Experimental Evaluation Of A CI Engine Running On Blends Of Diesel And Methanol Fuel With Copper Oxide Nano Particles

G. Manikandan, K. Karthikeyan, S. Gokul

Abstract: The energy demands of the present world are increasing day by day with the reduction in availability of fossil fuel resources. In order to meet the energy demands, various automotive industries are focusingon alternative sources of energy in which biodiesel have a significant impact. Biodiesel has a great impact in reducing the emissions compared with the diesel. Among the various sources of biodiesel available, methanol is the better choice. But there are certain disadvantages of using this biodiesel in CI engines. It emits more nitrous oxide than diesel and also it has more fuel consumption. So, in order to eliminate these drawbacks, copper oxide (CuO) is used as a nano additive. The nanoparticles added to the biodiesel reduce the ignition delay during the combustion process which results in improved thermal efficiency. These additives also improve the brake specific fuel consumption. Nitrous oxide is formed only at higher temperatures. Nitrogen reacts with oxygen to form oxides of nitrogen at higher temperature. The addition of nano additives reduces the ignition delay period to increase the combustion process. It also increases the heat exchange rate and reduces the engine temperature. Thus, nitrous oxide emission is greatly reduced. Since the surface area is more for nanoparticles it is also a reason for reduction in emission. It also acts as an antioxidant to prevent the oxidation process. This reduces the formation of nitrous oxides at higher temperature and reduces the emission.

Keywords: Fossil fuels, methanol, emission, nano additives, copper oxide, ignition delay.

I. INTRODUCTION

Nearly one half of the world is living in a place where the naturally available air is a major threat to the human life. The whole world is facing an intense fear that the pollution limits are already in danger. According to the report submitted by the World Health Organization, air pollution kills an estimated 7 million people worldwide every year from exposure to fine particles from polluted air that lead to diseases such as stroke, heart disease, lung cancer, chronic obstructive pulmonary diseases and pulmonary infections. The increase in fossil fuel consumption for the vehicular fuel will lead to an extinct of petrol and diesel. Biofuels are a potential alternative for a sustainable future in the vehicular pollution control. With the rapid increase in needs for fuels there must be more production of such biodiesels. So, the current world is investing more and more and it has been increasing exponentially every year to achieve an eco-friendly environment. When the situation reaches to an alarming condition the world seeks for an alternative. We are convenient and practiced to use fossil fuels and also our vehicles are manufactured only for that. So, if we go for an alternative it should replicate the properties that the fossil fuels exhibit. It should give better or near equal performance with lesser emissions. So, to satisfy all these specifications biodiesel is the best alternative that every country wants to go with it.

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METHANOL AND ITS PROPERTIES

Methanol also known as methyl alcohol among others, it is a chemical with formula CH3OH. Methanol acquired the name wood alcohol because it was once produced chiefly by the destructive distillation of wood. Today, methanol is mainly produced industrial product by hydrogenation of carbon monoxide. Methanol is the simplest alcohol, consisting of a methyl group linked to a hydroxyl group. It is a light, volatile, colourless, flammable liquid with a distinctive odour similar to that of ethanol (drinking alcohol). Methanol is however far more toxic than ethanol. At room temperature, it is a polar liquid. With more than 20 million tons produced annually, it is used as a precursor to other commodity chemicals, including formaldehyde, acetic acid, methyl tart-butyl ether, as well as a host of more specialized chemicals.

- Chemical formula for methanol is CH3OH
- Methanol sometimes abbreviated as MEOH
- Methanol is a volatile, colorless liquid that has a slight odour.
- It burns with a smokeless blue flame that is not always visible in normal light.
- Methanol hydroxyl group is able to participate in hydrogen bonding, rendering it more viscous and less volatile than less polar organic compounds of similar molecular weight, such as propane.
- Methanol is slightly more refractive than water, having a refractive index of 1.36242 (at λ=589.3 nm and 18.35 °C or 65.03 °F).
- The triple point for ethanol is 150 K at a pressure of 4.3 × 10^{-4} Pa.
- Methanol is a versatile solvent, miscible with water and with many organic solvents.
- Methanol miscibility with water contrasts with the immiscibility of longer-chain alcohols. Water miscibility decreases sharply as the number of carbons increases.
- The crystal structure of methanol is mono clinic.
- The miscibility gap tends to get wider with higher alkanes.

Mixing ethanol and water is exothermic, with up to 777 J/mol being released at 298K.

I. REVIEW OUTCOME

Biofuel is the better alternative for the increased number of pollution and the decrease in fossil fuels. It has more oxygen content which leads to more emissions. And also, it has less calorific value with increased fuel consumption. So trans esterification process was done to obtain biofuel from the oil which has the specified properties as per the diesel engines. The biofuel obtained was used as a blend with diesel fuels in order to increase the performances of the fuel. But also, the nitrous oxide emissions and the soot particle emissions were increased when biodiesel was used in the diesel engines. To avoid this copper oxide additives were used in the blends. It was mixed with the biodiesel with the help of a magnetic stirrer. This improved the efficiency of the additives. It reduced the specific fuel consumption, increased brake thermal efficiency and leads to complete combustion. And also, the brake power increases with the increase in load when additive is added with the biodiesel. These additives increased the thermal efficiency and also increased the heat transfer capacity of the fuel. This is due to the main properties of the additives such as higher specific surface area, thermal conductivity, catalytic activity and chemical properties. And also, it increases the surface area to volume ratio that enables oxidation capacity.

II. EXPERIMENTAL SET-UP

The test facility includes the following instruments analyzers:

- Test engine coupled to an alternator and an electrical loader.
- Airflow measurement using orifice plate and U-tube manometer.
- Using a burette and stopwatch arrangement, the diesel flow is measured.
- For measuring the cylinder pressure, Piezo -electric pressure pick up was used.
- Infrared device for Top dead center position measurement.
- K type thermocouples are used for measuring the temperature in exhaust gases, intake charge, coolant water and EGR system.
- Computer based digital data acquisition system is used for analyzing the pressure crank angle data and for obtaining heat release rate.
- Smoke meter is used to measure the exhaust smoke from the engine.
- Exhaust gas analyzer is used for measuring HC, CO, NOx, and CO2 emissions.
- Flow meter is used for maintaining the cooling water flow and EGR flow.
- Digital tachometer for the measurement of speed.

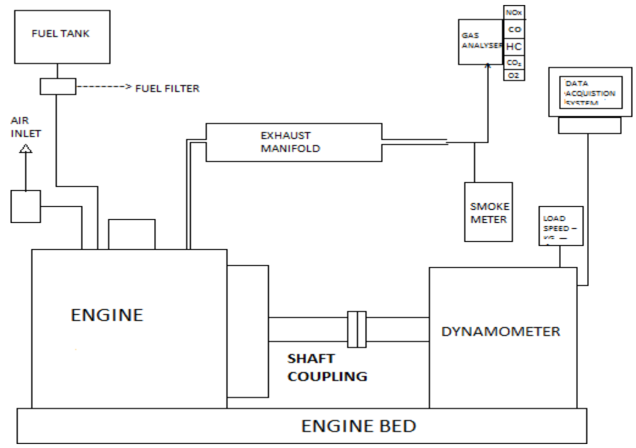

Fig 1. *Engine setup layout*

Make	Kirloskar
Power	3.5 kW
Type of Engine	Single cylinder 4-stroke multi-fuel VCR engine with eddy current dynamometer
Compression ratio	18:1
Bore and Stroke	87.5 mm and 110 mm
Method of cooling	Water cooling
Type of ignition	Compression ignition
Fuel injection timing	23° before TDC
Nozzle opening pressure	210 bar
Lube oil	SAE 40

Table 1. *Engine specification*

III. RESULT AND DISCUSSION

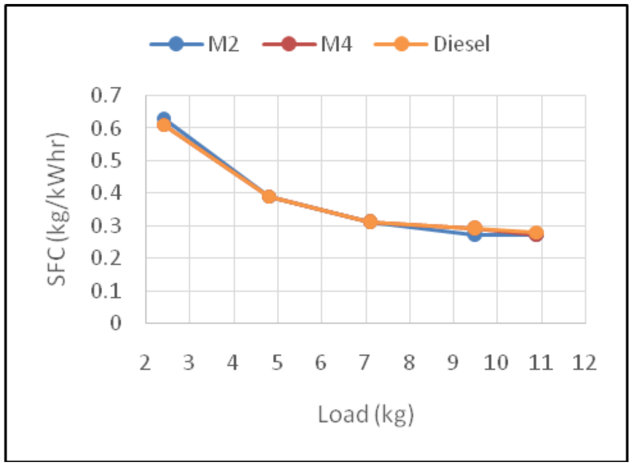

Fig 2. *Variation of SFC with various engine loads*

From the Fig 2. it is clear that whenever the load is increased, the specific fuel consumption is decreased. Among all the blends diesel has the lower amount of fuel consumption because of its higher calorific value whereas all the other blends have more fuel consumption than diesel. M2 has more amount of fuel consumption than the other biodiesel blends. M4 has least fuel consumption among the three biodiesel blends.

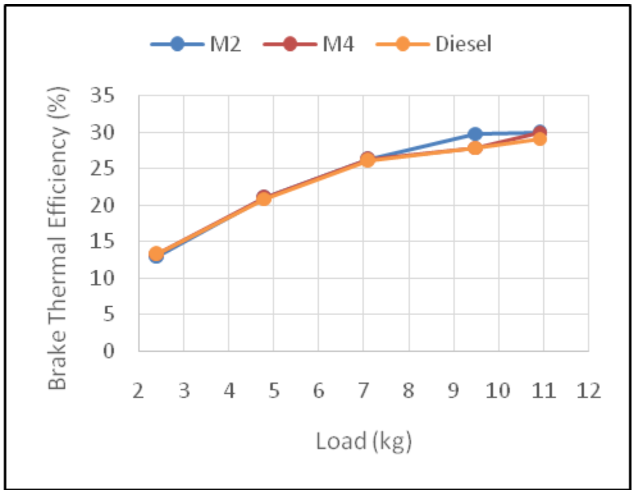

***Fig 3**. Variation of BTE with various engine loads*

Fig 3. represents the variation of brake thermal efficiency with various Load. The brake thermal efficiency is lower for M2 than all the other blends of biodiesel. Diesel has higher efficiency at all loads. M4 increases gradually from lower loads and reaches higher at top load.

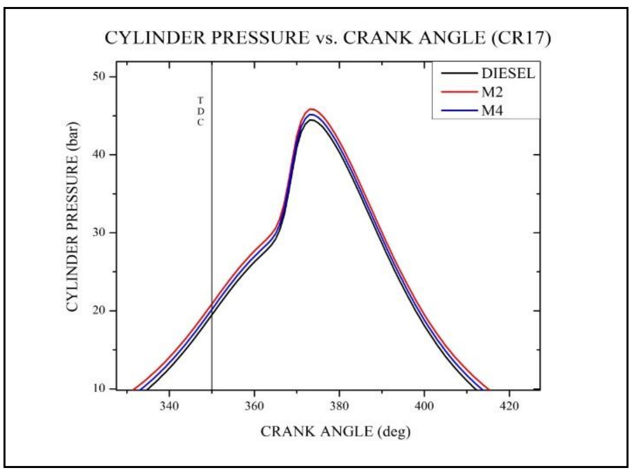

***Fig 4**. Combustion characteristics of various biodiesel blends and diesel*

The variation of cylinder pressure for different blends of biodiesel is represented in Fig 4. From this graph, it is evident that the cylinder pressure of M2 (47.31 bar) was substantially high in comparison with all other blends of biodiesel and diesel.

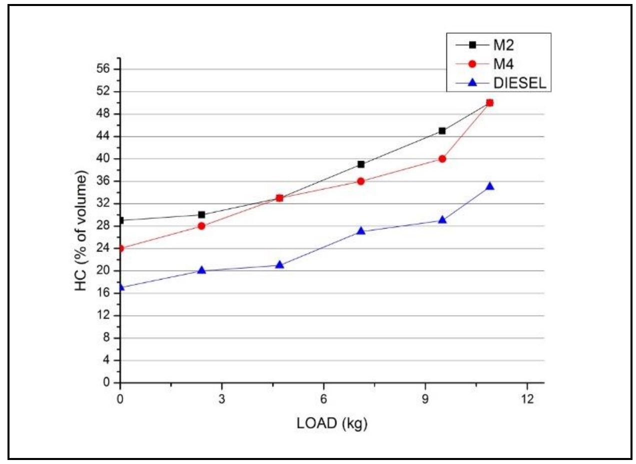

***Fig 5**. Variation of HC with various engine loads*

The emission of hydrocarbon is formed from the unburnt fuels released from the engine combustion chamber. The figure shows the comparison of Hydrocarbon emissions for M2, M4 Methanol blends with pure diesel at Compression ratio 17. From the Fig 5, M2 shows the highest amount of HC emissions for all the loads among biodiesels and diesel.

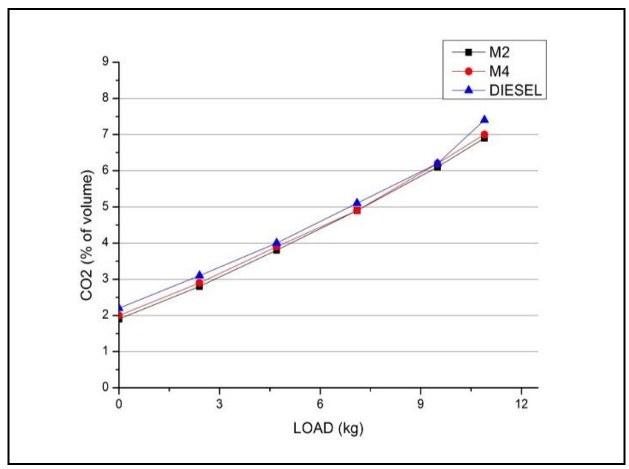

***Fig 6.** Variation of CO_2 with various engine loads*

The fuel used to propel the vehicle consists of carbon ad hydrogen atoms. The carbon atoms present in the fuel combines with the oxygen from the inlet manifold and forms carbon dioxide during the combustion process. The Fig 6. shows the amount of CO2 emissions for M2, M4 and diesel fuel at CR 17. Diesel emits higher CO2 than all other blends. At all the loads M2 emits lesser CO2 than M4 and diesel.

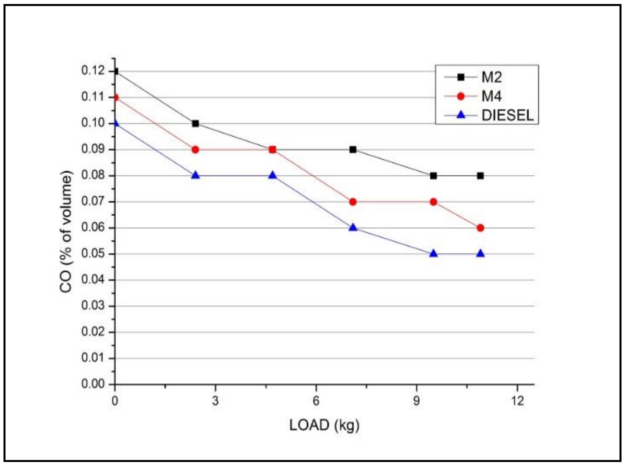

***Fig 7**. Variation of CO with various engine loads*

Fig 7. shows the comparison of carbon monoxide emissions with M2 and M4 blends with diesel at CR 17. Carbon monoxide is the result of unavailability of oxygen in the diesel engines. It is formed because of the partial oxidation of the carbon components. Usually carbon dioxide is formed due to incomplete combustion. But when there is insufficient oxygen for oxidation carbon monoxide will be formed. From the graph, it is clear that M2 and M4 blend has the higher CO emissions. Diesel has the lesser amount of CO emissions for all the loads.

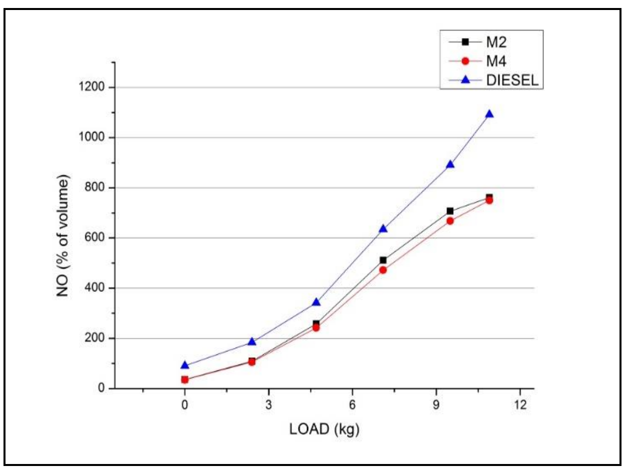

***Fig 8.** Variation of NO_x with various engine loads*

Nitrous oxide is formed due to the higher temperature obtained in the combustion chamber. When the temperature is increased in the combustion chamber the nitrogen present in the fuel gets oxidized and due to that oxidation reaction nitrous oxide is formed. Fig 8. represents the variation of Nitrous oxide emissions with various engine loads at CR 17. Methanol emits the lower amount of Nitrous oxide for all the loads whereas diesel has the more amounts of nitrous oxide emissions which increases constantly from 0 to 100% load. M4 emits lower emission values in all loads comparatively.

IV. CONCLUSION

The performance, emission and combustion characteristics of methanol biodiesel with adding copper oxide nano additive are studied. From the experimental studies performed the following results and conclusions are obtained.

- The Indicated power (BP) was increased for biodiesel blends of M4 with addition of copper oxide nano particle at CR 17 and CR 18 than diesel and all other blends.
- The Specific fuel consumption (SFC) was increased for diesel and M2 blends in both CR 17 and CR 18. M4 had better fuel consumption result than other blends.
- The Brake thermal efficiency was more for normal diesel than biodiesel blends, but M4 had increased brake thermal efficiency among all the biodiesel by copper oxide addictive.
- The combustion pressure was maximum for biodiesel than diesel. Here M2 was better than the remaining blends. The Hydrocarbon emission was better for all the biodiesel blends than diesel. M4 at CR 17 had lower emissions comparatively among the other blends.
- Diesel had higher carbon dioxide emissions. Here complete combustion takes place due availability of oxygen content. M2 at CR 17 emitted lower carbon dioxide than diesel at lower loads.
- It is clear that M2 and M4 blend has the higher CO emissions. Diesel has the lesser amount of CO emissions. But M4 at CR 18 has emitted lesser amount of CO at lower loads
- Diesel has the more amounts of nitrous oxide emissions which increases constantly from 0 to 100% load. M4 at CR 17 emits lower emission values in all loads comparatively.
- From all the results it was concluded that M4 at CR 17 was better than all the blends
- The carbon dioxide, nitrous oxide emissions were reduced better in biodiesel than diesel.

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