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CONSIDERATIONS ABOUT FUEL QUALITY USED IN MOTOR VEHICLES

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Abstract: *The present paper is a result of complex theoretical and experimental research made in time (at the Automotive Department of the Technical University of Cluj-Napoca) with the purpose of highlighting the quality of fuels in Romania. The physical and chemical properties are studied along with the soot deposits on the quartz liner and piston of a single cylinder research engine from AVL, and also the soot formation during an engine cycle.*

Keywords: Fuel, gasoline, Diesel, research engine

INTRODUCTION

It is known that for using fuels in an internal combustion engine, the fuel needs to fulfil certain requirements like: to ensure the safe and fast starting of the engine at any given ambient temperature; to allow a safe functioning of the engine at a high efficiency; to avoid producing high mechanical and thermal wear; to burn completely without producing harmful substances; not to corrode the materials that it comes in contact with; to allow transportation and storage without difficulty, without danger; to maintain its temperature in time, and others. Currently, liquid fuel is the one that best meets these requirements.

Fuels and lubricating oils for engines fitted in road vehicles are composed of mixtures of hydrocarbons derived from processing oil.

Hydrocarbons extend over a wide range of distillation, from the most volatile, to the heavy, non-volatile hydrocarbons that are found in the distillation residues. Beside hydrocarbons, heavier fuels and oils contain small proportions of substances that consist not only of carbon and hydrogen, that form the hydrocarbons, but also other substances. The most frequent one is sulphur, nitrogen and oxygen and some metals (in a very small amount) that form a complex and non-volatile molecule.

In addition to these petroleum based products, in the last years products that contain oxygen have been used more and more, like alcohol (methyl and ethyl) for spark ignited engines and vegetable oil based fuels for Diesel engines.

Characterisation of fuels for internal combustion engines is necessary for their use in different conditions, depending on the operating modes for which the internal combustion engines are designed.

Since fuels consist of hydrocarbon blends, their properties fall into two categories: physicochemical properties and performance characteristics (behaviour).

The physical and chemical properties are determined generally by conventional methods. They are relatively easy to determine in the laboratory, serve mainly for production control or identification purposes, and are included in the delivery conditions (density, distillation curve, viscosity, and others).

Some physicochemical properties of the fuel influence the processes taking place in the engine (fractional composition, density, viscosity, surface tension and ignition, calorific value, cetane number, octane, coke, and others), other properties influence the engine wear (mineral and organic acid, sulphur content, water, ash, dirt, mechanical, presence of metals, corrosive property) while others influence the transport and storage (freezing point, filterability, tolerance to water).

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Performance characteristics usually consider complex phenomena, which cannot be always examined using easy and rapid laboratory methods (resistance to flow at low temperatures, the behaviour in operation in various conditions of load, speed, temperature range and others).
Some of the performance characteristics can be determined using complex laboratory methods (corrosive property, resistance to oxidation and others). The performance of fuels can be made on special dynamometer testbeds equipped with electronics that allow provide automatic scheduling of test cycles. In some cases, the obtained results are verified on operating vehicle engines, in a larger period of time.

EXPERIMENTAL RESEARCH

The determination of the quality of fuels for vehicles marketed and used in Romania was made for both gasoline and diesel, using specific physicochemical determination methods and also by testing the fuels on a single cylinder engine that has a quartz combustion chamber and a high speed camera that filmed inside the combustion chamber (which allowed the visualisation of the soot formation inside the combustion chamber).
The determination of the properties in accordance with the SR EN 228 standard was performed for four samples of COR 95 gasoline, from four different gas stations.
The octane determination test (by comparison to a known blend with CO) was performed on a a single cylinder research engine with variable compression ratio and the results for the octane number were: for the sample from the first station, the octane number is 96.7, for the sample from the second station the octane number is 96.4, for the sample from the third station the octane number is 96.2 and for the sample from the forth station is 96.1 (figure 1).

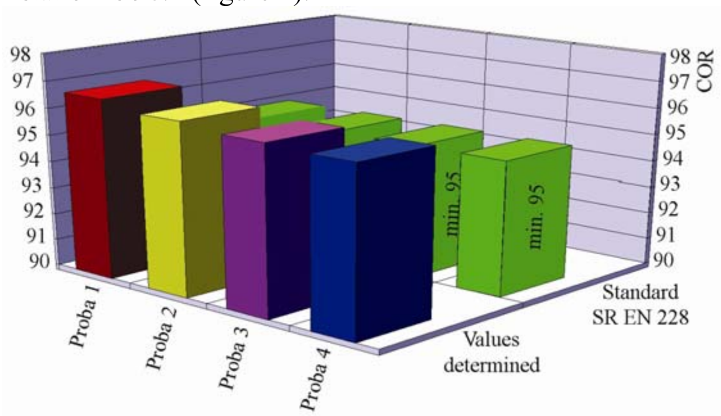


Figure 1. Octane number determined for the four samples of gasoline

The determination of the density of the four samples of gasoline was made using the Stabiner SVM 3000/G2 viscometer, and the results are presented in figure 2. Even though the standard density is between 720 and 775 Kg/m^3, almost all samples have values close to the maximum value of the standard.

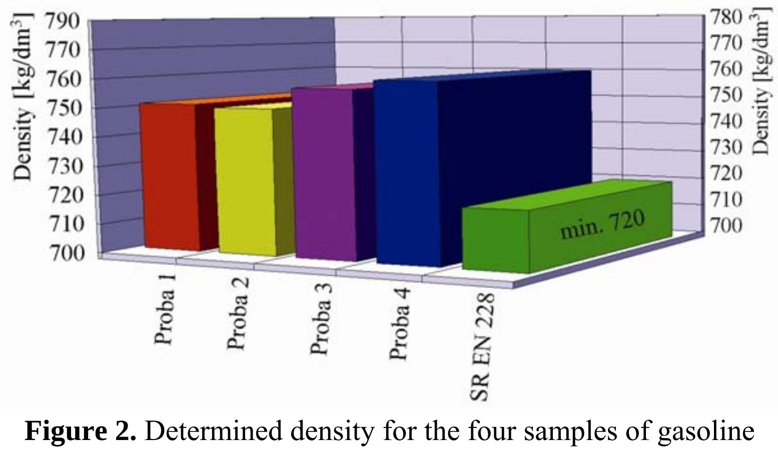


Figure 2. Determined density for the four samples of gasoline

Like in the case of gasoline, also Diesel was analyzed, with samples from the same four gas stations. The cetane number of Diesel was determined on a four cylinder engine with variable compression ratio and indirect injection in a precombustion chamber. The results are presented in figure 3 in comparison to the SR EN 590 standard. Raising the cetane number (with more than 20 units) an important reduction of NO_x can be ensured. The inadequate values of the cetane number (see sample 4) favors the calamine deposits and the growth of the free carbon concentrations in the exhaust gases.

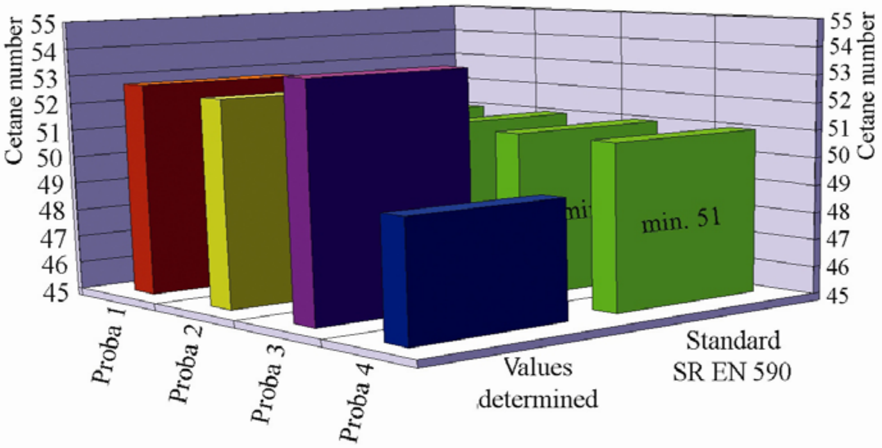


Figure 3. Determined cetane number for the analyzed samples of diesel

By analyzing figure 4, in which the density determination results are presented for the four samples of Diesel, it can be seen that all values are according to the standard between 820 kg/m^3 – max. 845 kg/m^3, but they are close to the maximum accepted value. The high values of the density (caused by the heavy fractions content) determine the growth of the Diesel droplets, also the fuel jet penetration rises, the resistance to self-ignite rises and the rise of the calorific value.

Also the finesse of the pulverization, the uniformity of the jet and the dispersion angle shrink. The influence of fuel density on particle emissions is significant especially in the case of transitory load (for a growth of 5% for the density, the particle emissions grow with 90%). When the engine is working in the full load domain, the influence of the fuel density is diminished.

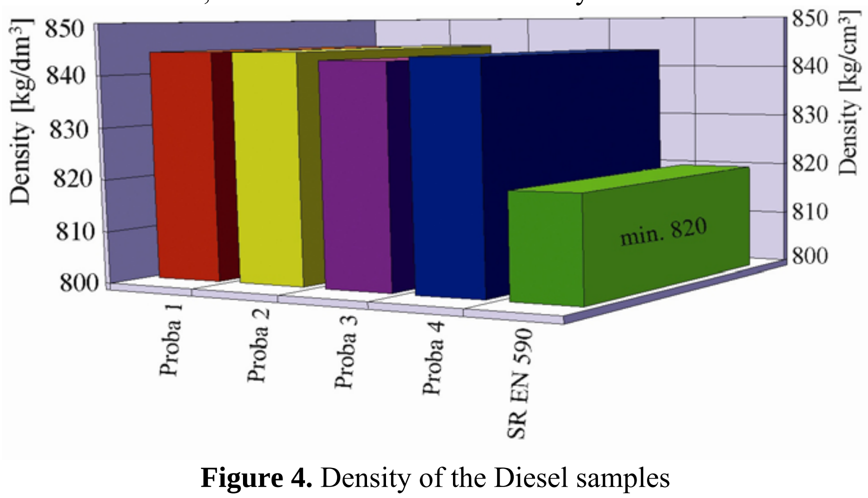
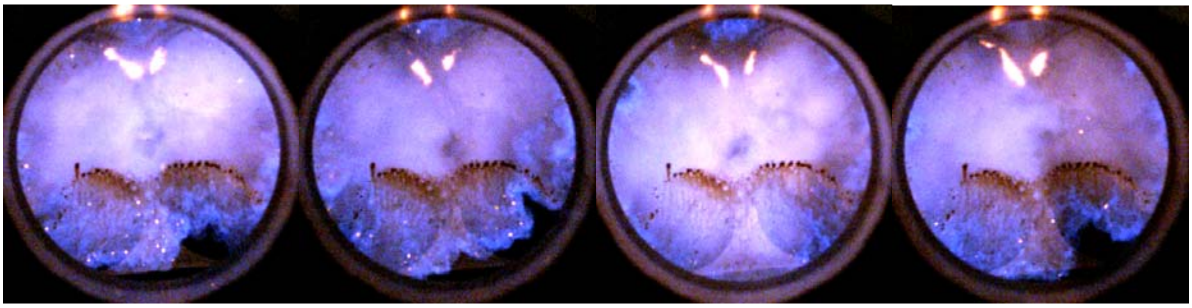


Figure 4. Density of the Diesel samples

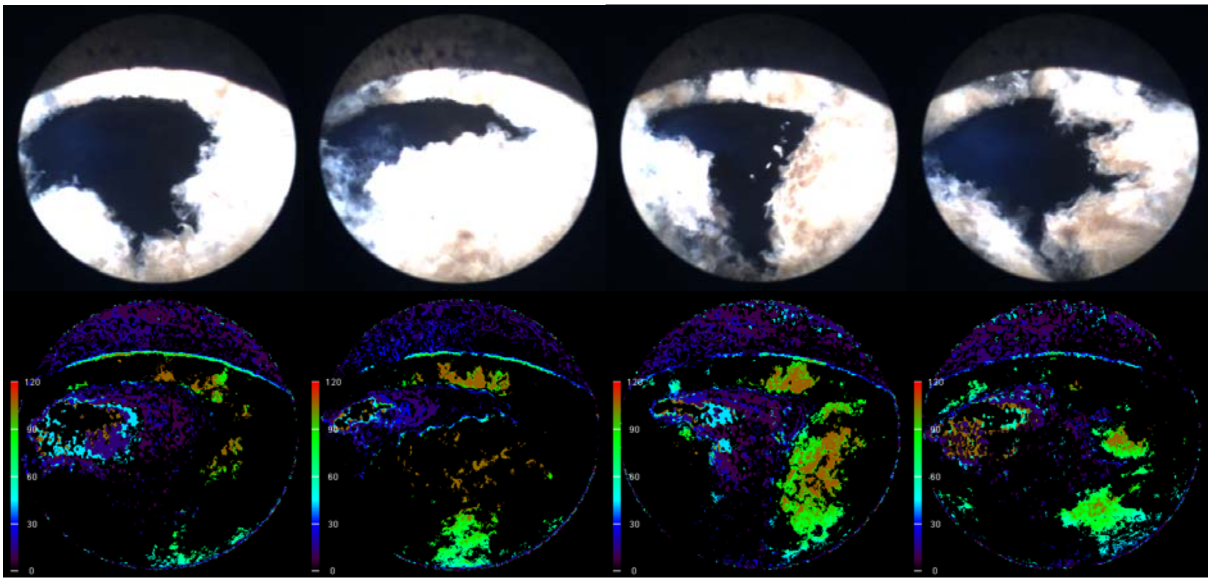
In order to analyze the burn of gasoline, the AVL single cylinder research engine was used, from the Testecocel Laboratory of the Technical University of Cluj-Napoca, and the used sample was sample number 2, because it has the lowest density. The soot deposits can be seen in figure 5 – the soot deposits are formed really quickly.



after 31°CA **after 32°CA** **after 33°CA** **after 34°CA**

Figure5. Soot deposits in the gasoline engine

In order to evaluate the burn of diesel the AVL Diesel engine was used, also from the Testecocel Laboratory of the Technical University of Cluj-Napoca, and the used sample was sample 2. By using the endoscopic camera, the soot formation was analyzed for the studied sample. The evolution of the flame is presented in figure 6 and by using the Thermovision software, the photos from the chamber were analyzed and the soot formation is calculated.



11°CA **12°CA** **13°CA** **14°CA**

Figure 6. Soot formation analysis for the Diesel engine

CONCLUSIONS

Because the physicochemical properties of fuels used in internal combustion engines are standardized, with this paper the authors wanted to present a small part of an experimental research using samples from gas stations in our country.

It can be seen that the four samples of gasoline, and the four samples of diesel (from different producers), are generally corresponding with the standard, except the cetane number for the sample 4 – that has a value of 49.6, under the limit of 51.

The high values for the density (for gasoline and also for diesel) and the soot formations that appear raise some question marks.

Unfortunately, the personal interest (winning at all costs) of many entrepreneurs do not take into account the conditions of use of fuels and especially the effects they can have on the internal combustion engines.

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