Performance Analysis of Diesel Engine using Copper Oxide Nano Additive

Sabarish Kumar P, Arthur Jebastine Sunderraj, K. Arun Vasantha Geethan, Harish Praveen, Gilbert

Abstract: ***This experimental study focuses on investigation of performance and utterance attributes of a normal diesel engine with biodiesel prepared from pongamia. This study aims to reduce the emission of nitrogen oxide by adding an oxidation inhibitor Tert-Butylhydroquinone (TBHQ). The analysis for each sample is to be carried out in compression ignition engine (standard diesel engine). The engine is tested with standard diesel, pongamia methyl ester biodiesel without any additives. Then the analysis is to be carried by adding nano additive copper oxide for about 50 ppm in the above mentioned fuels. From this the best combination is found out and test is again carried out by adding the oxidation inhibitor.***

Keywords: Pongamia biodiesel, Tert-Butylhydroquinone (TBHQ), copper oxide.

I. INTRODUCTION

In the past decades, petroleum based liquid fuels have played a significant role in fulfilling the energy demand as far as automobiles are concerned. Petroleum based liquid fuels are derived from fossil energy sources which are non-renewable in nature which may get depleted in few more decades. These have led researchers to focus on renewable source of energy for reducing the reliance on fossil fuels. Also the petroleum products lead to severe environmental problems such as air pollution and global warming. In that view, biodiesel which is renewable form of energy is derived from vegetable oil or animal fat based oil has drawn a lot of attention among researchers. It is considered to be the better alternative for diesel fuel in standard diesel engine. This is because biodiesel possess almost similar properties as diesel. Also the use of biodiesel does not require a major modification in the engine construction.

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Biodiesel has become an attractive for environmental benefits such as non-toxic and eco-friendly and these are made from the renewable resources. Biodiesel contains large amount of oxygen content. This leads to complete combustion. Due to this fact the emission of carbon monoxide and hydrocarbon is reduced. However, the emission of nitrogen oxides increased slightly compared to diesel. It also has other drawbacks such as higher viscosity, higher molecular weight, lesser heating value compared with diesel. These drawbacks cause poor atomization of fuel. Antioxidants play significant role in emission characteristics as well as performance characteristics.

Biodiesel can be derived from edible oil as well as non-edible oil. The use of edible oils for biodiesel production may lead to self-sufficiency problem in vegetable production. It is considered to be the better alternative for diesel fuel in standard diesel engine. This is because biodiesel possess almost similar properties as diesel. Also the use of biodiesel does not require a major modification in the engine construction. In that view, biodiesel which is renewable form of energy is derived from vegetable oil or animal fat based oil has drawn a lot of attention among researchers. The use of non-edible oil is significant because edible oil is necessary for food. Also the biodiesel production from edible vegetable oil is considered to be expensive. In this experimental study, the biodiesel is produced from pongamia oil which is non-edible vegetable oil. This experimental investigation is to conducted in two stages. The second stage is the same analysis is to be carried by adding nano additive copper oxide in the above mentioned fuels. From this the best combination is found out and test is again carried out by adding an oxidation inhibitor. The objective of this study is to find the best fuel among the above combination to achieve better performance and reduced emissions.

These have led researchers to focus on renewable source of energy for reducing the reliance on fossil fuels. Also the petroleum products lead to severe environmental problems such as air pollution and global warming. This study aims to reduce the emission of nitrogen oxide by adding an oxidation inhibitor Tert-Butylhydroquinone (TBHQ).Therefore in this study the analysis is to be carried by adding nano additive copper oxide for about 50 ppm in the above mentioned fuels. From this the best combination is found out and test is again carried out by adding the oxidation inhibitor.

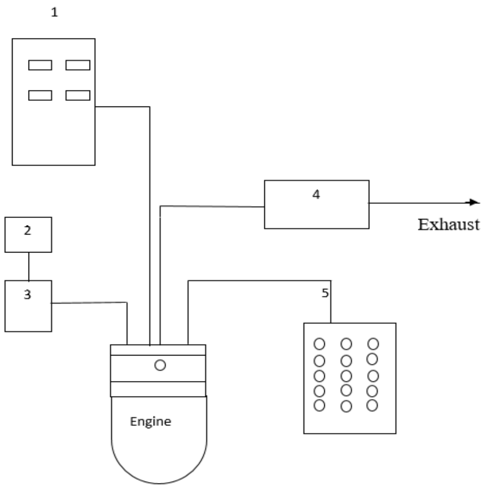
II. MATERIALS AND METHODS

Table 1 Properties of Pongamia methyl ester and diesel

Properties	Diesel	Pongamia methyl ester (B20)
Kinematic viscosity at 40°C	4.3	3.45
Density	831	723
Caloricity	40,226	36,356 KJ/kg
Flaring point°C	59	63
Ignition point°C	64	67
Carbon residue	0.28	0.35

III. EQUIPMENT SETUP

The experiment was conducted in single cylinder four stroke diesel engine. The encumbrance at which the fuel is injected was about 200 bars. The detailed information about the engine is presented in the Fig 2.1. Eddy current dynamometer is used to put on fluctuating loads. AVL Di gas 444 analyzer was used to measure the emission of hydrocarbon, carbon monoxide and nitrogen oxides.



1. Control panel
2. Fuel tank
3. Fuel flow meter
4. AVL Digas 444 analyser
5. Electrical loading using DC generator

Fig 2.(a) Equipment setup

IV. RESULTS AND DISCUSSIONS

4.1 Comparison Of Thermal Efficiency

The brake thermal efficiency for all fuel samples is shown in Fig 5.1. It is witnessed that the productivity has been escalated by 13.36% for biodiesel blend with TBHQ and adding Copper oxide (B20+CuO+TBHQ) on comparison with biodiesel blend (B20) and for the diesel with CuO the brake thermal efficiency is increased by 12.35% on comparison with pure diesel. Then the values are compared between B20 with CuO and diesel with CuO, it is perceived that the productivity has been boosted by 24.67% for B20 with CuO on comparison with diesel with CuO.

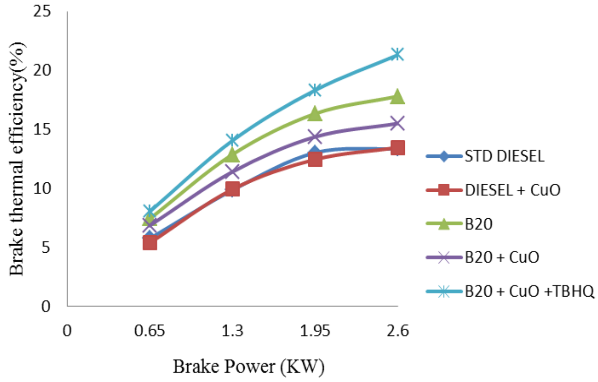


Fig 3.(a) Comparison of Brake thermal efficiency

4.2 Comparison Of Fuel Intake

The brake specific fuel consumption for all fuel samples can be inferred from Fig 5.2. It is witnessed that the brake specific fuel consumption has been decreased by 2.63% for biodiesel blend with TBHQ and adding Copper oxide (B20+CuO) on comparison with biodiesel blend (B20) and for the diesel with CuO the brake specific fuel consumption is increased by 1.425% on comparison with pure diesel. Then the values are compared between B20 with CuO and diesel with CuO, it is observed that the brake specific fuel consumption is increased by 5.83% for B20 with CuO as additive on comparison with diesel with CuO.

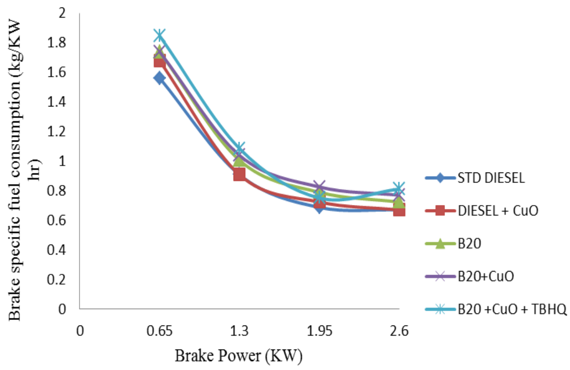


Fig 3.(b) Variation of Fuel intake

4.3 Hydrocarbon Discharge

It is witnessed from the fig. 3(c) that the hydrocarbon emission is increased by 44.7% for biodiesel blend with TBHQ and adding Copper oxide (B20+CuO+TBHQ) on comparison with biodiesel blend (B20) and for the diesel with CuO the hydrocarbon emission is decreased by 41.6% on comparison with pure diesel. HC emission slightly increased by 6.2% for B20 on comparing with pure diesel. This increase is due to the addition of antioxidant because antioxidant will reduce oxygen content in fuel thereby the HC emission is increased. Hydrocarbon emission decreases when there is high oxygen content in fuel.

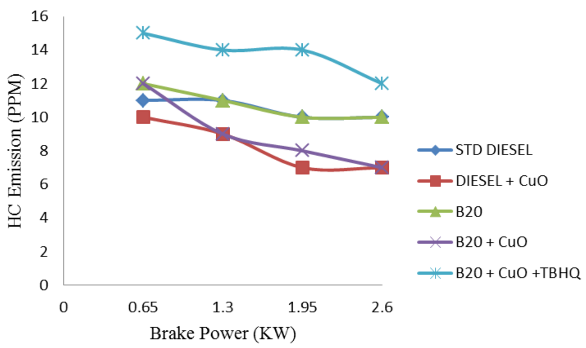


Fig 3.(c) Comparison of emission of hydrocarbon

4.4 Carbon Monoxide Discharge

It is observed from the fig 3.(d) that the carbon monoxide emission is increased by 42.04% for biodiesel blend with TBHQ and adding Copper oxide (B20+CuO+TBHQ) on comparison with biodiesel blend (B20) and for the diesel with CuO the carbon monoxide emission is increased by 19.86% on comparison with pure diesel. This increase is due to the addition of antioxidant because antioxidant will reduce oxygen content in fuel thereby the CO emission is increased. Carbon monoxide emission decreases when there is high oxygen content in fuel.

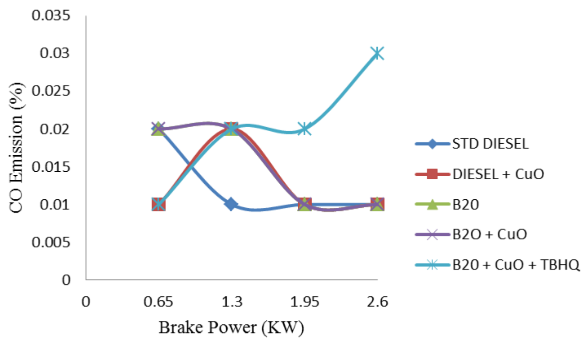


Fig 3.(d) Variation of CO Discharge

4.5 Nitrogen Oxide Discharge

It is witnessed from the fig 3.(e) that the nitrogen oxide emission is decreased by 23.73% for biodiesel blend with TBHQ and adding Copper oxide (B20+CuO+TBHQ) on comparison with biodiesel blend (B20) and for the diesel with CuO the nitrogen oxide emission is increased by 14.1% on comparison with pure diesel. Then the values are compared between B20 with CuO and diesel with CuO, it is observed that the NOx emission is increased by 23.31% for B20 with CuO as additive on comparison with diesel with CuO. The emission reduces because of the addition of antioxidant TBHQ.

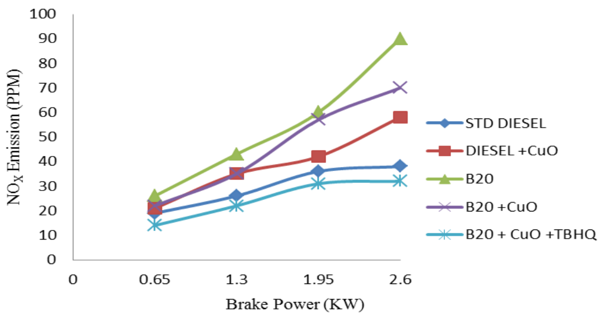


Fig 3.(e) Comparison of emission of nitrogen oxide

V. CONCLUSION

The subsequent points are the inferences that we obtained from this experiment

- The energy conversion (thermal to mechanical) has been escalated for B20 blend with TBHQ and adding Copper oxide (B20 +CuO +TBHQ) sample on comparison with diesel.
- Brake specific fuel consumption increases slightly for all samples on comparison with pure diesel.
- Emission of HC and CO increases slightly in its value for the B20 blend with TBHQ and adding Copper oxide (B20 +CuO +TBHQ) on comparing with B20 and pure diesel.
- Emission of NOx decreases for B20 blend with TBHQ and adding Copper oxide (B20 +CuO +TBHQ) on comparing with B20 and pure diesel.
- NOx emission decreases as the result of addition of antioxidant.

Considering all the above points, B20 blend with TBHQ and adding Copper oxide (B20 +CuO +TBHQ) fuel sample have higher brake thermal efficiency and lower NOx emission with slight increase in brake specific fuel consumption and slight increase in emission of HC and CO value

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