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Performance Evaluation of Gasoline Vehicle with Gasoline-Ethanol-Water Emulation as a Fuel

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Abstract: It is necessary to encourage the usage of renewable biofuels like ethanol in vehicles in the countries like Ethiopia to reduce the dependency on importation of the oil and environmental pollution. Efforts are being put in from different corners of the world in the direction of improving performance of gasoline-ethanol blends in the engines. This thesis is done with main objective of testing the effect of gasoline-ethanol-water emulsion on the performance of gasoline vehicle. The vehicle was tested for brake power, brake torque and brake specific fuel consumption using chassis dynamometer. The performance tests were conducted using chassis dynamo meter on a vehicle equipped with a four cylinder production spark ignition (SI) engine, without any major modifications of hardware to investigate the comparative performance characteristics of the gasoline, ethanol-gasoline and water-ethanol-gasoline mixtures. In addition to performance test, the study on the miscibility of water, ethanol and gasoline blend was conducted mainly to know what extent water can be added to ethanol gasoline blend without phase separation. The amount of water that could be tolerated in the hydrated alcohol when used as a blending component with gasoline is 0.5%V.The gasoline - ethanol - water blend miscibility test shows that 0.05% water, 9.95% ethanol & 90% gasoline fuel does not separate up to 0°C, but below 0°C separation starts to begin. From the performance testing it is observed that on an average there is a slight decrease in brake power with gasoline-ethanol-water as a fuel. There is a slight reduction in brake torque compared to gasoline but slightly higher brake torque is registered compared to gasoline-ethanol blend. At medium speeds there is a reduction in torque compared to gasoline, but it is similar with gasoline-ethanol blend. The brake power of water-ethanol-gasoline is higher than gasoline & ethanol-gasoline when the vehicle is driving at medium speed especially at 40 - 50 km/hr 2nd gear and 3rd gear. The brake specific fuel consumption (bsfc) and brake thermal efficiency, result shows that the performance of the gasoline-ethanol-water blend is better than gasoline & gasoline-ethanol blend.
Key words: Gasoline-ethanol-water, brake power, brake torque, brake specific fuel consumption

I. INTRODUCTION

Alternative fuels include ethanol, natural gas, hydrogen, biodiesel and methanol. These fuels are being used in a variety of vehicle applications. Among alternative fuels, ethanol is one of the fuels employed most widely. Some of its reasons are introduced in the following. First, it can be produced from "cellulosic biomass", such as trees and grasses and is called bio-ethanol. Secondly, ethanol (CH_3CH_2OH) is made up of a group of chemical compounds whose molecules contain a hydroxyl group, OH, bonded to a carbon atom. So, the oxygen content of this fuel favors the further combustion of gasoline. In addition, ethanol is commonly used to increase gasoline's octane number [1].

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II. MATERIALS AND METHODS

The study were conducted on a vehicle equipped with a four cylinder, inline, natural aspirated, spark ignition engine in a series of experiments.

The experiment involved the following tasks

- Gathering data like tractive effort, power and fuel consumption for engine running with gasoline, ethanol-gasoline blend & water- ethanol-gasoline blend fuels at different vehicle speeds.

After that the data was compiled. The brake power, brake specific fuel consumption, and fuel conversion efficiency were determined using the fuel flow reading, the engine speed, and the dynamometer force. Then Microsoft Excel is used to plot the data and compare the results for the three different test fuels.

2.1 Test vehicle and engine specification

Test vehicle specification		
Model		KE20(corolla)
Transmission	speed	4 speed
	Gear shift	Manual
	Gearbox model	K 40

Table 3. 1: Vehicle Specification for Toyota corolla model KE20

Figure 3.1: Toyota corolla KE20 Test vehicle

III. RESULT AND DISCUSSION

1) 3.1 Tractive effort and wheel power

The force available at the contact between the rear wheel tyres and road is known as tractive effort. When the vehicle is driven with gasoline fuel in first gear with full throttle, the engine is running at its maximum speed. When the vehicle is driven by 25 km/hr, of first gear, the engine rpm is 3999.99 rpm. At 30 km/hr rpm reaches 4799.15 rpm, and at 35 km/hr engine runs at 5599 rpm. When the vehicle is running with ethanol-gasoline blend fuel the maximum tractive force is obtained at second gear. The tractive force registered by dynamo meter in the second gear for gasoline, ethanol-gasoline & water-ethanol-gasoline is almost equal when the vehicle is driven at different speeds. At high engine rpm charge filling is adversely affected due to very short intake stroke duration. The fact that ethanol-gasoline is supplied to the engine will make the situation even worse because ethanol-gasoline needs a little time to be mixed with air. Consequently, when the engine is running at first gear tractive effort is reduced and the wheel power of gasoline and water-ethanol- gasoline blend is almost equal and higher than ethanol-gasoline blend fuel for 25km/hr. But at high rpm the power at the wheel of water-ethanol-gasoline is higher than gasoline & ethanol-gasoline blend fuels registered by the chassis dynamometer. The change came due to the existence of water; the temperature of the cylinder reduce, increase thermal efficiency, minimize heat loss, prevent pre- ignition of fuel is more sufficient enough to produce a power that is capable of producing a tractive force that can be sensed by the chassis dynamometer. In addition, at high engine speed, friction increases significantly. The rise of friction reduces the power at the rear. The main reason for wheel power reduction is that due to the raise of friction this heat loss, these reduces the power at the wheel. The heat loss through the exhaust also increases as the speed increase, thus reducing tractive effort. The tractive efforts at different gears have a behavior of increasing for a while and then drops. This is basically due to reduction in charge filling as engine
speed increases.

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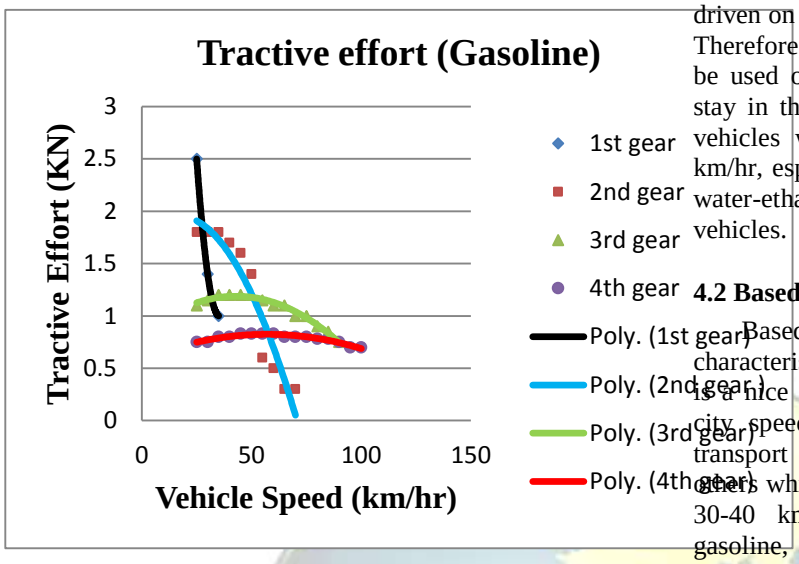

Figure 3. 1: Gasoline tractive efforts

IV. Conclusion

The main aim of the study was to test the performance of gasoline vehicle with gasoline - ethanol - water emulsion as a fuel making necessary modification in the fuel system. For starting purpose gasoline fuel was used.

4.1 Based on the brake torque characteristics

Water-ethanol-gasoline has produced more brake torque than gasoline & ethanol-gasoline blend. When running on water-ethanol-gasoline a maximum brake torque of 69.44 Nm, when running on gasoline-ethanol maximum brake torque of 68.34 Nm and when running on gasoline maximum brake torque of 65.60 Nm was found. The least brake torque of 10.60 Nm is also registered when running on gasoline & water-ethanol –gasoline blends. The least brake torque of ethanol-gasoline is 19.14 Nm. The average torque when running on gasoline is 50.2 Nm, for water- ethanol-gasoline blend it is 49.68 Nm and for ethanol-gasoline blends 49.38 Nm. On average the brake torque of gasoline is slightly higher than the brake torque of ethanol-gasoline & water-ethanol- gasoline. The lesser density of gasoline and the lesser octane number are responsible for gasoline increased brake torque. Based on the torque performance characteristics, it can be concluding that Water-ethanol-gasoline performs nearly as well as gasoline & ethanol-gasoline, if the vehicle is driven on 3rd gears between the speed of 25 and 30 km/hr. Therefore, Water-ethanol-gasoline fuel system is better to be used on vehicles which, most of their running time, stay in this speed range. For example, mostly for those vehicles which are driven in the proximity of 25- 30 km/hr, especially when the vehicle is driven in the cities, water-ethanol-gasoline is a better alternative to be used on vehicles.

4.2 Based on the brake power characteristics

Based on the brake power performance characteristics, it can be seen that water-ethanol-gasoline is a nice choice for vehicle that is mostly driven within city speed limits. Vehicles that such as taxis, school transport vehicles, automobiles operating in town and others which are mostly driven at speeds in the vicinity of 30-40 km/hr are better fuelled with water-ethanol-gasoline, also for high transport vehicle such as minibus for those mostly driven with the third gear 60-80 km/hr. If such vehicles are converted to run on water-ethanol-gasoline blend the performance will be good when compared to ethanol-gasoline & gasoline fuels.

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