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Monitoring and Evaluation of Exhaust Gas Emission of Gasoline - *Cadoba Farinosa Forskk* Bio-Ethanol Blended Fuel Samples Run on a Spark Ignition Engine

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***Abstract*:- This paper present monitoring and evaluation of exhaust gas analysis of gasoline - cadoba farinosa forskk bio-ethanol blended fuel samples run on a spark ignition engine. For the blended fuel samples; GE2 (98% gasoline and 2% bio-ethanol volumetric proportion), GE4 (96% gasoline and 4% bio-ethanol volumetric proportion), GE6 (94% gasoline and 6% bio-ethanol volumetric proportion), GE8 (92% gasoline and 8% bio-ethanol volumetric proportion), and GE10 (90% gasoline and 10% bio-ethanol volumetric proportion) respectively. The engine performance and exhaust gas analysis were also conducted to investigate the effect of bio-ethanol as gasoline fuel extender, with a TD110-115 single cylinder, four stroke and air-cooled, spark ignition engine test rig, under different loading conditions, and incorporated with an SV-5Q automobile exhaust gas analyzer was used to monitor and measure concentration of gaseous emissions such as; exhaust gas temperature (EGT), carbon dioxide (CO_2), carbon monoxide (CO), and unburned hydrocarbon (HC), from the engine tail pipe. For Exhaust Gas Temperature but an appreciable increased of exhaust gas temperature was observed due to the rise in cylinder pressure and temperature respectively. An appreciable decrease in HC, CO, CO_2 emissions was recorded for all blended fuel samples than gasoline- with the least CO and CO_2 emission levels observed for GE6 fuel samples. For reasons of its satisfactory engine performance behavior, gasoline fuel conservation advantages, and inherent greenhouse gas mitigation potentials, the candidacy of *Cadaba Farinosa Forskk* bio-ethanol and gasoline blends, offer a promise of a prospective fuel source for spark ignition engines.**

Keywords: Emission, spark ignition engine, unburned hydrocarbon (HC), carbon monoxide (CO), and carbon dioxide (CO_2)

1.0 INTRODUCTION:

The demand for energy around the world is increasing, specifically the demand for petroleum fuels. World energy consumption is expected to increase to 180,000 GWh/year by 2020 [1]. Facing the increasing consumption of petroleum fuels and the increasingly stringent emission regulations, biofuels, such as ethanol and biodiesel, have been explored to reduce fuel consumption and engine emissions. There are many studies on the application of ethanol on diesel engine, which focus on the three aspects: application techniques of ethanol on spark ignition engine, fuel properties of ethanol-gasoline blends, and effects on the combustion and emission characteristics of ethanol-gasoline blends [2]. Ethanol is considered to be one of the most promising alternative renewable fuels. Ethanol can be fermented and distilled from sugarcane and grain, cellulosic materials such as wood, agricultural solid wastes, coal, sweet sorghum etc. and also it has potential to reduce CO, HC, NOx, and particulates emissions. Ethanol has some advantages over gasoline, such as high octane number and flame speed, high latent heat of vaporization thereby higher volumetric efficiency. It contains 35% oxygen that helps in complete combustion of fuel and thus reduces harmful tailpipe emissions. Although having these advantages, due to limitation in technology, economic and regional considerations ethanol as a fuel still is not used extensively. Under the environmental consideration, using ethanol gasoline blend is better than use of pure gasoline because of the renewability and less toxicity of ethanol. Several studies on the performance and emission characteristics of spark ignition engines, fuelled with pure gasoline and blended with ethanol, have been performed and are reported in the literature.

1.1Characteristics of Ethanol-Blended Fuels

Blending ethanol with gasoline has multiple effects. Ethanol increases the heat output of the unleaded gasoline, which produces more complete combustion resulting in slightly lower emissions from unburned hydrocarbons. The higher the concentrations of ethanol, the more the fuel has polar solvent-type characteristics with corresponding effects on conducting fire suppression operations. However, even at high concentrations of ethanol, minimal amounts of water will draw the ethanol out of the blend away from the gasoline. Ethanol and gasoline are very similar in specific gravity. The two differing fuels mix readily with minimal agitation, but the blend is more of a suspension than a true solution [3].

Ethanol has a greater affinity for water than it does for gasoline. Over time, without agitation, gasoline will be found floating on a layer of an ethanol/water solution. The resulting ethanol/water solution is still flammable since the concentration of ethanol is still fairly rich. Phase separation can occur in fuel storage systems where water is known to be present [3].

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1.2 Emission Characteristics of Bio-Ethanol Fueled SI Engine

Due to the introduction of stringent emission norms through different international protocols, environmental impacts of any alternative fuel to be used in IC engines should be evaluated first. Most of the emissions from the engines are carcigenous and harmful for environment as well as human health. Only three most important emissions considered under this study are CO, unburned hydrocarbon (HC) and CO_2.

2.0 MATERIALS AND METHODS

2.1 Experimental Procedure

Technical detail of the engine is given in Table 1. A hydraulic dynamometer was coupled to the engine for torque measurement. Experiments were conducted with the blended fuel samples; GE2 (98% gasoline and 2% bio-ethanol volumetric proportion), GE4 (96% gasoline and 4% bio-ethanol volumetric proportion), GE6 (94% gasoline and 6% bio-ethanol volumetric proportion), GE8 (92% gasoline and 8% bio-ethanol volumetric proportion), and GE10 (90% gasoline and 10% bio-ethanol volumetric proportion) respectively. The time taken by the engine to consume 8ml of the fuel was recorded. AVL DiGas 4000 gas analyser was used to measure exhaust gas temperature (EGT), concentration of gaseous emissions for unburned hydrocarbon (UHC), carbon monoxide (CO), carbon dioxide (CO_2) to evaluate and compute the behavior of the petrol engine. The results obtained from the emission analyses were tabulated and necessary graphs were plotted.

2.2 Experimental Set-up

Table 1: Technical specifications of engine test rig

Type	Single cylinder, four stroke, air-cooled
Bore * Stroke	65 mm x 70 mm
Brake power	2.43kW
Rated speed	1500rpm
Starting method	Manual cranking
Compression ratio	20.5:1
Net weight	45kg
Manufacturer	TQ Educational Training Ltd
Model	TD110-115

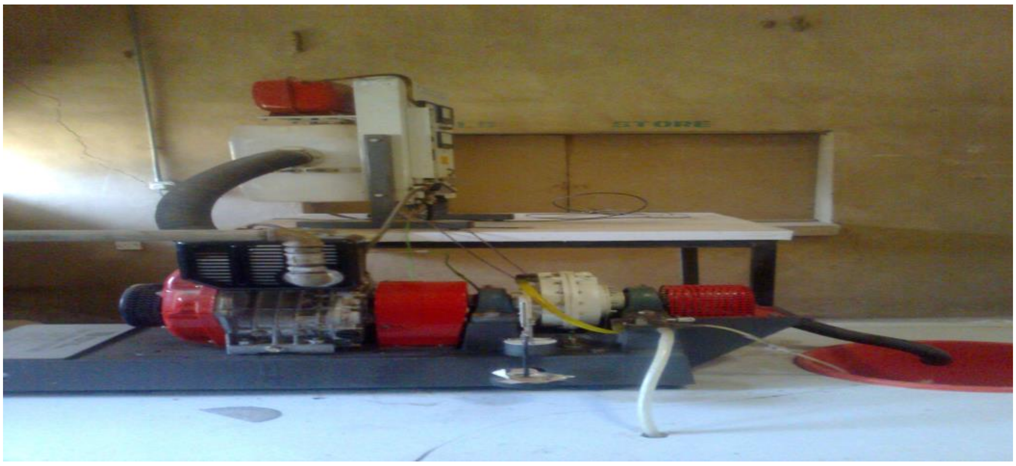

Figure 1: Engine test rig

Figure 2: AVL DiGas 4000 gas analyser

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3.0 RESULTS AND DISCUSSION

3.1 Exhaust Temperature of gasoline and ethanol-gasoline blends

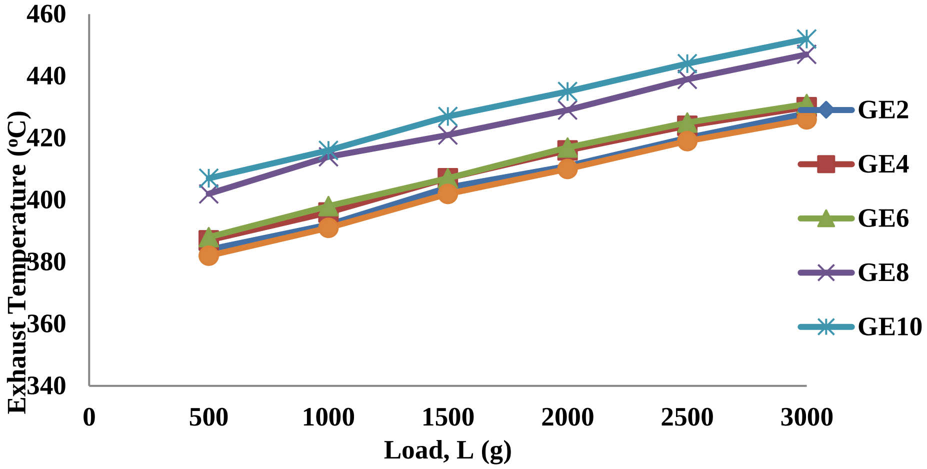

Figure 3: Variation of Exhaust Temperature for the Gasoline and the Blends with Increase in Load

The variation of exhaust gas temperature (EGT) in relation to load for all the fuels increases with increase in load as shown in Fig. 3. The increased exhaust gas temperature of the engine with the use of bio-ethanol blends may be caused by the rise in peak cylinder pressure resulting in higher peak combustion temperature as reported. In addition, a relationship could be established between exhaust temperature and brake power because a rise in combustion temperature brings about a commensurate increase in the pressure acting on the piston, to improve mechanical power output.

3.2 Carbon dioxide emission of gasoline and ethanol-gasoline blends

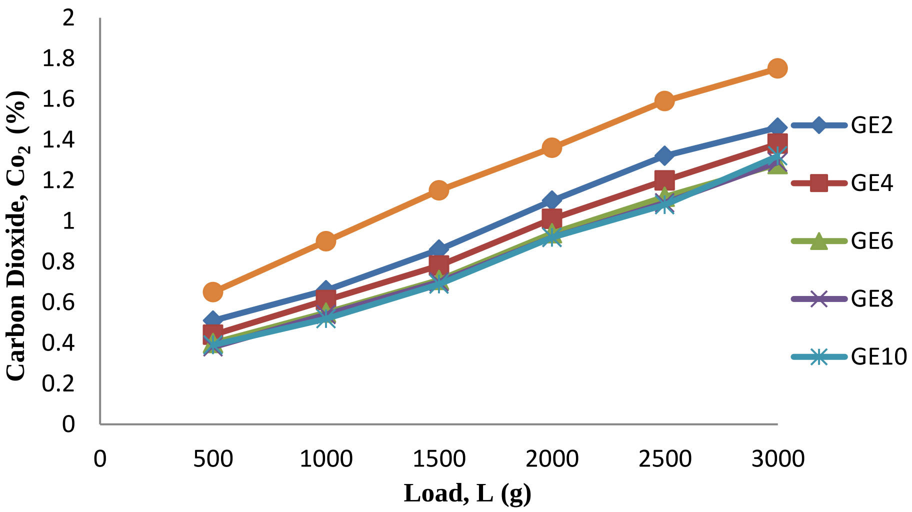

Figure 41: Carbon Dioxide (CO_2) Emission for the Gasoline and the Blends with Increase in

Fig. 4 shows the emission levels of carbon dioxide (CO_2) for various blends and gasoline. Test measurements reveal that the CO_2 emission for all blended fuel samples under study was lower compared to gasoline for different loads. However, CO_2 emission increased with increase in load for all blends. The rising trend of CO_2 emission with load is due to the higher fuel entry as the load increases. This too is attributed to the fact that bio-ethanol is a low carbon fuel and has a lower elemental carbon to hydrogen ratio than gasoline, the effect of bio-fuel on global greenhouse gas emissions through the life cycle of CO_2 emissions is such that bio-fuel is likely to cause 50–80% reduction in CO_2 emissions compared to petroleum fuel.

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3.3 Carbon monoxide emission of gasoline and ethanol-gasoline blends

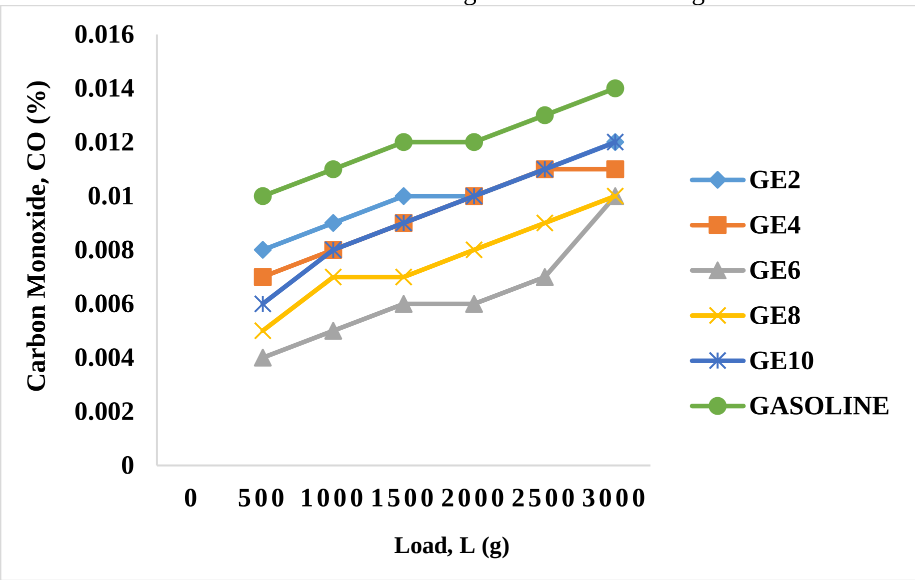

Figure 52: Carbon Monoxide (CO) Emission for the Gasoline and the Blends with Load.

Carbon monoxide (CO) is an intermediate combustion product and is formed mainly due to incomplete combustion of fuel. If combustion is complete, CO is converted to CO_2. If the combustion is incomplete due to shortage of air or low gas temperature (LGT), CO will be formed. The variation of CO emission with load is shown in Fig. 5. It was observed that the engine emits more CO for gasoline under all load conditions when compared to other blends understudy. However, as the proportion of ethanol in the blend increases, the percentage emission decreases due to higher oxygen content or oxygenation and lower carbon to hydrogen ratio in bio-ethanol compared to gasoline.

3.4 Hydrocarbon emission of gasoline and ethanol- gasoline blends

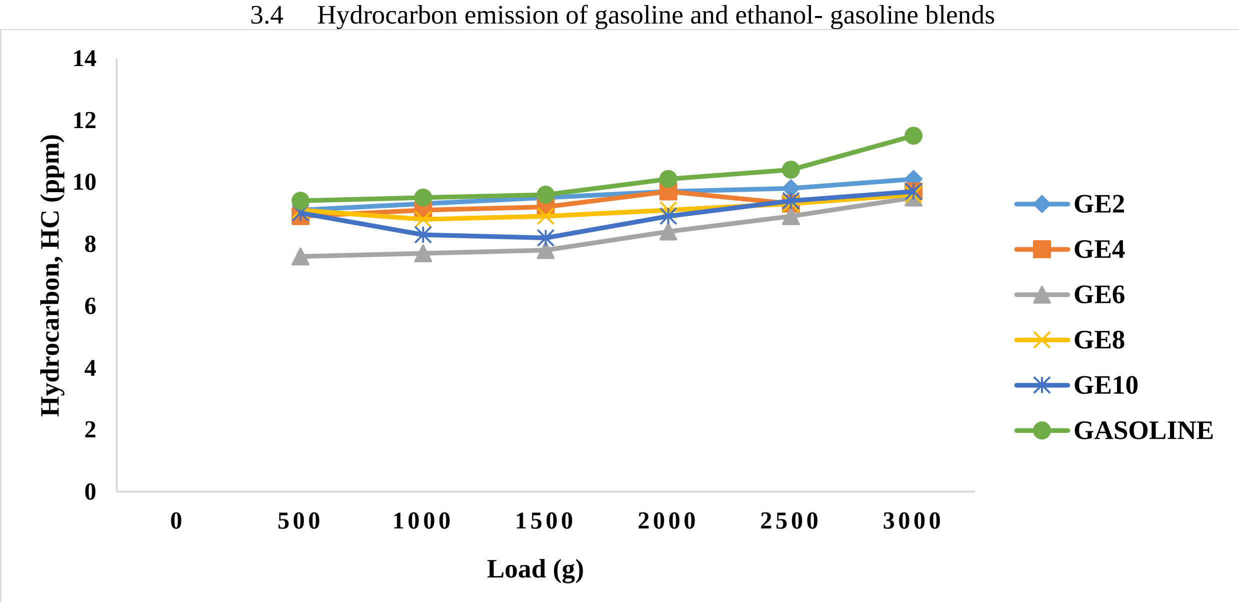

Figure 6: Hydrocarbon (HC) Emission for the Gasoline and the Blends with Increase in Load

Hydrocarbons (HC) in exhaust are a result of incomplete burning of the carbon compounds in the fuel. The HC emission variation for different blends is indicated in Fig. 6. All blends have lower values than gasoline owing to higher combustion chamber temperature, which helps in cracking and faster burning. It was also observed that the HC emission increased with sharp increase in engine load (i.e. 500g -2500g), and then increased slightly further with increase in load for all the samples. The HC emission for the blends also followed a similar trend but comparatively the values were lower than the level for gasoline emission. The presence of oxygen in the bioethanol blends aids combustion and reduces the hydrocarbon emission considerably.

4.0 CONCLUSION

From the foregoing study, the following could be concluded:
In comparison to the emission profile of gasoline fuel, a significant reduction in CO_2, CO and HC emissions was

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recorded for GE2, GE4, GE6, GE8, and GE10 blended fuel samples. An impressive reduction in CO_2, CO and HC emissions were recorded for all tested blended fuel samples, but an appreciable increased of exhaust gas temperature was observed This lends credence to the candidacy of bio-ethanol derived from *Cadaba farinosa forskk* shrub and it's blends as fuel for spark ignition engines, and also provides a remediation measure for environmental pollution control caused by engine exhaust emission.

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