Effect Of Bioethanol – Gasoline Blends On The Exhaust Emissons And Performance Of A Vehicle

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Abstract: In this study, the effect of using new generation fuel injection system and electronic ignition system in a spark ignition (SI) vehicle as an alternative fuel by using bioethanol on the exhaust emissions and performance of vehicle will be experimentally examined. By mixing bioethanol and gasoline in diverse proportions as 50%, the effects of this on the exhaust emissions and performance of vehicle will be searched. An order to establish the emissions of vehicle, by running the vehicle in different clutch types and various vehicle speed were accounted through measuring wheel power, fuel consumption and CO, CO2, HC, NOx exhaust emissions were measured at each gear for each fuels.

Keywords: Bioethanol, Alternative fuels, Exhaust emissions from vehicle.

Introduction

The increase in prices of petroleum based fuels, strict governmental regulations on exhaust emissions with increasing focus on global warming due to the greenhouse gas effect and future depletion of worldwide petroleum reserves encourage studies to search for alternative fuels. Alcohols (ethanol and methanol) have been considered as alternative fuels for Otto and Diesel engines. One of these alternative fuels, bioethanol, can offer substantial reductions in consumption of fosil fuels and emission of greenhouse gases [1-2].

Bioethanol has the opportunity to contribute to the gradual substitution of fossil fuels not only in the gasoline sector but even in the diesel one, by two means: direct blending and ethanolysis. Besides the advantages in production costs, direct blending of bioethanol provides higher oxygen concentration, and thus higher potential for emissions reduction with the same volume fraction of renewable fuel blended [3].

Bioethanol is a renewable energy, it can be made from many raw materials such as sugar cane, molasses, cassava, waste biomass materials, sorghum, corn, barley, sugar beets, etc. by using already improved and demonstrated technologies [4-5]. Since ethanol can be fermented and distilled from biomasses, it can be considered as a renewable energy. Under the environmental consideration, using ethanol blended with gasoline is better than methanol because of its renewability and less toxicity [6,7].

In this study, bioethanol was obtained from sugar beet by fermantasyon method. The use of bioethanol in a vehicle having SI engine and its effect on emissions and vehicle performance were investigated. The study is given as a new investigation due to using vehicle having new electronic ignition and injection system, and performed on chassis dynamometer of experiments.

Description Of The Experimental Setup And Testing Procedure

Vehicle specifications used in the study are given in Table 1. Controlling of tyre pressure and tooths, wheel balance and rod adjustment, engine controls performed before experiments.
The vehicle was coupled to Delorenzo HPT 6100 type chassis dynamometer. Vehicle exhaust emissions were measured using exhaust emission analyzer which Italo – Spin type, digital displaying, can measure CO (% vol) with 0.001 sensibility, CO_2 (% vol) with 0.001 sensibility, NO_x (ppm) and HC (ppm) values. As fuel, E0 (98 octane gasoline) and E50 (50% bioethanol – 50% gasoline as volumetric) were used. Fuels specifications used in the study are given in Table 2.

First, the vehicle was tested with E0 fuel. Then, the bioethanol – gasoline blend was also tested E50 fuel. Exhaust emissions were measured at each gear and for each fuel. The ambient air temperature, relative humidity, and atmospheric pressure were almost constant during the tests.

Results

Wheel performance

Wheel power and fuel consumption were studied as vehicle performance. The variations of wheel power with vehicle speed for the tested all fuels at each gear is depicted in Figure 1, 2, 3. Maximum wheel power was measured at 60 km/h as 36.4 kW for E0 at second gear. Wheel power was measured as 31.2 kW with E50 at same gear and speed. Maximum wheel power was measured at 80 km/h as 32.7 kW for E0 at third gear. Wheel power was measured as 28.3 kW with E50 at same gear and speed. Maximum wheel power was measured at 110 km/h as 29.4 kW for E0 at forth gear. Wheel power was measured as 25.7 kW with E50 at same gear and speed.

Make	FIAT
Model	Albea
Version	1.2 Active EL
Driving axle	Front wheel drive
Production year	2008
Minimum vehicle weight (kg)	1055
Specifications of vehicle engine	
Total cylinder volume (cm^3)	1242
Valve number	16
Compression ratio	10.6:1
Fuel system	Electronic MPI
Max. engine power (HP – 1/min)	80 – 5000
Max. engine torque (Nm – 1/min)	112 – 4000

Table 1. Vehicle specifications used in the study

	E0	E50
Density to 15^oC (kg/m^3)	770.2	780.3
Viscosity to 40^oC (mm^2/s)	0.593	0.784
Low Heating Value (cal/g)	48.1	36.2
Water content (ppm)	286.96	894.58
Copper corrosion	1a	1a

Table 2. Fuels specifications used in the study

According to results, wheel power values of E50 were lower than E0. The decrease in average power was 12.13% for usage of E50 at second gear. The decrease in average power was 13.56% for usage of E50 at third gear. The decrease in average power was 13.4% for usage of E50 at forth gear. The lower wheel power obtained for E50's could be due to fuel flow problems, as higher density and higher viscosity, and decreasing combustion efficiency as lower thermal efficiency by heating value lower than E0.

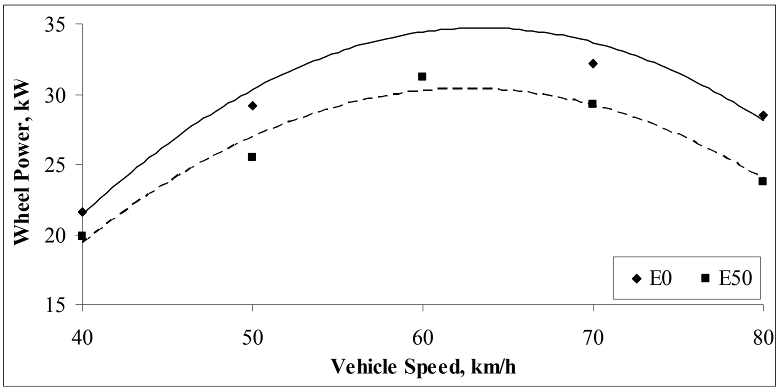

Figure 1. The variations of wheel power at second gear

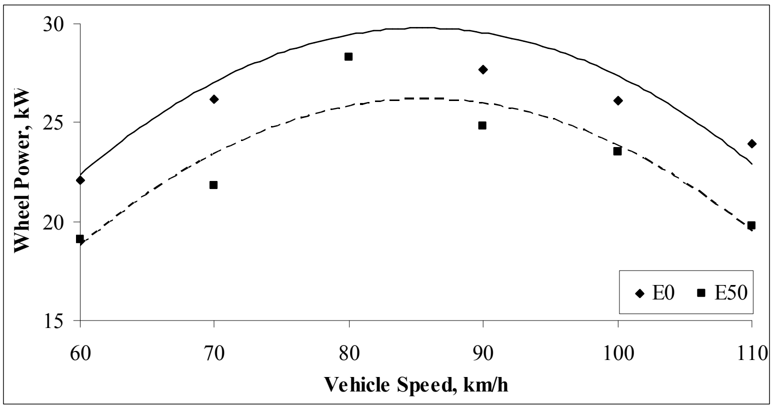

Figure 2. The variations of wheel power at third gear

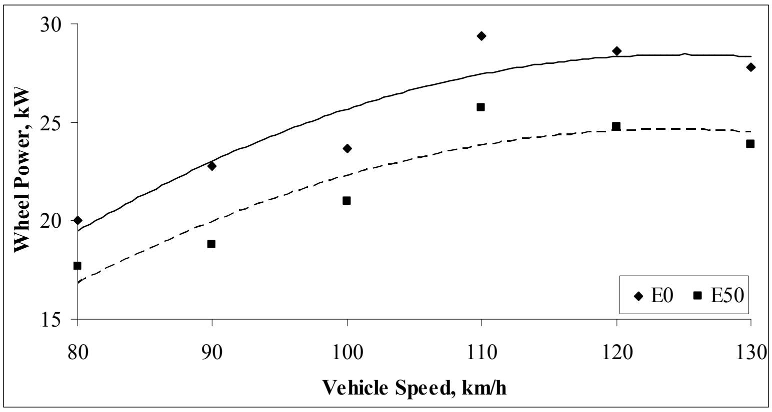

Figure 3. The variations of wheel power at forth gear

Fuel consumption

The variations of fuel consumption with vehicle speed for the tested all fuels at each gear are depicted in Figure 4, 5, 6. At all vehicle speed, fuel consumption values of E50 were higher than E0. The increase in average fuel consumption was 18.86% for usage of E50 at second gear. The increase in average fuel consumption was 28.1% for usage of E50 at third gear. The increase in average fuel consumption was 34.2% for usage of E50 at forth gear.

One possible explanation for this increase could be due to lower heating value and higher density compared to E0 (Table 3). Therefore, thermal efficiency of E0 is higher than thermal efficiency of E50, and fuel consumption value of E0 is lower than fuel consumption of E50.

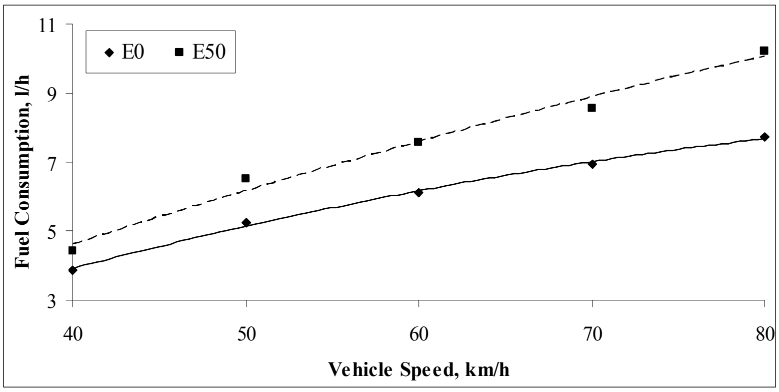

Figure 4. The variations of fuel consumption at second gear

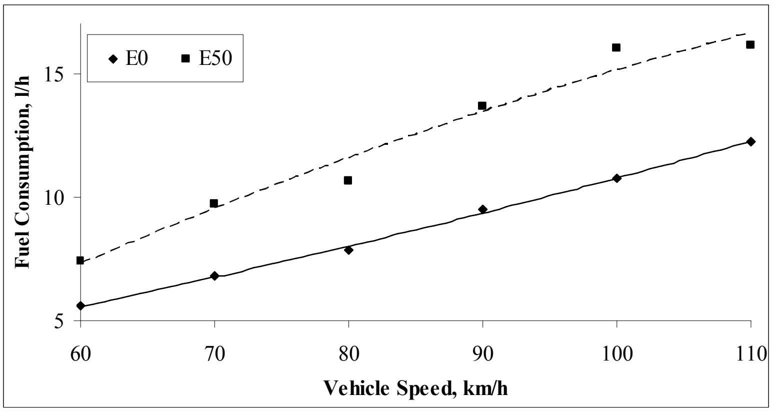

Figure 5. The variations of fuel consumption at third gear

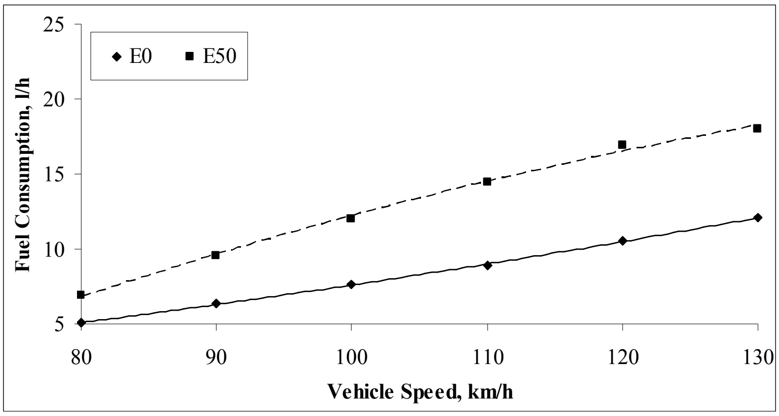

Figure 6. The variations of fuel consumption at forth gear

Exhaust Emissions

CO, CO_2, HC and NO_x emissions were studied as exhaust emissions.

CO emission

The variations of CO produced by running the vehicle using E0 and E50 fuels are shown in Figure 7, 8, 9. In general, CO emissions of E50 are equal or lower than E0. The decrease in average CO emission was approx. 18.61% for usage of E50 at second gear. The decrease in average CO emission was approx. 13.75% for usage of E50 at third gear. The decrease in average CO emission was approx. 14.97% for usage of E50 at forth gear. Cause of the decrease is content O_2 in bioethanol.

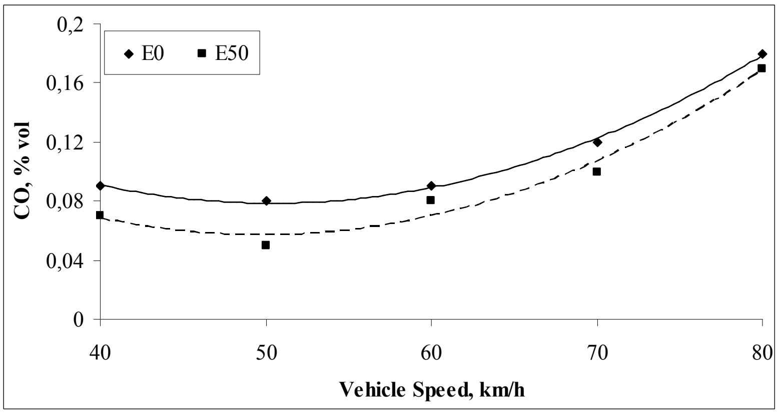

Figure 7. The variations of CO emission at second gear

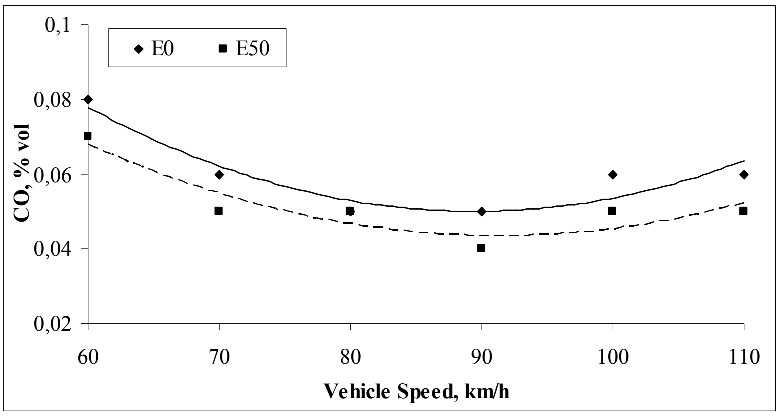

Figure 8. The variations of CO emission at third gear

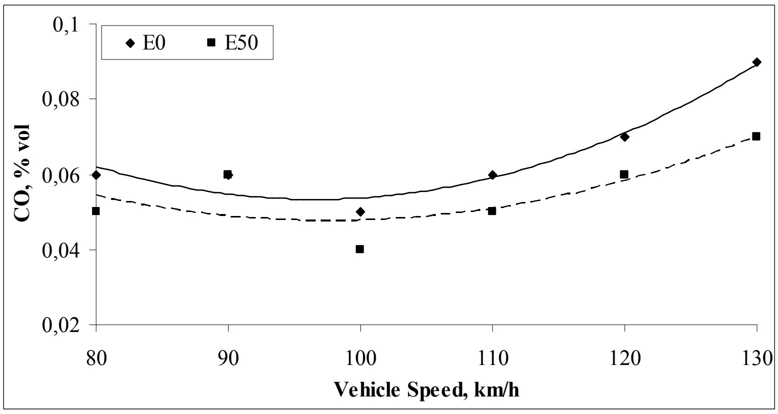

Figure 9. The variations of CO emission at forth gear

CO_2 emission

The variations of CO_2 produced by running the vehicle using E0 and E50 fuels is shown in Figure 10, 11, 12. At all vehicle speed and each gear, CO_2 emissions of E50 are lower than CO_2 emission of E0. The decrease in average CO_2 emission was approx. 11.16% for usage of E50 at second gear. The decrease in average CO_2 emission was approx. 7.75% for usage of E50 at third gear. The decrease in average CO_2 emission was approx. 8.93% for usage of E50 at forth gear. Cause of the decrease which C atoms in E50 are lower than E0.

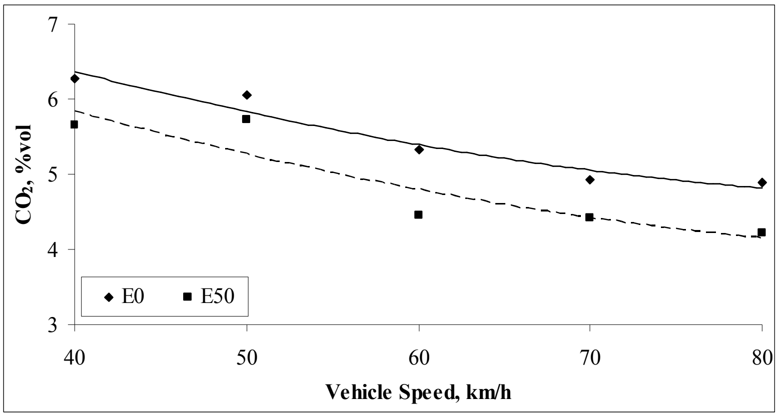

Figure 10. The variations of CO_2 emission at second gear

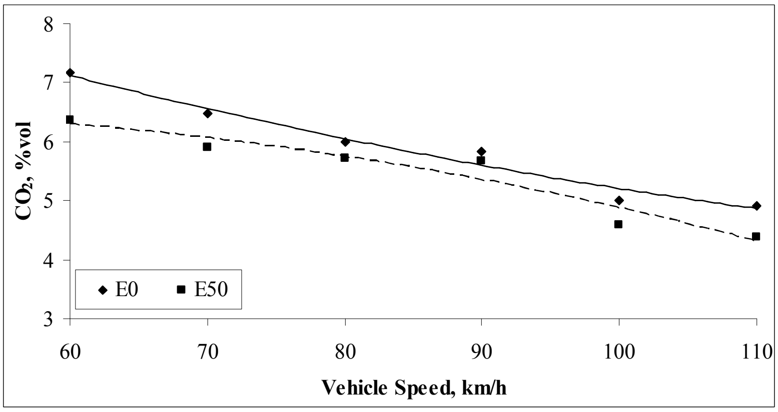

Figure 11. The variations of CO_2 emission at third gear

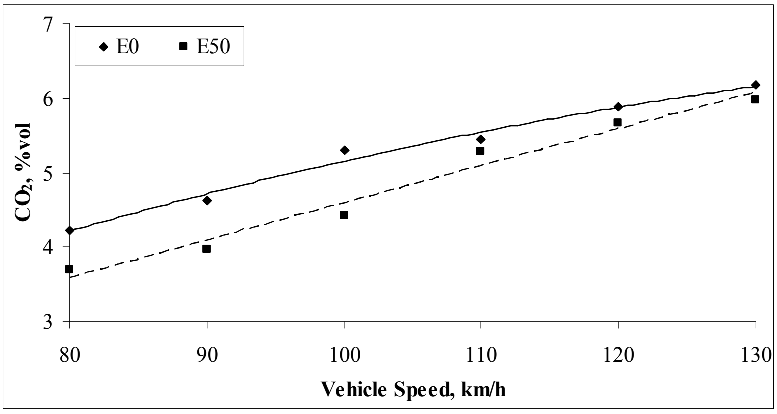

Figure 12. The variations of CO_2 emission at forth gear

HC emission

The variations of HC produced by running the vehicle using E0 and E50 fuels is shown in Figure 13, 14, 15. At all vehicle speed and each gear, HC emissions of E50 fuel are higher than HC emission of E0. The increase in average HC emission was approx. 60% for usage of E50 at second gear. The increase in average HC emission was approx. 54.28% for usage of E50 at third gear. The increase in average HC emission was approx. 65% for usage of E50 at forth gear. Cause of this is bad burning with bioethanol fuels. However, HC emission of E50 fuel is decrease due to lower heating value of E50 fuel.

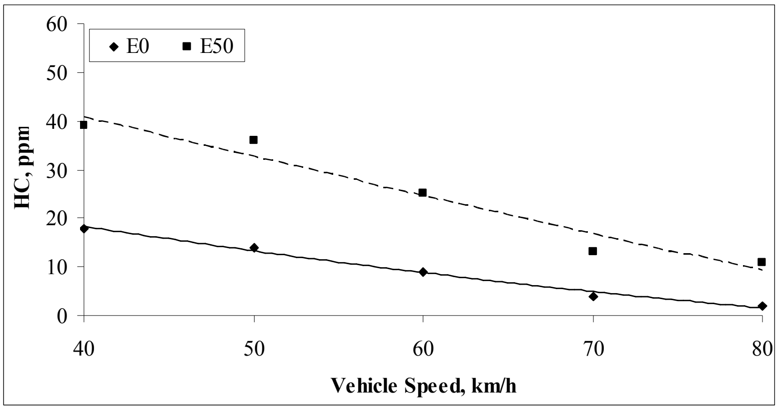

Figure 13. The variations of HC emission at second gear

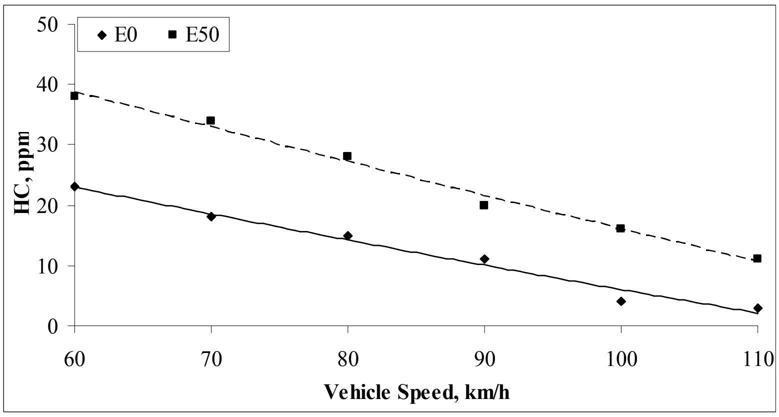

Figure 14. The variations of HC emission at third gear

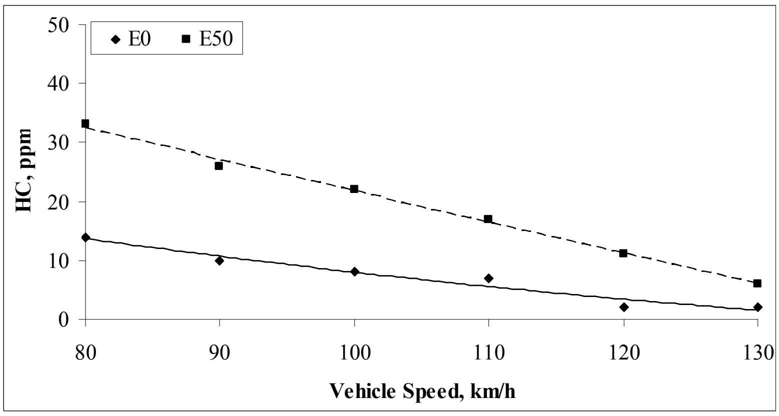

Figure 15. The variations of HC emission at forth gear

NO_x emission

The variations of NO_x produced by running the vehicle using E0 and E50 fuels is shown in Figure 17, 18, 19. At all vehicle speed and each gear, NO_x emissions of E50 fuel are lower than NO_x emission of E0. The decrease in average NO_x emission was approx. 45.2% for usage of E50 at second gear. The decrease in average NO_x emission was approx. 53% for usage of E50 at third gear. The decrease in average NO_x emission was approx. 61.71% for usage of E50 at second gear. Cause of the decrease is low of lower heating value of E50 fuel, and thus, temperature at burning end is decrease.

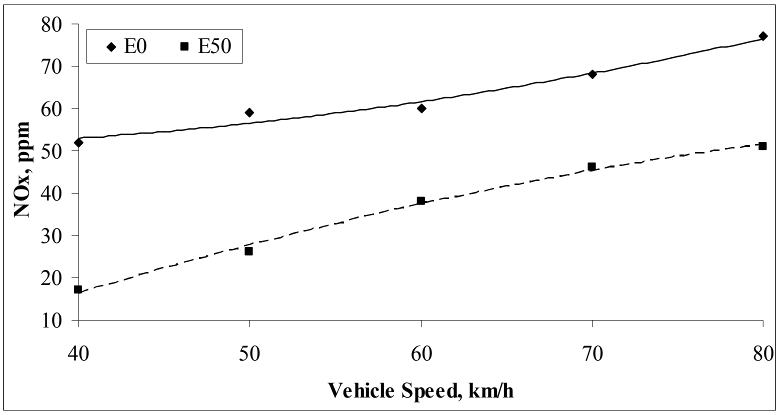

Figure 16. The variations of NO_x emission at second gear

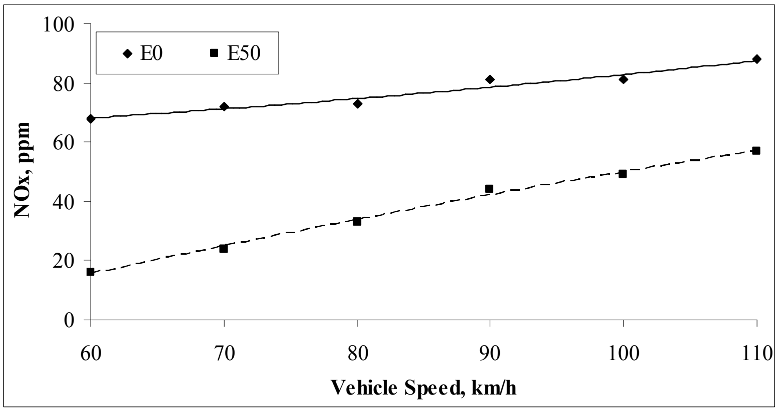

Figure 17. The variations of NO_x emission at third gear

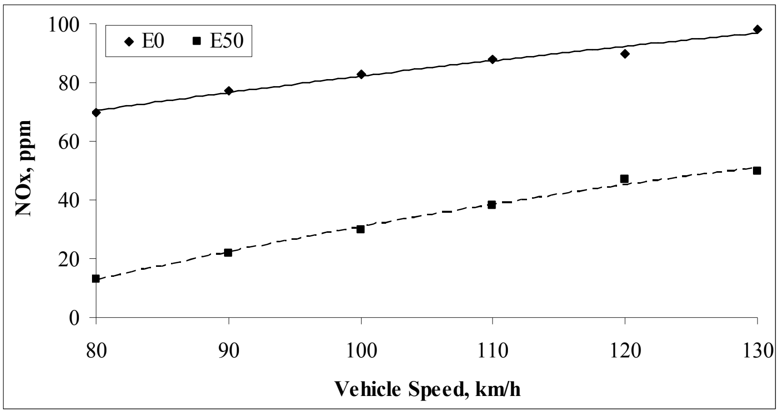

Figure 18. The variations of NO_x emission at forth gear

Conclusion

In this study, it is shown that bioethanol as alternative SI engine fuel can be used successfully to operate a electronic ignition SI engine without modifications to engine or injection system.
The following conclusion may be drawn from the result of the present study:

- Bioethanol is a renewable energy resource.
- Gasoline and bioethanol are similar in their chemical and physical properties.
- Bioethanol can be used cheaply and as an alternative fuel in a SI engine instead of gasoline.
- Exhaust emissions of bioethanol and bioethanol blend fuels was better than gasoline.

Result of emission tested of bioethanol's emission values are optimistic.

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