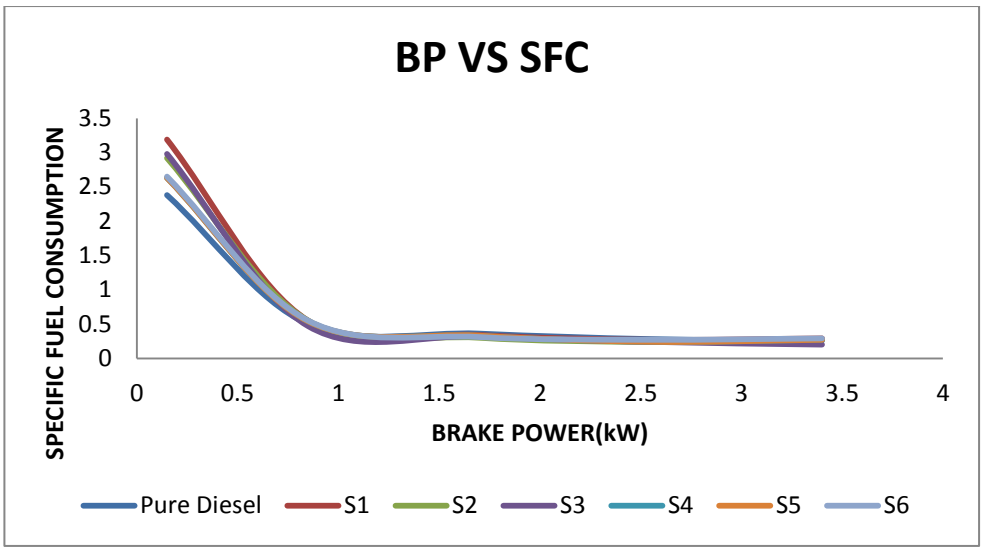

Figure-3. BP VS SFC.

Complete combustion and utilization of less fuel consumption for producing particular amount of brake power and makes engine more effective. In the above Figure-3 almost all the blends and diesel have the same SFC. Even though B15 with additive (S3) has a little higher value in the initial stage, throughout the graph B15 with additive (S3) has a lower range of SFC. It has 3% lesser specific fuel consumption than diesel. B15 with additive (S3) has the less fuel consumption compared to other blends because of viscosity and nano-additive added. Nano- additive oxygenate the fuel and enhances the combustion rates which helps in complete combustion. Due to complete combustion, engine functions continuously and there is decrease in the usage of fuel.

3.2. Emissions investigation

3.2.1. Brake Power (BP) Vs Carbon Monoxide (CO)

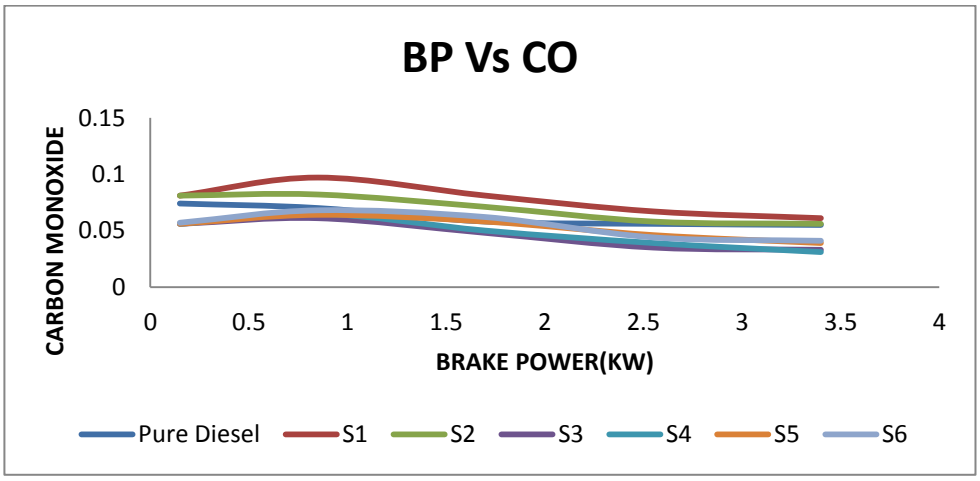

Figure-4. BP VS CO.

Carbon monoxide is formed due to improper combustion and variation in oxygen: carbon ratio results improper reaction between oxygen and carbon to form CO_2. From the Figure-4, we can observe that B15 with additive (S3) has the lowest CO emissions than any other blend including pure diesel. S3 has 40% lower CO level than pure diesel. B15 with additive (S3) has the good combustion percentage and oxygen carbon ratios compared to the pure diesel and other blends. As the result of good combustion percentage and oxygen: carbon ratio, oxygen and carbon undergo proper reaction and forms CO_2 which decrease the level amount of CO.

3.2.2. Brake Power (BP) Vs Hydro Carbons (HC)

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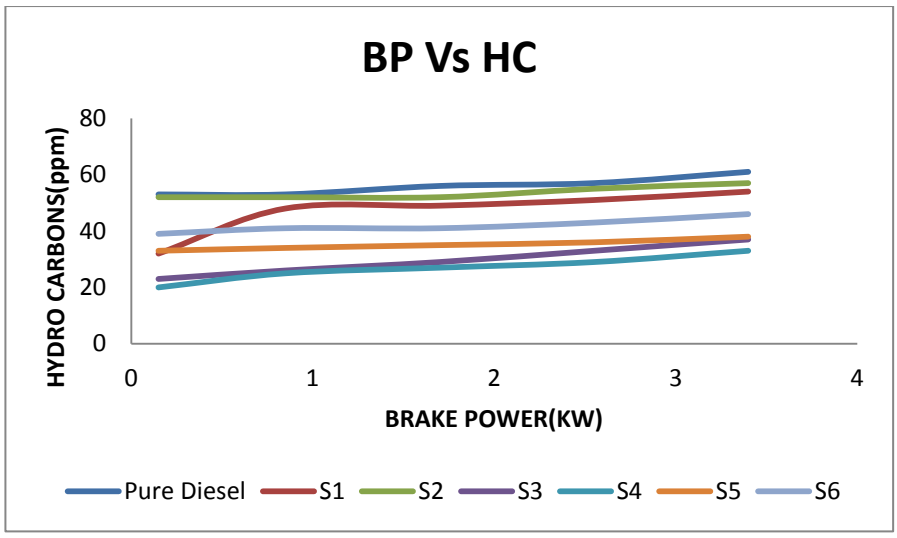

Figure-5. BP VS HC.

3.2.3 Hydrocarbon is formed due to amount of moisture content present in fuel

From Figure-5, it is very evident that all the blends had lower HC levels when compared to pure diesel. Of all the blends B30 with additive (S4) has the lowest HC levels whereas sample 2 has highest except pure diesel. S4 has 46% less HC emission than pure diesel. The moisture content present in the B30 with additive (S4) is very low when compared to the pure diesel. Due to low moisture content of B30 with additive (S4) the amount of hydrocarbon produced in S4 is low when compared to other blends and pure diesel.

3.2.4. Brake Power (BP) Vs Nitrous Oxides (NO_X)

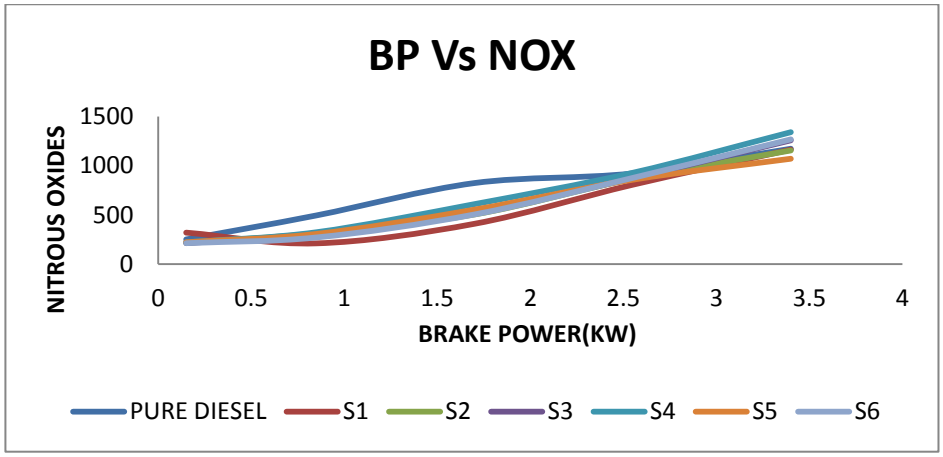

Figure-6. BP VS NO_x.

Nitrous oxide is formed due to reaction of nitrogen content and oxygen in the fuel. Pure diesel has a gradual rise when compared to other samples but B45 without additive (S5) also has a slow rise and even lower than that of pure diesel. All other samples have a decrease in value and then a high rise. The amount of nitrous and oxygen present in the B45 without additive (S5) is less compared to the pure diesel and other blends. Small load gives less NO_x and when the load is increased the combustion is improper as the result the level of NO_x gets increased. There is a huge variation NOx level in other blends with change in load.

4. CONCLUSIONS

The differences in emission levels when compared with pure diesel and other blends. B15 with additive (S3) has 40% lower CO level. B30 with additive (S4) has 46% less HC emission. In CO2 levels, B15 with additive (S2) which is almost all identical to pure diesel but has a sudden rise at brake power of 2.5KW. All the samples in small load gives less NOx and when the load is increased the combustion is improper as the result the level of NOx gets increased. B45 with additive (S6) have the lowest opacity levels whereas all other samples have very high levels of opacity.

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From this work, it was clear that there was significant difference between blends with additive and without additive. Here pure diesel is chosen as a reference. When additive is added HC levels were decreased but NOX were slightly increased.

REFERENCE

[1] Ahmad Fayyazbakhsh, Vahid Pirouzfar. 2017. Comprehensive overview on diesel additives to reduce emissions, enhance fuel properties and improve engine performance. Renewable and Sustainable Energy Reviews. 74: 891-901.

[2] Ahmed I. El-Seesy, Ali K. Abdel-Rahman, Mahmoud Bady, Ookawara. S. 2017. Performance, combustion, and emission characteristics of a diesel engine fueled by biodiesel-diesel mixtures with multi-walled carbon nanotubes additives. Energy Conversion and Management. 135: 373-393.

[3] Esmail Khalife, Meisam Tabatabaei, Ayhan Demirbas, Mortaza Aghbashlo. 2017. Impacts of additives on performance and emission characteristics of diesel engines during steady state operation. Progress in Energy and Combustion Science. 59: 32-78.

[4] Liaquat A.M, Masjuki. H.H, Kalam. M.A, Varman. M, Hazrat M.A. 2012. Application of blend fuels in a diesel engine. Energy Procedia. 14: 1124-1133.

[5] Masjuki H.H, Kalam M.A, Syazly M, Mahlia T.M.I, Rahman A.H, Redzuan M, Varman M. 2006. Experimental Evaluation of an Unmodified Diesel Engine using Biodiesel with Fuel Additive. IEEE. 1-4244-0427-4/06.

[6] Mehmet Çelik, Hamit Solmaz, H. Serdar Yücesu. 2015. Examination of the effects of organic based manganese fuel additive on combustion and engine performance. Fuel Processing Technology. 139: 100-107.

[7] S. Karthikayana, S. Ganesan, P. Vasanthakumarc, G. Sankaranarayanand, M. Dinakare. 2017. Innovative Research Trends in the Application of Thermal Barrier Metal Coating in Internal Combustion Engines. Materials Today: Proceedings. 4, pp. 9004-9012.

[8] Karthikayansundararajan, Ganesansubbiah and Sankaranarayanan Gomathinayakam. 2016. Emission Estimation of neat paradise tree oil ombustionssisted with superheated hydrogen in a 4-stroke natural aspirated DICI engine. THERMAL SCIENCE. 20(4): S1137-S1144.

[9] S. Padmanabhan, S. Rajasekar, S. Ganesan, S. Saravanan and M. Chandrasekaran. 2017. Performance and Emission Analysis on CI Engine using soapnut oil as Biofuel. ARPN Journal of Engineering and Applied Sciences. 12(8): 2491-2495.

[10] Ganesan S, Padmanabhan. S, Vuruturu. Vihaari, Sanivada Krishna Kumar and PinisettyYamini. 2017. Influence of Mgo on emissions of di engine using blends of biodiesel. ARPN Journal of Engineering and Applied Sciences. 12(6), ISSN 1819-6608.