Measuring Techniques of Particulate PAH Emissions from Petrol Engine with High Octane Number Fuel

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Abstract

Petrol engines are widely used in variety of vehicles due to its fuel efficiency and low maintenance compared to the other fuel engines. Even though Petrol engine exhaust has less Carbon Monoxide (CO) and Hydrocarbon (HC) than Diesel engine exhaust, it posses considerable amount of Particulate Matter (PM) and Oxides of Nitrogen (NOx). Poly Aromatic Hydrocarbon (PAH) emissions from Petrol engines, as a part of Soluble Organic Fraction (SOF) of Petrol particulates, are of concern as most of them are carcinogenic.

The sample was collected by using series of water bubblers and condensate traps immersed in an ice- water bath. The soluble organic fraction, which is present in the collected sample, was extracted in the soxhlet extraction apparatus. The determination of PAH present in the Soluble Organic Fraction (SOF) was estimated by High performance Thin Layer Chromatography (HPTLC). An investigation into the effects of octane number and octane improvers on engine emissions was conducted using 11 test fuels- having octane number in the range of 89-940N

Key words: Poly Aromatic Hydrocarbon, Particulate Matter, Oxides of Nitrogen, Soluble Organic Fraction, High Performance Thin Layer Chromatography

I. INTRODUCTION

The research into the influence of Ecological petrol additives in the Automobile Laboratory Ethanol has been known as a fuel for many decades. Indeed, when Henry Ford designed the Model T, it was his expectation that ethanol, made from renewable biological materials, and would be major automobile fuel. However, it is now widely used because of its high price. But as fuel for spark-ignition (SI) engines, ethanol some advantages over petrol, such as better anti-knock characteristics and less of CO and UHC emissions. Although having these engine conditions. The sample was collected by using series of water bubblers and condensate traps immersed in an ice- water bath. The soluble organic fraction, which is present in the collected sample, was extracted in the soxhlet extraction apparatus. Since ethanol can be fermented and distilled from biomasses, it can be considered as a renewable source of energy. Ethanol blended with petrol is better than pure petrol because of its renewing ability and less toxicity.

Looking forward of Lithuania becoming a member of the EU it is very important to use a larger amount of renewing fuel. Based on economic and environmental considerations of Lithuania, we are interested in studying the effects of ethanol contents in the blended ethanol-petrol fuel on the engine performance and pollutant emission of SI engine. Twenty years age the interest in alternative fuels rose also because of the increase of environment pollution with harmful combustion products. In accordance with the EU requirements of Law of Biological Fuels Nr. VIII-1875 was passed in Lithuania of June 18, 2000 which provides for the use of spirits of vegetable origin and rape oil as raw materials.

Aspects of the use of ethanol were examined abroad and also at the Vilnius Goldmines Technical University (VGTU) [3-8].Ethanol (C2H5OH) is pure substance. However, petrol is composed of C4 C12 hydrocarbons and has wider transitional properties. Ethanol contains an oxygen atom so that it can be viewed as a partially oxidized hydrocarbon. Ethanol is completely miscible with water in any proportion, while the petrol and water are immiscible [9]. This may cause the blended fuel to contain water, and further result in the corrosion problems of the metallic components, especially of the components made of copper, brass of aluminum.

As the combustion characteristics, the auto-ignition temperature and flash point of ethanol are higher than those of petrol, it made it safer for transportation and storage. The latent heat of evaporation of ethanol is 3-5 times higher than that of petrol; this makes the temperature of the intake manifold lower, and increases the volumetric efficiency. The heating value of ethanol is lower than that of petrol. Therefore, we need 1,6 times more ethanol to achieve the same energy output. The stoichiometric air-fuel ratio (AFR) of ethanol is about 2/3 that of the petrol, so the required amount of air for complete combustion is less for alcohol (AFR for air-petrol mixture is 14.7, for air ethanol 9,07).

The air pollution caused by automobiles and motorcycles is one of the important environmental problems to be solved. Since using ethanol-petrol fuel blends can case off the air pollution and the depletion of petroleum fuels simultaneously, many researchers [3,10,11] have been devoted to studying the effect of these alternative fuels on the engine performance and pollutant emission. Palmer [12] used various blend rates of ethanol petrol fuels in engine tests. Results indicated that 10% ethanol addition increases the engine power output by 5% and the octane number can be increased by 5% for each 10% of ethanol added.

Abdel-Rahman and Osman [13] recently have tested 10% 20% 30% and 40% of ethanol is blended fuels in a variable compression ratio engine. They found that the increase of ethanol content increased the octane number, but decrease of ethanol content increases the octane number, but decreases the heating value. The 10% addition of ethanol had the most obvious effect on increasing the octane number. Under various compression ratios of engine, the optimum blend rate was found to be 10% ethanol with 90% petrol.

Bata etal. [14] Studied different blend rates of ethanol-petrol fuels in engines and found that the ethanol could reduce the CO and UHC emission to some degree. The reduction of CO emission is apparently caused by the wide range of flammability and oxygenated characteristic of ethanol. In the study[12] palmer indicated that 10% of ethanol addition to petrol could reduce the concentration of CO emission up to 30%. However, using ethanol-petrol fuel blends increases the emission of acetaldehyde and acetone 5,12-13,8 times than those or petrol. Although the emission of aldehyde will increase when we use ethanol as a fuel, the damage to the environment by the emitted aldehyde is far less than that by the poly-nuclear aromatics emitted from burning petrol. Therefore, using higher percentage of alcohol in blended fuel can make the air quality better [15] in comparison with petrol.

After the literature review, we understood that alcohol-petrol fuel blends can effectively reduce the pollutant emission without modifications of the engine. <moreover, the ethanol can be made from biomasses. These factors make it appealing to us in Lithuania. We therefore used engine test facilities to investigate the effects on the engine performance and pollutant emission of 3,5 % and 7,0% ethanol in the fuel blend and special additives ("OP" and "EKO"), which reduce emissions and increase octane rating.

II. GOAL AND METHOD OF THE RESEARCH

The opportunity occurred and a decision was made to test additives which now can be found in the market. The tests were carried out in the Maintenance laboratory of the Automobile transport department of VGTU for two cars. Golf IV 1,6116V (car number plate RVP 420) and VAZ-21093(car number plate NVR 641). Test speed 60 km/h, loading 10,15,20 kW and maximum power, "run" on the chassis dynamometer. For normal engine temperature conditions of fan, blowing to the car from the front was arranged. Feeding systems were felt unchanged.

Engine exhaust gases were measured by the analyzing meter AVL DiGas 465, fuel consumption by the instrument AIC 2022L-Jetronic, engine power, torque and power on wheels by the chassis dynamometer MAHALPS 2000. Instrumental errors not exceeded from 1% to 2%. There are notations used in the text of the fuel blends in table.

Experiments were carried out after heating of engine and transmission oil by "run" on dynamometers drums with one person inside the car. For better accuracy every experiment was repeated for all planned meanings. With the purpose of reduction of the influence of ambient conditions on the experiment results, the experiments for every car were carried out on the same day.

Table : The notations of the fuel blends:

Column headings	Meanings.
3,5 % E -	Blend of petrol and 3,5% ethanol;
7,0 % E	Blend of petrol and 7,0% ethanol;
3,5 %E	Blend of petrol and 3.5% ethanol with patented leadless antiknock additive.
7,0 % OP	Blend of petrol and 7,0% ethanol with patented leadless antiknock additive;
1 % EKO	Blend of petrol and 1% ethanol with patented additive, reducing the amount of harmful components in the exhaust gases.
2% EKO	Blend of petrol and 2% ethanol with patented additive, reducing the amount of harmful the amount of harmful components in the exhaust gases.

III. RESULTS

After the measurement of the car power it was established, that the use of ethanol based additives in creased the VAZ 21093 engine power (Fig 1), but the maximum power of VW Golf car engine was reached when petrol without additives (Fig 2) was used. Changes of harmfulness of the engine exhaust gases at run speed 60 km/h for different fuel blends and loadings are shown in fig. 3-6.

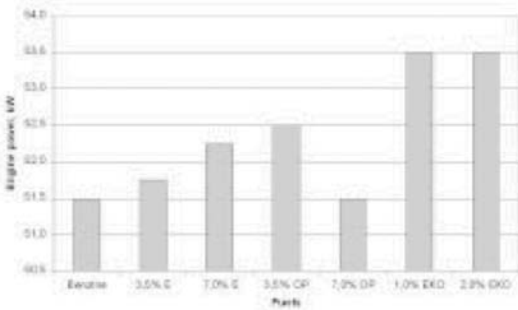

Fig 1 Dependence of VAZ - 21093 Engine Power on The Sort of Fuel

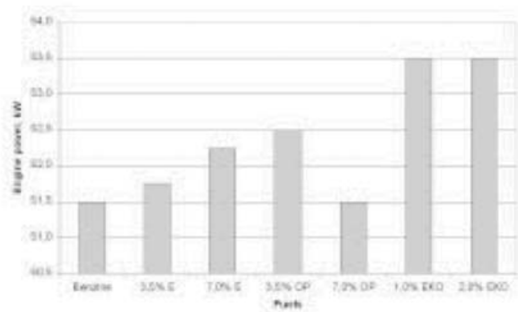

Fig 2. Dependence of VW Golf IV 1.6 116V Engine Power on the Sort of Fuel

Fig.3 shows that almost in all cases CO emission is the highest when petrol without additives is used. It is so because of the use of the ethanol-based additives, having up to 36% of oxygen, which improves combustion.

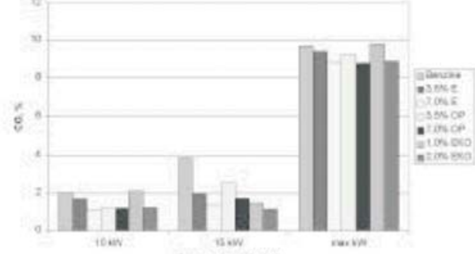

Fig. 3 Dependence of CO emission on the sort of fuel at run speed 60 km/h and different load for VAZ-21093 car

Fig. 4 shows that catalytic converter absolutely neutralizes the CO gases for VW Golf, when the car runs with the partially pressed accelerator, and only at full opening of the throttle the control unit enriches the intake mixture, and CO appears in the exhaust gases. The Experiments showed that the maximum amount of CO was when the engine is fed by petrol.

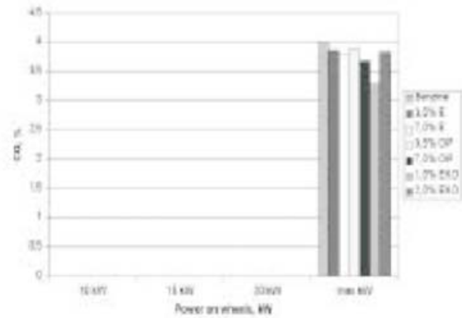

Fig 4. Dependence of CO Emission on The Sort of Fuel At Run

Figs 5 and 6 show changed in fueled consumption when different additives were used. Fig. 5 shows fuel consumption of VAZ car. As the car prepares the combustion mixture in the carburetor, the steep ascend on the graph takes place at maximum loading because of activation of the economizer. The graph shows that maximum fuel consumption corresponds to petrol without additives. Graph on Fig 6 shows (although insignificant, but difference can be seen), that maximum fuel consumption corresponds to 7%E blend. It can be understood, for the heating value of ethanol is more than two times less, if compared with petrol, therefore more fuel is necessary for the same power.

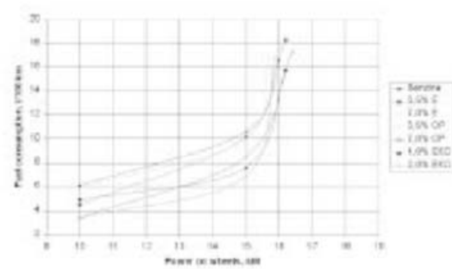

Fig.5 Dependence of fuel Consumption on the Son of Fuel At Run Speed 60 Km/h and Different Lead for VAZ-2 1093 ear

It can be seen that for power of 10,15and 20kW all additives had no significant influence on fuel consumption. For the maximum power (about 25 kW) the use of the 7,0% E blend reduced the engine power, but fuel consumption reached the maximum value. The average deviation of the specific fule consumption for the maximum power for all blends did not exceed 0.18V 100 km. The largest difference of the consumptions was

18,317,2 = 1,11/100 km.

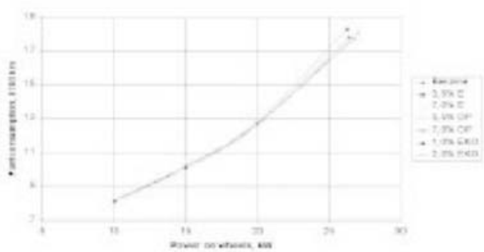

Fig. 6 Dependence of Fuel Consumption on the Sort of Fuel at Run Speed 60km/h and Different Load for VW Golf IV 1.61 16V car

IV. CONCLUSION

The maximum power and the maximum torque were reached with the "EKO" additives for VAZ engine and petrol without additives for VW Golf engine. The maximum CO emission in the exhaust gasses in almost all cases was with pure petrol (for the both cars).The maximum fuel consumption was : for VAZ car working with pure petrol and for VW Golf car with 7,0%E blend. It was observed that ethanol-based additives have different influence on power and ecological indications of cars with different feeding system. The generalizations of these research results do not allow asserting, that the "EKO" additive reduces the amount of harmful components in the exhaust gases. We suppose that ethanol, which was present in all the additives tested had some positive influence on the exhaust toxicity there.

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