The operation of pump using alcohol as fuel

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Abstract: - The following document examines the four-stroke gasoline engine, which is used for the operation of a small irrigation pump. The engine was fuelled by gasoline and gasoline-10%ethanol mixture. During the experiments air pollution caused by the engine and its fuel consumption was measured. The engines' power output was estimated by measuring the discharge produced by the pump keeping the pressure stable. A series of laboratory instruments was used for the realisation of the experiments and the results showed that the use of gasoline-ethanol mixture results in a CO and HC reduction. Engine speed was decreased and fuel consumption increased when alcohol petrol mixture was used, but not significantly.

*Keywords: G*asoline-ethanol mixtures, Gas emissions, Biofuels

1 Introduction

The oil-based fuels used at the present can be replaced by alternative fuels from biomass. When oil-based fuels are used, the exhaust gas emissions effect the air pollution that is observed in many places around the world [1,2,3].
The expected increases of the price of crude oil, the abrupt oil market changes, the finite of reserves and their location in politically unstable areas of the world, as well as the environmental pollution led to the revaluation of the importance of the rural and forestall factor as a renewable resources supplier. Atmospheric pollution is a problem of a great importance around the world. One of the factors that cause air pollution is the gas emissions from engines [2,4,5,6]. Nowadays alternative fuels are used in order to satisfy needs in energy production which are friendly to the environment. Ethanol is an alternative fuel which is produced from biomass and can be used in all the types of vehicles and engines that require gasoline. In many cases, ethanol is used in combination with gasoline to form a mixture of 10% ethanol and 90% gasoline but it also can be used in higher concentrations such as 85% ethanol and 15% gasoline or even in its pure form. Use of ethanol in blends with gasoline can result in exhaust emissions decrease. Important quantities of bioethanol are produced every year to be used as fuel [3]. Bioethanol has a high octane number, which means it can be used as a fuel additive, or as a substitute either as pure alcohol or as mixture of gasoline-alcohol [2,4,5,7,8]. Alcohol is produced in laboratories in many ways. Practical interest occurs in producing ethanol from the rich in sugar plants. ''Alcoholic fragmentation'' is the splitting of single sugars, type C6H12O6, mainly glucose and fructose, to CO2 which is catalysed by the zymasse enzyme. Raisins, molasses and starchy roots or fruits like potatoes, corn, barley and others are used for this purpose [6,7,9,10,11]. In Brazil, bioethanol containing about 5% water has been used successfully in vehicles designed to run on this fuel. Nowadays mixtures of gasoline - alcohol are used in the USA mainly as car fuel (gasohol), either to fight the energy crisis or to decrease environmental pollution, because of the limited CO, HC emissions[12,13,14,15]. Compared to pure gasoline, the gasoline-alcohol mixtures produce smaller calorific value. This is why the use of these mixtures in petrol engines reduces the power output of the engine [7,8,16,17,]. The power output decrease, in principle, increases in proportion to the alcohol percentage in gasoline.

2 Experimental set-up

The tests were realised on a four-stroke gasoline engine, 163 cm3, which is used for the operation of water centrifugal pump for agricultural works. The pump was connected with a water container, as it is presented in Figure 1. During the tests the engine rpm, exhaust gas composition, fuel consumption and the water flow were measured.

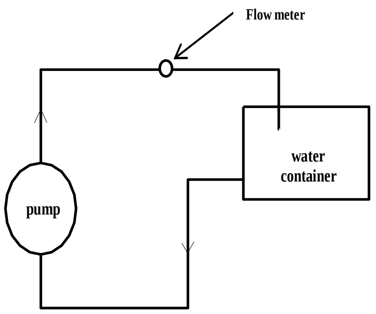

Figure 1. Typical operation system

For this purpose, the HP 3497A Data Acquisition Unit was used. For the rpm measurements an ignition pulse detector was used. The data acquisition unit was interfaced with a IBM-486 AT via the HP-IB 82990A Command Library IEEE-488 interface card. This particular measuring system and software completed a scanning cycle per channel every 0.1 s approximately. This measuring speed was considered adequate for the purpose of the experiment and the sampling capabilities of the chemical sensors. For the exhaust gas measurements a HORIBA MEXA-574GE infrared analyser was used. This unit has the following ranges: CO: 0-10% Volume, HC: 0-10000 ppm. The unit has ±2% accuracy and ±2% repeatability. The operating principle for the CO, HC measurements are Infrared Non Disperse Spectrometry and the time response for the CO, HC measurements was less than 10 s. The delay was not caused only by the actual sensors, but also by the time required for the exhaust gas to reach the sensing area via the connecting tubes and filters. The analyser was calibrated using a gas mixture provided by HORIBA. HC exhaust gas concentration calibration was based on n-hexane (n-C_6H_{14}). The unit was considered adequate for the steady state operation measurements required. A series of experiments were held, using as fuel gasoline and gasoline-10%ethanol mixture. The ethanol that was used was 95^o. For each of the above fuels, the engine operated with different velocity (1000-2000-3000rpm) and there was a continuous monitoring of the exhaust gases, CO and HC, the number of revolutions, the fuel consumption, and the water flow. The water flow was measured with a typical flow meter. The environmental conditions, for all of the testing above, were temperature 200^{o}C and pressure 1atm with negligible fluctuations.

3 Experimental results

The results obtained for the CO emissions at different engine speeds when gasoline(super) and gasoline -10%ethanol mixture are used as fuels, are illustrated in the Figures 2,3,4 below:

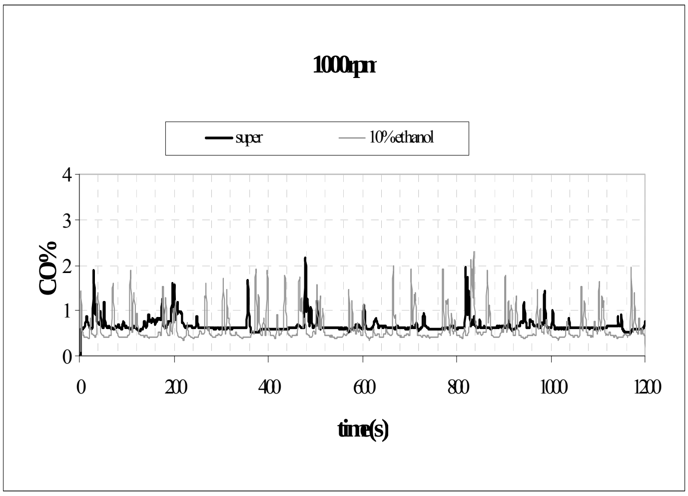

Figure 2. The CO variation at 1000rpm, for different fuels.

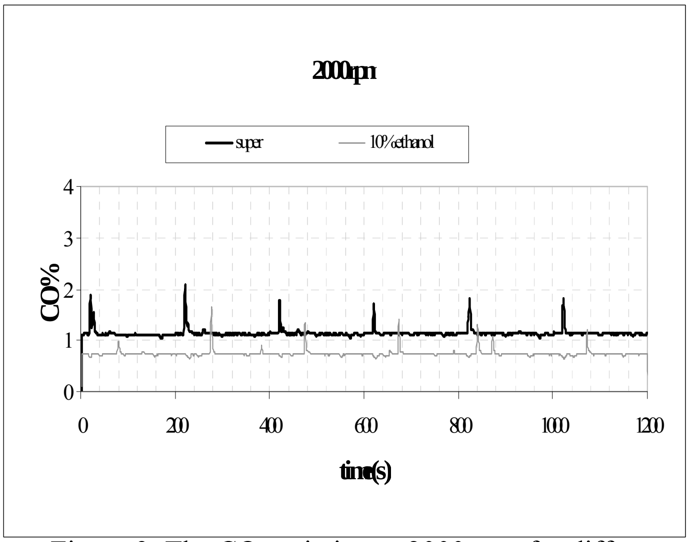

Figure 3. The CO variation at 2000rpm, for different fuels

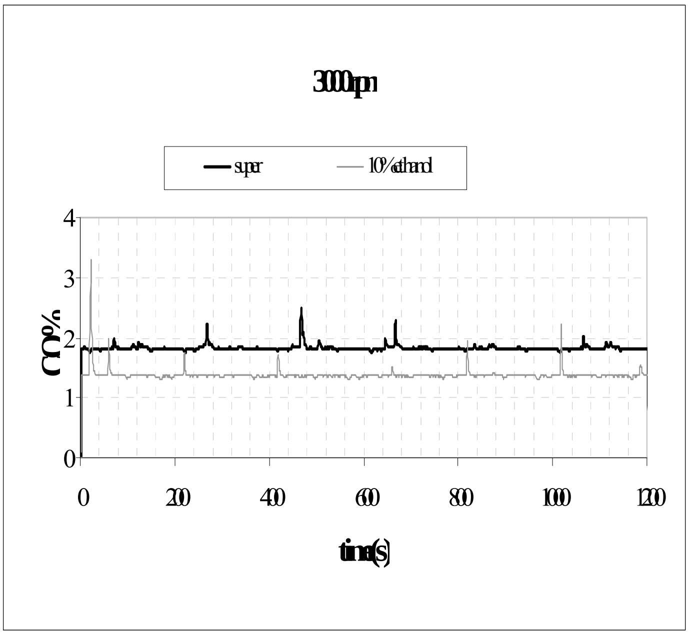

Figure 4. The CO variation at 3000rpm, for different fuels.

In Figures 2,3,4, it is observed that in the case of gasoline-10%ethanol mixture in all rpm(1000, 2000, 3000) the CO emissions are reduced. This reduction is better presented in the Table 1, which shows the average values of CO emissions. It is clear that the oxygen existing in the alcohol molecule improves the combustion of gasoline. This is more apparent in higher engine speeds.

Table 1. CO average results in relation to revolutions and the fuel mixture.

	gasoline	*gasoline-10%ethanol*
rpm	*CO%*	*CO%*
1000	0,67	0,6
2000	1,14	0,74
3000	1,83	1,38

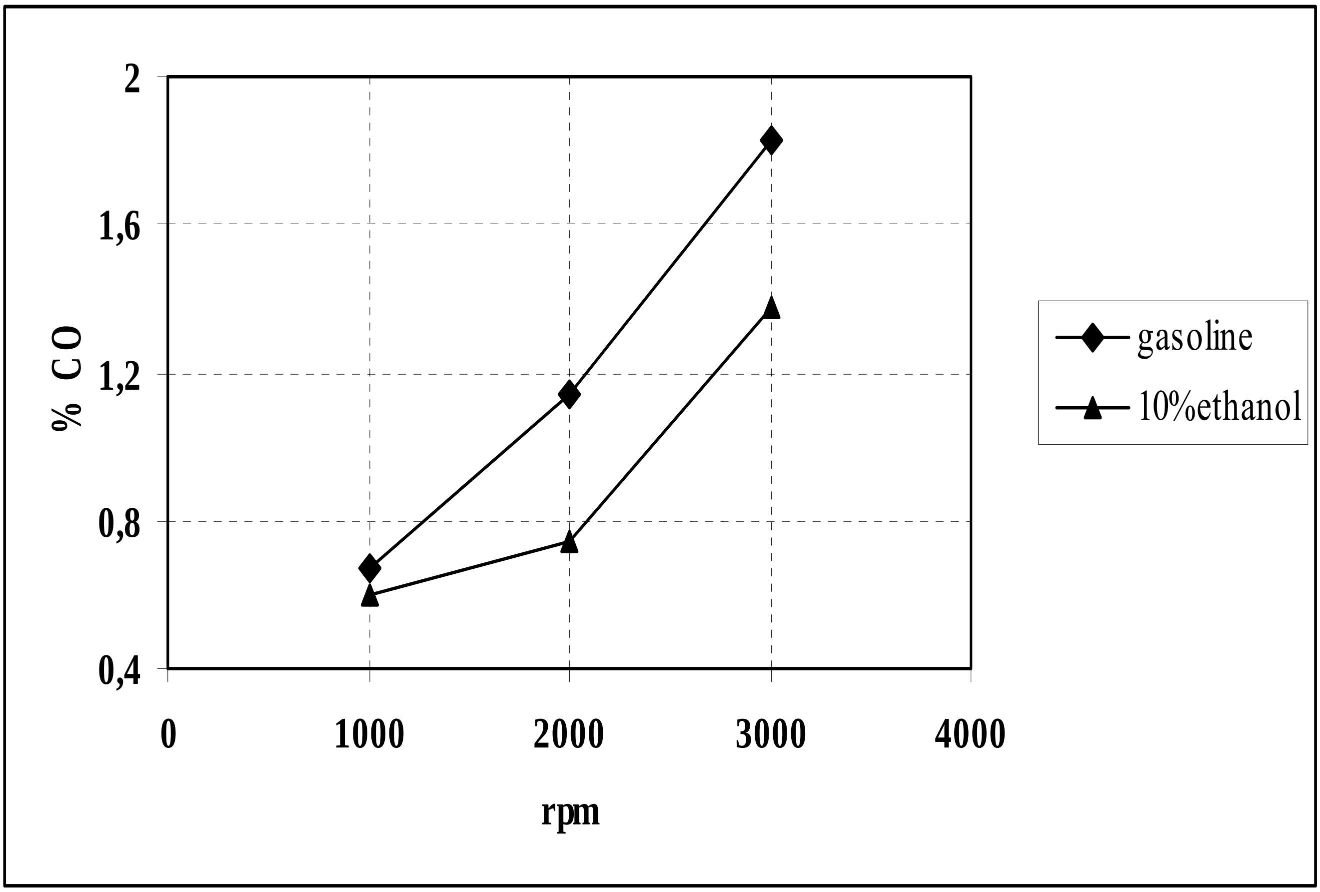

Figure . The CO average variation at differents fuels.

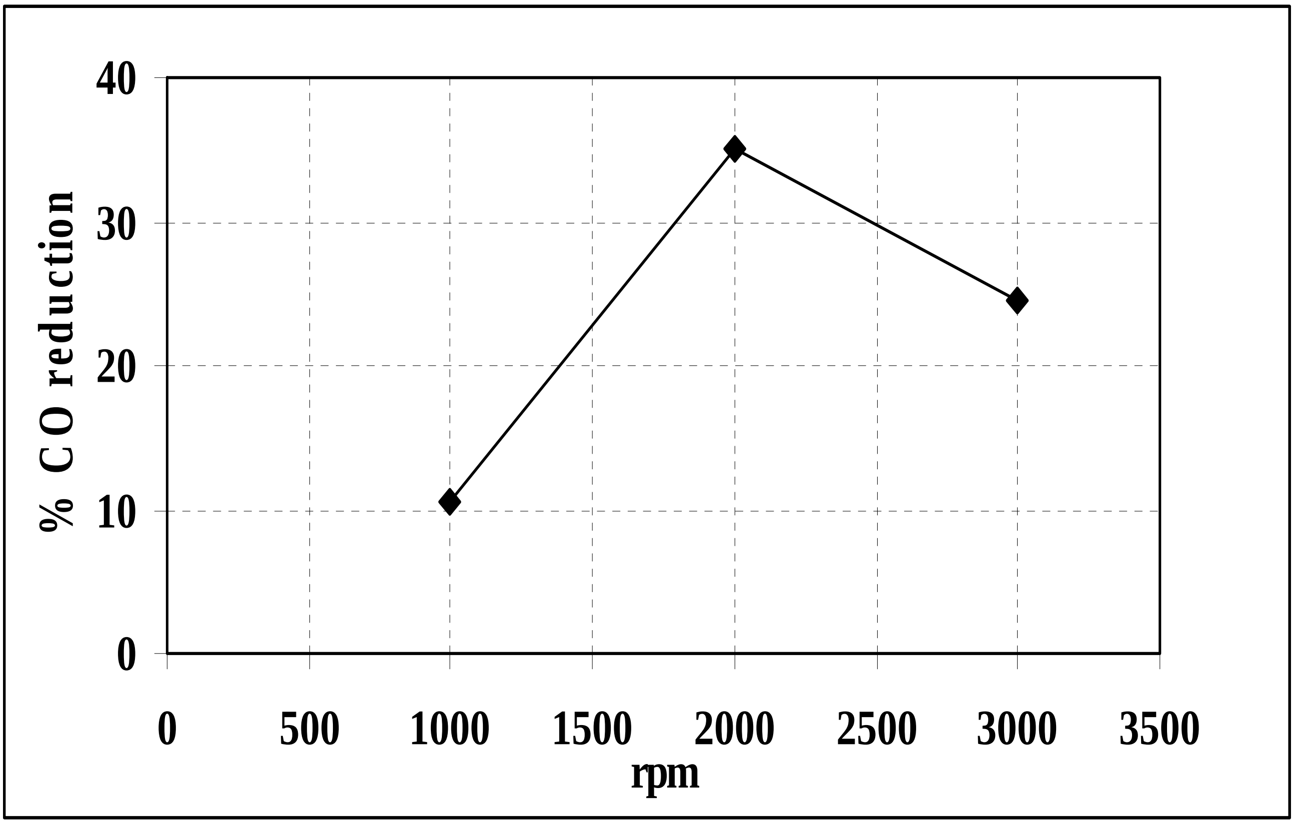

Figure The % CO reduction

Figures 5,6,7 present the HC variation in relation to engine rpm separately for each fuel.

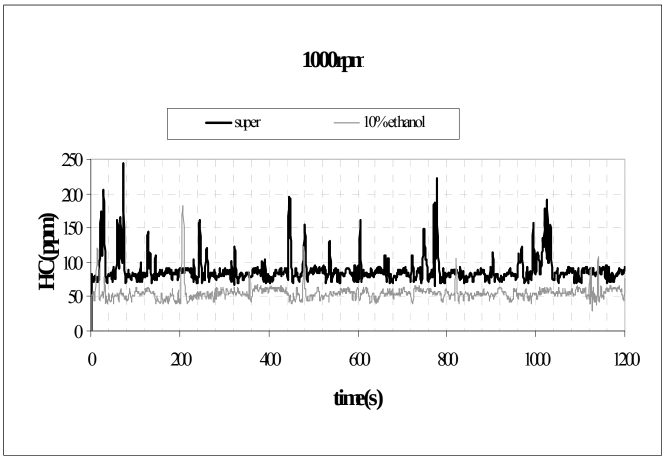

Figure 5. The HC variation at 1000rpm, for the fuels used

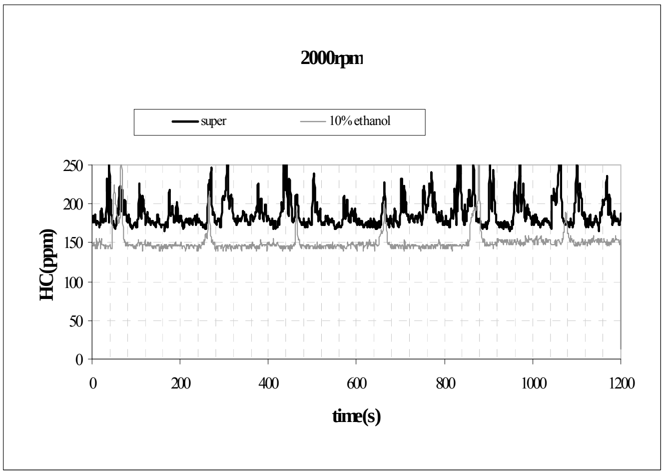

Figure 6. The HC variation at 2000rpm, for different fuels

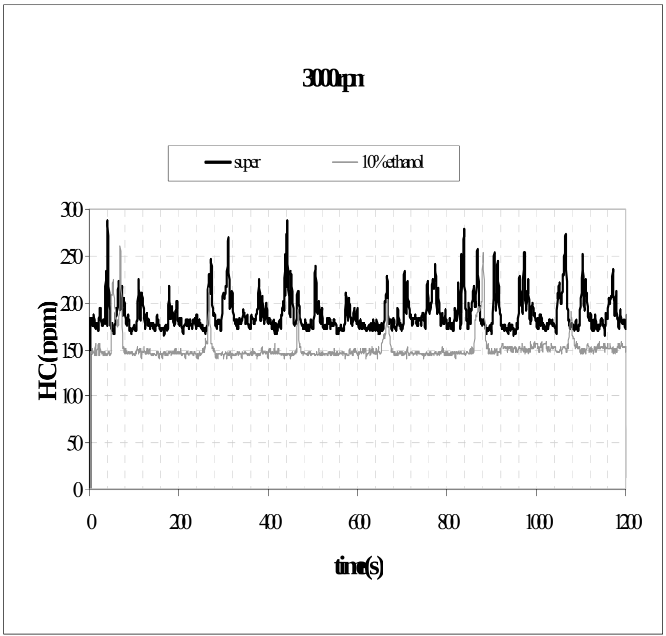

Figure 7. The HC variation at 3000rpm, for different fuels

In Figures 5,6,7 it is noticed that also in this case as in the case of CO emissions, HC emissions are reduced when gasoline-10% ethanol mixture is used. Average values are presented in Table 2.

Table 2. HC average results in relation to revolutions and the fuel mixture.

	Gasoline	***Gasoline-10%ethanol***
rpm	***HC(ppm)***	***HC(ppm)***
1000	90	56
2000	138	102
3000	188	150

From the above Figures and Tables it is observed that in the case of gasoline-10%ethanol mixture CO and HC emissions are reduced at different rpm(1000,2000,3000) and the reduction is larger at higher engine speed.. This fact is noticed due to better combustion of the gasoline-ethanol fuel obviously due to the oxygen content of alcohol.

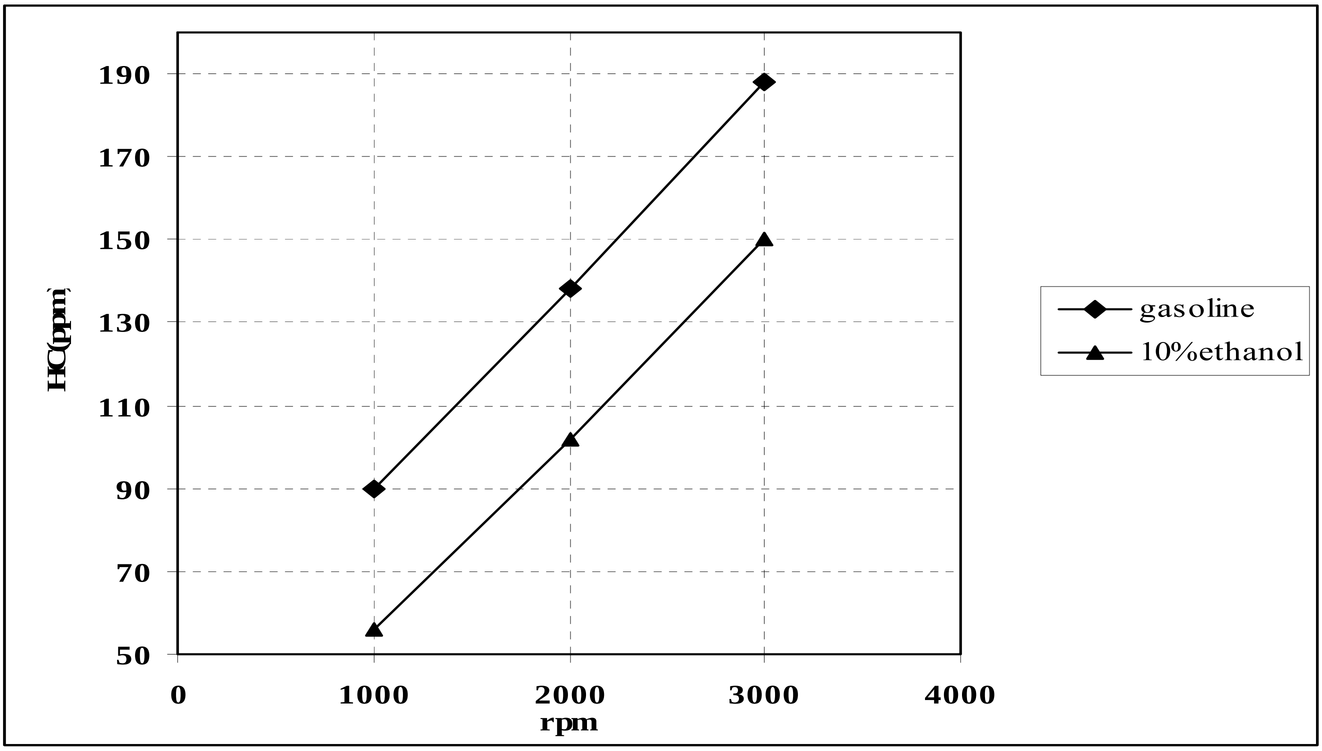

Figure 8. HC average results in relation to revolutions and the fuel mixture.

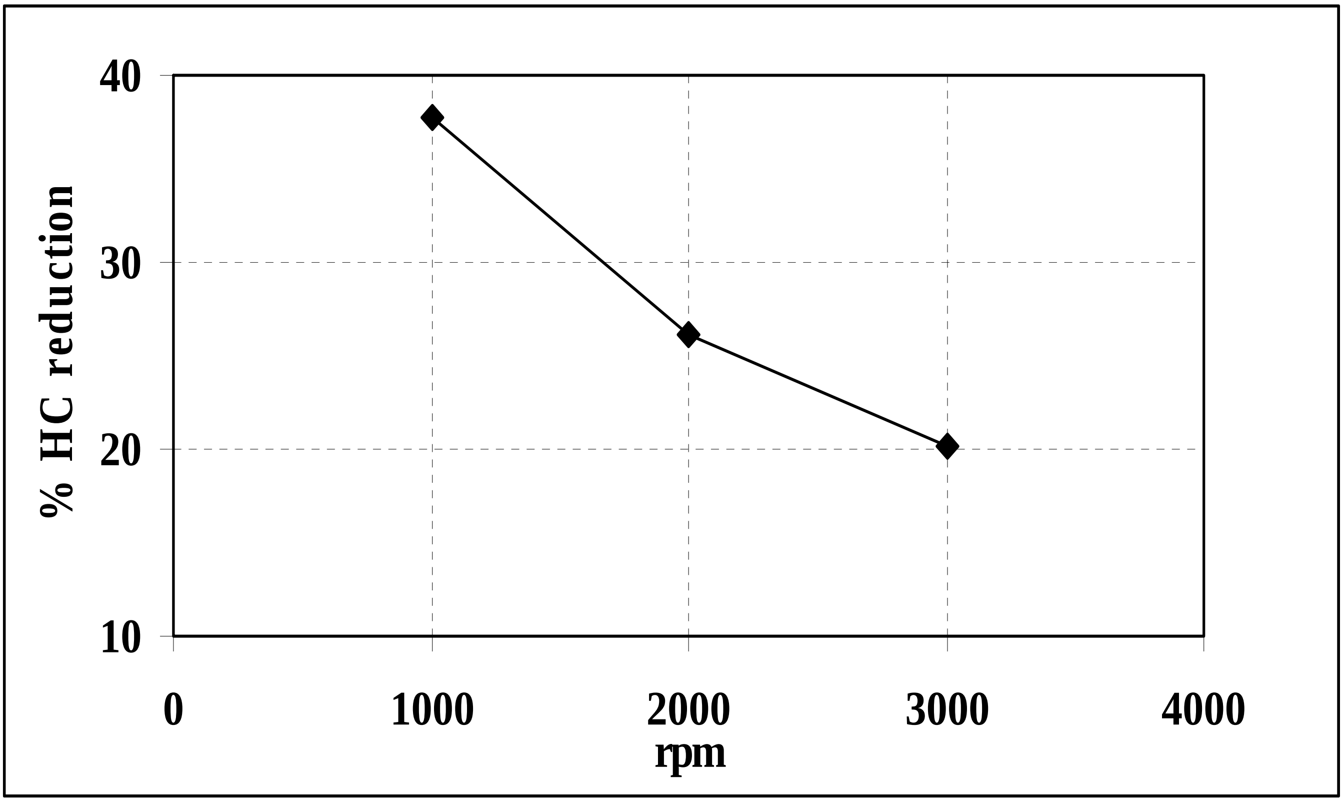

Figure 9. The %HC reduction

From the aspect of consumption it was measured in different rpm for every fuel. The results are shown in the Table 3.

Fuel used	*1000rpm*	*2000rpm*	*3000rpm*
	Fuel consumption (ml/min)	*Fuel consumption (ml/min)*	*Fuel consumption (ml/min)*
Gasoline (super)	6,41	7,54	9,23
10% alcohol	7,62	9,23	10,56

Table 3. Consumption results

Figure 10 is the graphic representation of table 3.

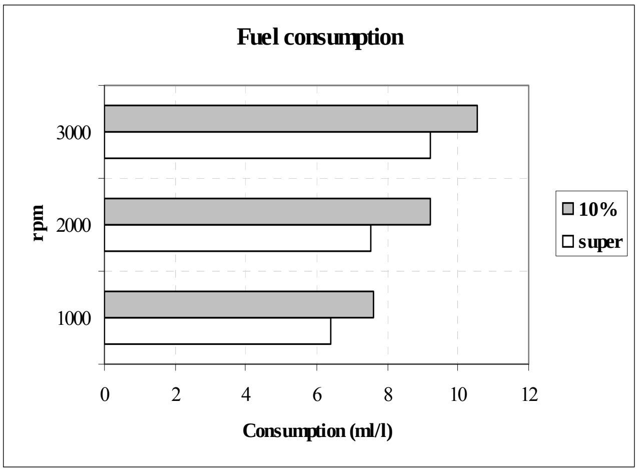

Figure 10. Fuel consumption variation as a function of rpm and fuel mixture.

Figure 4 shows that the engine consumption increases in the case of gasoline-10%ethanol mixture. This is the result of ethanol lower calorific value. This means that in order to achieve the same engine speed using pure Super gasoline, the fuel quantity in the combustion chamber must be increased when we use a gasoline-ethanol mixture.

When the consumption is maintained the same in both cases of fuels a decrease rpm was observed in the case of gasoline-10%ethanol mixture. This is shown in Table 4.

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Table 4. The rpm reduction

Consumption	***6,41***	***7,54***	***9,23***
rpm(10%)	905	1818	2719
rpm(gasoline)	1000	2000	3000

Figure 9 is the graphic representation of Table 4

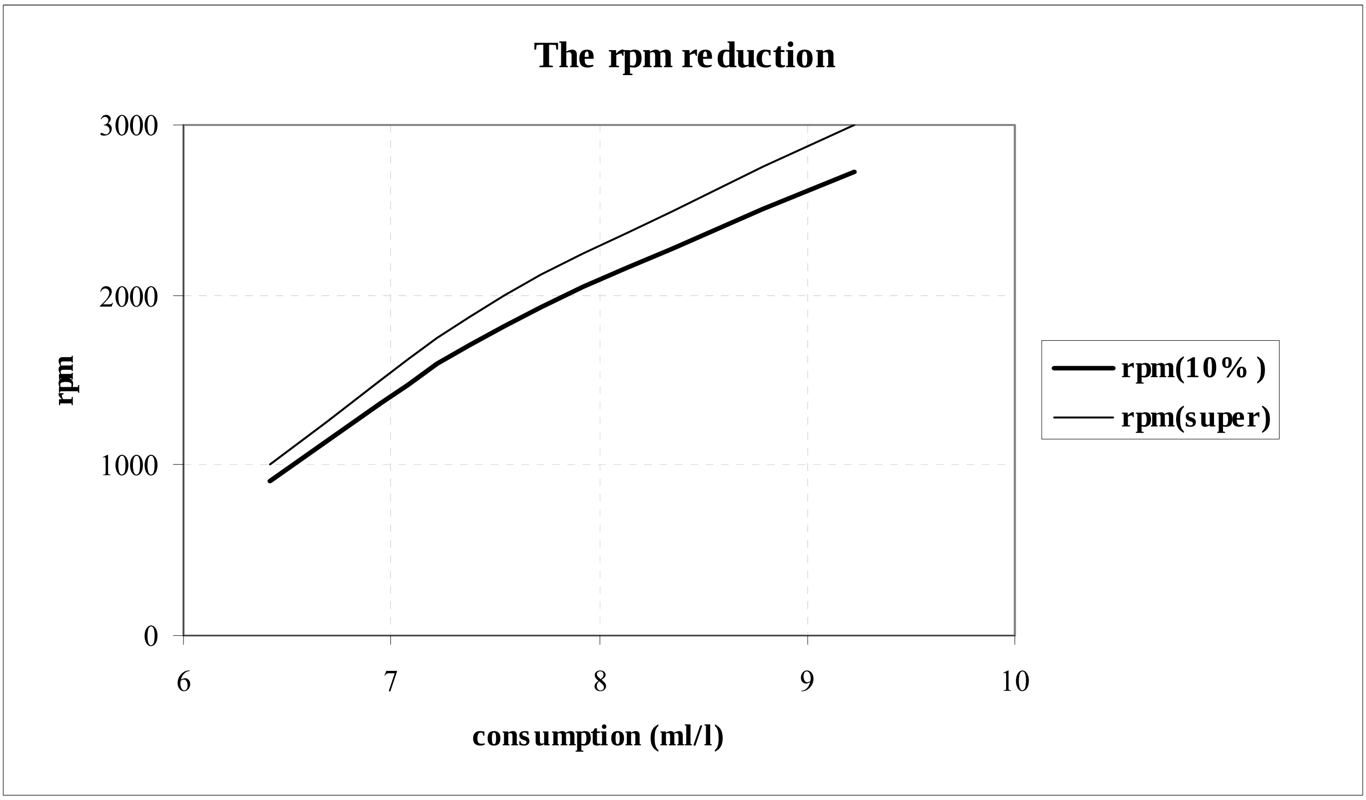

Figure 11. The rpm reduction

Engine speed reduction when gasoline-alcohol mixture was used is shown in Figure 11. The water flow and the pressure of a centrifugal pump depend on the engine rpm.

Keeping the same pressure the rpm reduction caused a power output decrease in the case of gasoline-10%ethanol mixture. The % rpm reduction for the same consumption is illustrated in the table 5.

consumption (ml/l)	6,41	7,54	9,23
% rpm reduction ***(in case of gasoline-10%ethanol***	9,5	9,1	9,37

Table 5. The % rpm reduction

Figure 12 is the graphic representation of table 5.

Figure 12. The % rpm reduction

The water flow was measured with the flow meter, with the same fuel consumption in both cases of fuels:
Table 6. The water flow in relation to rpm for this consumption when gasoline is used as fuel

Consumption	***6,41***	***7,54***	***9,23***
rpm	1000	2000	3000
Water flow(lt/min)	108	203	380

Table 7. The water flow in relation to rpm for this consumption when gasoline-10%ethanol mixture is used as fuel.

Consumption	***6,41***	***7,54***	***9,23***
rpm	905	1818	2719
Water flow(lt/min)	94	182	349

Tables 6,7 show that while the consumption is maintained stable in the case of gasoline-10%ethanol mixture, rpm and water flow decrease but not significantly.

4 Conclusion

The use of gasoline-ethanol mixture, from the pollution viewpoint, results in a CO and HC reduction. This is caused because of the better combustion and the higher octane number of gasoline-ethanol mixture[18]

The fuel consumption increases when there is alcohol in the fuel, but not significantly. In addition, it is very important that ethanol can be produced by vegetable raw materials.

The power variations of the engine, due to the use of gasoline - ethanol mixtures will be the target of future research work.

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