Tarım Makinaları Bilimi Dergisi (Journal of Agricultural Machinery Science)
2012, 8 (3), 317-320

The Effect on Vehicle Performance and Exhaust Emissions of Gasoline – Ethanol Blend which is High Ethanol Rate

İlker ÖRS[1], Murat CİNİVİZ[2], Hüseyin KÖSE[2]

[1]Aksaray Üniversitesi, Aksaray Meslek Yüksekokulu, Otomotiv Teknolojisi Programı
[2]Selçuk Üniversitesi, Teknik Eğitim Fakültesi, Makine Eğitimi Bölümü
ilkerors@hotmail.com

Received (Geliş Tarihi): 07.04.2011 Accepted (Kabul Tarihi): 17.05.2011

Abstract: In this study, the effects of blending gasoline and ethanol which will probably be consumed as an alternative for gasoline in the future on wheel power, CO, HC, NO_x and CO_2 emissions were examined at spark ignition engines, at vehicles with electronic ignition system and injection fuel system. As fuel, gasoline-ethanol blend with a %85 ethanol were used. According to the results of the experiment, wheel power was decreased. Fuel consumption was increased. In case exhaust emissions, CO, CO_2 and NO_x emissions were decreased, HC emission was increased.

Keywords: Gasoline-ethanol blends, alternative fuels, vehicle performance, exhaust emissions.

INTRODUCTION

Needless to say, the world population is increasing at an alarming rate and so is the liquid fuel demand in the transport sector. Global warming, depletion of fossil fuels and increasing price of petroleum-based fuels are gaining great concern and the exigency of the situation has forced the search for alternative, sustainable, renewable, efficient and cost-effective energy sources with lesser green house gas emissions. Biomass can serve as an excellent alternative source to meet the present and future fuel demands. Any type of fuel generated from biomass is termed biofuel. The two most common and successful biofuels are biodiesel and bioethanol which are aimed at replacing mainly the conventional liquid fuels like diesel and petrol (Nigam and Singh, 2010; John *et al.*, 2011).

Bioethanol is the most widely used liquid biofuel. It is an alcohol and is fermented from sugars, starches or from cellulosic biomass. Most commercial production of ethanol is from sugar cane or sugar beet, as starches and cellulosic biomass usually require expensive pretreatment. It is used as a renewable energy fuel source as well as for manufacture of cosmetics, pharmaceuticals and also for the production of alcoholic beverages (Demirbaş, 2005).

Bioethanol can be mixed with the petroleum products (gasoline and diesel) and it is substituted for and can be burned in traditional combustion engines with virtually no modifications needed. Bioethanol is blended with gasoline to form an E10 blend (10% bioethanol and 90% gasoline), but it can be used in higher concentrations such as E85 or E95. Bioethanol can be used as a 5% blend with petrol under the EU quality standard EN 228. This blend requires no engine modification and is covered by vehicle warranties. With engine modification, bioethanol can be used at higher levels, for example, E85 (85% bioethanol). Some countries have exercised biofuel programs both from bioethanol-gasoline blend programs such as the United States [E-10 and for Flexible Fuel Vehicle (FFV) E-85], Canada (E- 10 and for FFV E-85), Sweden (E-5 and for FFV E-85), India (E-5), Australia (E-10), Thailand (E-10), China (E-10), Columbia (E-10), Peru (E-10), Paraguay (E-7), Brazil (E-20, E-25, and FFV any blend) (Loppacher and Kerr, 2005; Balat, 2005; Balat, 2009; Kadiman, 2005).

Bioethanol has a higher octane number (108), broader flammability limits, higher flame speeds, and higher heats of vaporization than gasoline. These properties allow for a higher compression ratio, shorter burn time, and leaner burn engine, which lead to theoretical efficiency advantages over gasoline in an ICE. Disadvantages of bioethanol include its lower energy density than gasoline (but about 35% higher than that of methanol), its corrosiveness, low flame luminosity, lower vapor pressure (making cold starts difficult), miscibility with water, and toxicity to ecosystems (MacLean and Lave, 2003).

On the combustion characteristics, the auto-ignition temperature and flash point of alcohol are higher than those of gasoline, which make it safer for transportation and storage. The latent heat of evaporation of alcohol is 3–5 times higher than that of gasoline, which makes the temperature of the intake manifold lower, and increases the volumetric efficiency. The heating value of alcohol is also lower than that of gasoline. Therefore, we need 1.5–1.8 times more alcohol fuel to achieve the same energy output. Moreover, the stochiometric air–fuel ratio (AFR) of alcohol is about 2/3–1/2 that of gasoline, hence the required amount of air for complete combustion is lesser for alcohol (Yüksel and Yüksel 2004).

Spark ignition engines are major contributors of various types of air pollutant emissions such as carbon monoxide (CO), oxides of nitrogen (NOx), hydrocarbon (HC), and other harmful compounds. With the increasing concern of environmental protection and more stringent government regulation on exhaust emissions, reduction in engine emissions becomes a major research task in engine development. It is difficult to reduce PM and NOx simultaneously owing to the trade-off relationship between NOx and PM. There are many researchers are dedicating to develop a new technology to reduce PM and NOx simultaneously (Xing-cai *et al.*, 2004).

MATERIAL AND METHOD

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 E85 (85% bioethanol – 15% 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 E85 fuel. Exhaust emissions were measured at fourth gear and for both fuel. The ambient air temperature, relative humidity, and atmospheric pressure were almost constant during the tests.

Table 1. vehicle specifications used in the study

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 2. fuels specifications used in the study

	E0	E85
Density to 15^{o}C (kg/m^3)	770.2	789.5
Viscosity to 40^{o}C (mm^2/s)	0.593	1.039
Low Heating Value (cal/g)	48.1	29.7
Water content (ppm)	286.96	1666
Copper corrosion	1a	1a

RESULTS

Vehicle Performance

The variations of wheel power with vehicle speed for the tested both fuels at fourth gear is depicted in Figure 1. Maximum wheel power was measured at 110 km/h as 29.4 kW for E0. Wheel power was measured as 22.4 kW with E85 at same speed. But, maximum wheel power with E85 was obtained at 120 km/h as 23,5 kW.

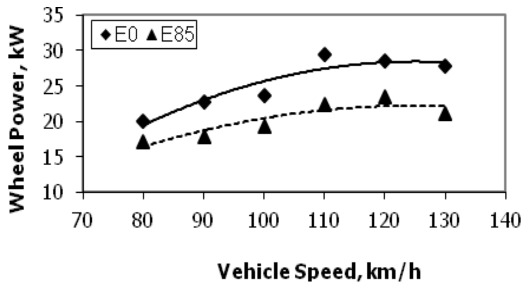

Figure 1. the variations of wheel power with vehicle speed

According to results, wheel power values of E85 were lower than E0. The decrease in average power was 20.22% for usage of E85. The lower wheel power obtained for E85'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.

The variations of fuel consumption with vehicle speed for the tested both fuels at fourth gear is depicted in Figure 2. At all vehicle speed, fuel consumption values of E85 were higher than E0. The increase in average fuel consumption was 38% for usage of E85.

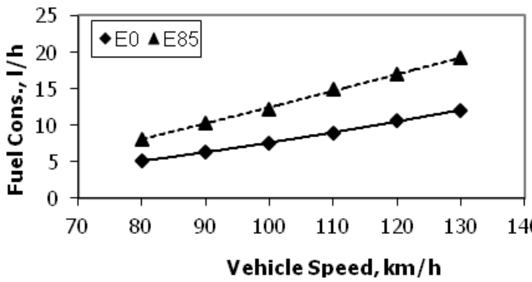

Figure 2. the variations of fuel consumption with vehicle speed

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 E85, and fuel consumption value of E0 is lower than fuel consumption of E85.

Exhaust Emissions

The variations of CO produced by running the vehicle using E0 and E85 fuels are shown in Figure 3. At all vehicle speed, CO emissions of E85 are lower than E0. The decrease in average CO emission was approx. 25.64% for usage of E85. Cause of the decrease is content O_2 in bioethanol.

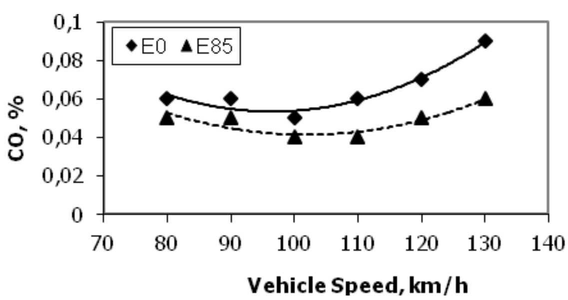

Figure 3. the variations of CO emission with vehicle speed

The variations of CO_2 produced by running the vehicle using E0 and E85 fuels is shown in Figure 4. At all vehicle speed, CO_2 emissions of E85 are lower than CO_2 emission of E0. The decrease in average CO_2 emission was approx. 13.45% for usage of E85. Cause of the decrease which C atoms in E85 are lower than E0.

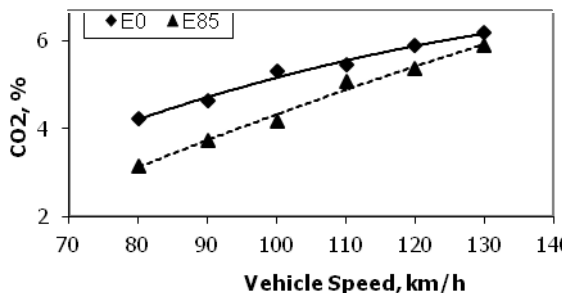

Figure 4. the variations of CO_2 emission with vehicle speed

The variations of HC produced by running the vehicle using E0 and E85 fuels is shown in Figure 5. At all vehicle speed, HC emissions of E85 fuel are higher than HC emission of E0. The increase in average HC emission was approx. 70% for usage of E85. Cause of this is bad burning with bioethanol fuels. However, HC emission of E85 fuel is increase due to its lower heating value.

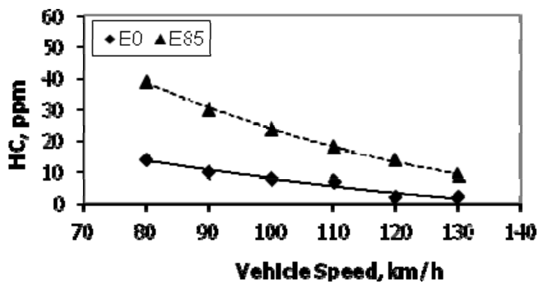

Figure 5. the variations of HC emission with vehicle speed

The variations of NO_x produced by running the vehicle using E0 and E85 fuels is shown in Figure 6. At all vehicle speed, NO_x emissions of E85 fuel are lower than NO_x emission of E0. The decrease in average NO_x emission was approx. 67% for usage of E85. Cause of the decrease is low of lower heating value of E85 fuel, and thus, temperature at burning end is decrease.

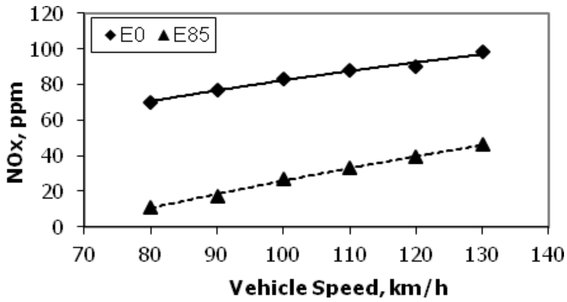

Figure 6. the variations of NO_x emission with vehicle speed

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.

Acknowledge

This work is supported by The Coordinatorship of Selcuk University's Scientific Research Projects (Grant Number: 08401119).

REFERENCES

Balat, M., 2005. Current Alternative Engine Fuels. Energy Sources. 27:569–577.

Balat, M., 2009. Bioethanol as a Vehicular Fuel: A Critical Review. Energy Sources. 31: 1242-1255.

Demirbaş, A., 2005. Bioethanol from Cellulosic Materials: A Renewable Motor Fuel from Biomass. Energy Sources. 27: 327-337.

John, R.P., G.S. Anisha, K.M. Nampoothiri, A. Pandey, 2011. Micro and Macroalgal Biomass: A Renewable Source for Bioethanol. Bioresource Technology. 102: 186-193.

Kadiman, O. K., 2005. Crops: Beyond Foods. 1st International Conference of Crop Security, Malang, Indonesia, September 20–23.

Loppacher, L. J., W.A. Kerr, 2005. Can Biofuels Become a Global Industry?: Government Policies and Trade Constraints. Energy Politics 5:7–27.

MacLean, H. L., L.B. Lave, 2003. Evaluating Automobile Fuel/Propulsion System Technologies. Prog. Ener. Combus. Sci. 29:1–69.

Nigam, P.S., A. Singh, 2010. Production of Liquid Biofuels from Renewable Resources. Prog. Energy Combust. Sci. doi:10.1016/j.pecs.2010.01.003.

Yüksel, F., B. Yüksel, 2004. The Use of Ethanol-Gasoline Blend as a Fuel in an SI Engine, Renewable Energy, 29:1181-1191.

Xing-cai, L., Y. Jian-guang, Z. Wu-gao, H. Zhen, 2004. Effect of Cetane Number Improver on Heat Release Rate and Emissions of High Speed Diesel Engine Fueled with Ethanol Diesel Blend Fuel. Fuel. 83: 2013-2020.