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THE IMPACT OF TIRANA'S GASOLINE CARS ON THE AIR POLLUTION BY UNBURNED HYDROCARBONS

EDLIRA F. MULLA[a], ANGJELIN SHTJEFNI[b], ANDONAQ LONDO[b]
[a] Department of Chemistry. Polytechnic University of Tirana, ALBANIA.
[b] Department of Energetics. Polytechnic University of Tirana, ALBANIA.
Email: edimulla@gmail.com

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PERMBLEDHJE
Parku i automjeteve të Tiranës me mbi 77% makina nga 144280 automjete të regjistruara deri në fund të vitit 2009, më pak se 25 % e të cilave përdorin benzinë është një nga kontribuesit më të rëndësishëm për çlirimin e hidrokarbureve të padjegur (CxHy) në ajrin urban. Përqendrimet e CxHy, të pranishëm në gazet që çlirohen gjatë djegies së benzinës në motor kur makina është e ndalur në vend u mat për 121 makina me benzinë të prodhuara para vitit 1986, 425 makina të prodhuara gjatë periudhës 1987 – 1995 dhe 499 makina të prodhuara pas vitit 1996. Mosha mesatare e makinave të testuara ishte 25.3; 16.56 dhe 9.52 vjet respektivisht. Rezultoi se 5.8 %, 5.9 % dhe 3.0 % e makinave çliruan CxHy në gazet e djegies më shumë nga sa e lejon norma e miratuar për kategorinë e tyre (në ppm), e përcaktuar sipas vitit të prodhimit të tyre. Ekzistenca e një norme tolerante për makinat e vjetra, e kombinuar me mosmirëmbajtjen e duhur është arsyeja për nivelet e larta të CxHy në rrugët me trafik të rënduar në Tiranë.

SUMMARY
Tirana's vehicle fleet with over 77% cars out of 144280 registered vehicles in the end of the year 2009, less than 25% of which use gasoline is one of the significant contributors to the release of unburned hydrocarbons (CxHy) in the urban air. The CxHy concentrations, present in the exhaust gases released during combustion of gasoline at idle conditions were measured for 121 gasoline cars produced before 1986, 425 cars produced during 1987–1995 and 499 cars produced after 1996. The average age of tested cars was 25.3, 16.56 and 9.52 years respectively. It resulted that 5.8%, 5.9% and 3.0% of cars emitted CxHy in their exhaust fumes more than the approved norm (in ppm) for their category, determined by their production year. Existence of a tolerating norm for old cars, combined with the lack of proper maintenance is the reason of the increasing concentrations of CxHy in Tirana's heavy-traffic sections.
Key words: gasoline cars; exhaust fumes; unburned hydrocarbons; air pollution

INTRODUCTION

Tirana has the greatest number of road vehicles compared to other Districts of Albania. Till the end of the year 2009, in Tirana there were registered 36.2 % of road vehicles and 39.6 % of cars of all the country, as Figure 1 shows [1]. Besides its own vehicles, an additional over 30000 vehicles from other Districts circulate daily in the roads of the Albanian capital. From Figure 2 it is noticed that the number of other types of road vehicles has known very little increase compared to the constant and rapid increase of the number of private cars.

Although the gasoline cars do not constitute more than 25 % of the whole cars' fleet, the trend of purchasing gasoline vehicles is increasing in the last years. Figure 3 shows that the brand new cars purchased in the period 2006–09 are about 50 % gasoline and 50 % Diesel vehicles [1].

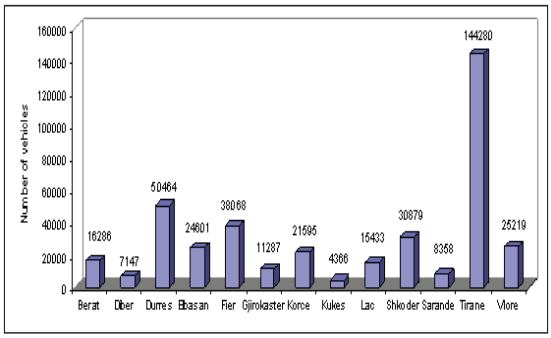

Figure 1. Number of vehicles registered in the regional Directories of Road Transport till 1 January 2010.

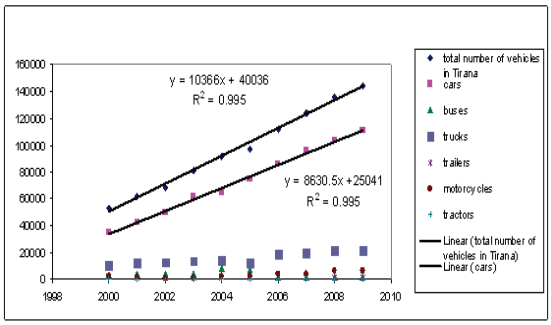

Figure 2. Progress in years of the number of vehicles according to their kinds, for Tirana District in the period: 2000-2009.

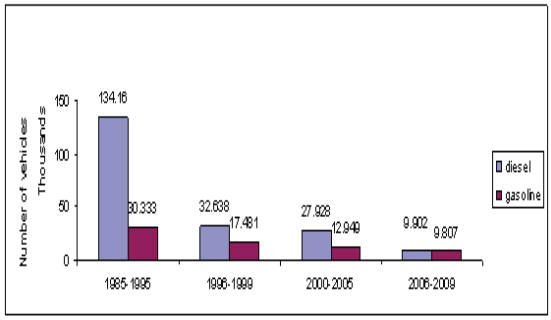

Figure 3. Vehicle fleet composition in Albania regarding the production years and the type of fuel till the end of 2009.

The incentive to perform such a study came from the very high levels of benzene (C_6H_6), which are much higher than the WHO recommendations in almost all monitoring points of Tirana, as is shown on Figure 4 [2]. Benzene is only one of the components under the category of air pollutants named "unburned hydrocarbons" which are emitted by gasoline cars. The well-known problem of having high air concentrations of benzene and other unburned CxHy is the adverse health effects that they have on humans. Benzene levels were especially high at the monitoring sites located close to streets with high traffic intensity in Tirana [2, 3].

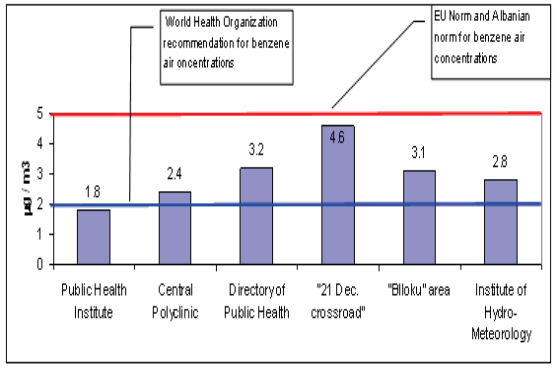

Figure 4. Concentrations of benzene in the air of Tirana. The monitoring results of 2008 by Public Health Institute.

Factors that contribute to the unburned CxHy in the air of Tirana are: vehicles' age, the presence of the catalytic converter in cars, gasoline quality and vehicles' maintenance. As shown in Figure 3, more than 50 % of the gasoline cars in Tirana are produced after 1996. Therefore the majority of these cars could be equipped with the catalytic converter.

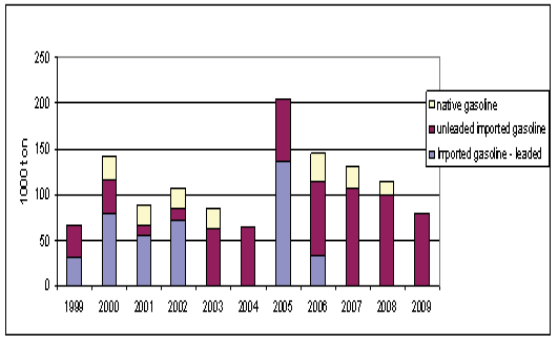

Figure 5. The progress in years of the quantity of the gasoline traded in Albania.

The gasoline used by vehicles in Albania comes totally from import. The quantities of gasoline of different types are presented in Figure 5 below. Fuel quality in general has been a challenge in Albania. This means that if the gasoline contains lead or sulfur in it, the catalytic converters of gasoline vehicles cannot function properly. Therefore exhaust fumes are expected to contain considerable levels of CxHy.

The governmental controlled vehicle inspection service in Albania requires the monitoring of the gaseous pollutants which are released into the air with the exhaust gases during the engine operations [4]. Concentrations of CxHy were quantified using gas-analyzers which do not specify the chemical composition of the CxHy. As a result, only the total concentrations of total CxHy are reported in this study. The norms of CxHy allowed to be present in the exhaust fumes, *in power during the time of this research,* are presented in Table 1.

Production year	Fuel type	Engine load Rot/min	Pollutants measured
			CxHy ppm
Before 1. 10. 1986	Gasoline	Without engine load 800–1000	800
After 1.10. 1986 till 30. 12. 1995	Gasoline		600
After 1. 01. 1996	Gasoline	Without engine load 800–1000	300
		On engine load 2000-2500	250

Table 1. The allowed norms for the unburned hydrocarbons that are released with the exhaust gases from the gasoline vehicles according to their categories.

The objective of the study was to evaluate the levels of CxHy emitted by gasoline cars in Tirana and their impact on the air concentrations of CxHy. The target group were 1045 gasoline cars with an average age at the moment of testing of 14.21 years old, ranging from 25.3 to 9.52 years old. There are three vehicle categories based on their production years, as described on Table 2 below.

Total number of cars tested	Production time period	Average age in the moment of purchase (years)	Average age in the moment of testing (years)
121	before 31 Dec. 1986	15.09	25.3
425	1 Jan. 1987-31 Dec. 1995	10.52	16.56
499	after 1 Jan. 1996	7.53	9.52
1045		9.62	14.21

Table 2. Detailed description of the target group according to their year of production.

MATERIAL AND METHODS

It is worth mentioning that this is the first time that such a research has been undertaken in Albania. Because there are not many published data, information on the fuels' quantity, vehicle numbers and benzene air concentrations was obtained from various Governmental Institutions, such as Ministry of Public Works, Transport & Telecommunication, Ministry of Finance, Agencies and Directorates as presented in the Bibliography.

The experiments were performed at the Center for Technical Inspection of Vehicles in Tirana by using the STARGAS 898 Global Diagnostic System [5, 6].

Car testing was done in idle conditions with the engine running at 800 – 1000 revolutions per minute (rpm) following the Guideline No. 6527 dt. 24.12.2004 issued by the Minister of Environment and Minister of Transports and Telecommunication [4]. Because in the documentation of the vehicles issued by the General Directory of Services to the Road Transport there is no information regarding the

presence of the catalytic converter or of the Lambda probe, during this research it was taken into consideration only testing without engine load regardless the production year of cars tested.

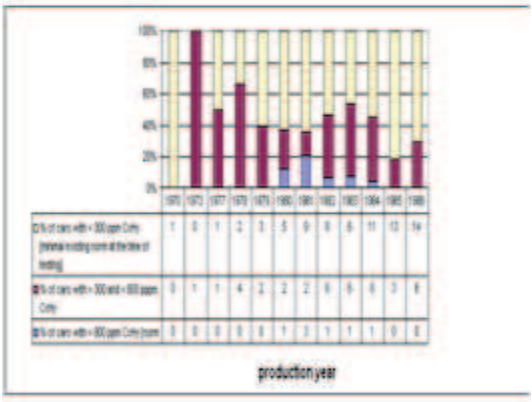

Figure 6. The percentage (and the number) of gasoline cars produced before the year 1986, which had concentrations of CxHy above the norm of their category and above the minimal existing norm.

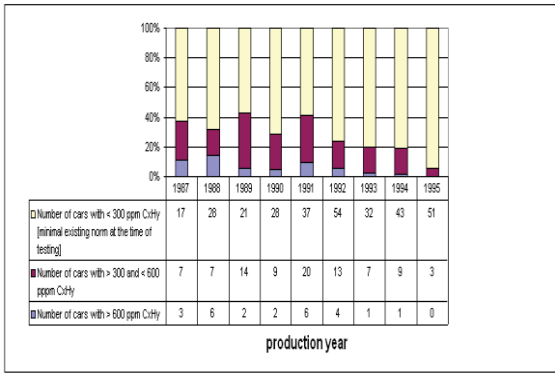

Figure 7. The percentage (and number) of gasoline cars produced in the period 1987 - 1995, which had concentrations of CxHy above the norm of their category and above the minimal existing norm.

RESULTS AND DISCUSSIONS

The number (and percentage) of cars which emitted more CxHy than the norm for their category, as well as the number (and percentage) of cars which emitted more CxHy than the minimal existing norm at the moment of testing are presented in Figures 6, 7, 8 respectively for each vehicle category.

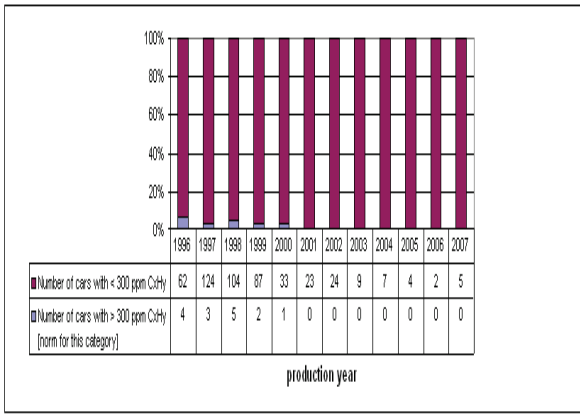

Figure 8. The percentage (and the number) of gasoline cars produced after the year 1996, which had concentrations of CxHy above the norm of their category, (the minimal existing norm).

The results of the impact of production year of cars on the average concentrations of CxHy for the entire target group are shown in Figure 9.

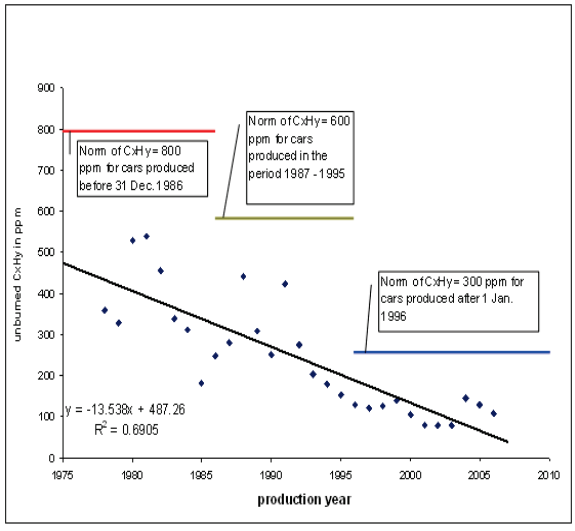

Figure 9. The dependence of average concentrations of CxHy (in ppm) from the year of production for the entire target group of gasoline cars included in this study.

As it is shown on the Figures 6, 7, 8, only 15 cars produced after 1996, had exhaust gas with concentration of CxHy above 300 ppm, whereas 41 cars produced before 1986 and 89 cars produced during 1987-1995 exceeded this level. These "polluting cars" have been allowed to circulate freely on the roads, although the concentration of their CxHy was much greater than 300 ppm, because they emitted less CxHy than the allowed norm for their categories, 800 ppm and 600 ppm respectively.

It is obvious that the average concentrations of CxHy emitted by newer cars are much smaller compared to the ones emitted by older ones (Figure 9). The presence of the catalytic converters on new cars could be one of the main reasons for it, because it conditions the drivers to purchase good quality gasoline for their new cars. In fact, the survey carried out with the drivers, in parallel with this research, showed that the economical state of the owners in general defines directly the age of car at the moment of purchase, the frequency and the quality of maintenance service rendered to their vehicles, the gasoline quality they use daily, and indirectly the level of pollutants emitted by their cars.

Since 2007, in accordance with the Decision of the Council of Ministers No. 147, dt. 21. 03. 2007 the imported gasoline in Albania has been unleaded [7, 8]. Based on a former research [9], the gasoline samples analyzed resulted unleaded, whereas the sulfur content on the same gasoline samples resulted much higher than the EURO 5 standard. According to other research [10] vehicle catalysts are sensitive also to the sulfur content in gasoline. This may explain the presence of relatively high concentrations of CxHy on the exhaust fumes even from new cars, whose drivers may not have used good quality gasoline on daily basis.

The Albanian norms based only on the production year of cars, and the favoritism for the cars produced before 1995 has not helped so far to solve the problem of high C_6H_6 air concentrations, which are a challenge for certain cross-roads in Tirana [11]. From similar research elsewhere [12], it is known that high benzene air concentrations derive primarily from the CxHy emitted by cars due to gasoline combustion. In several EU cities, benzene air concentrations have shown a decrease in the last decade. For example, in Dublin (Ireland) the C_6H_6 air concentrations decreased from about 5 $\mu g/m^3$ in 2001 to less than 1 $\mu g/m^3$ in 2009 [13]. In the United Kingdom the average benzene air emissions originated from road transport have gradually decreased from 20.1 thousand tones in 1998 to 5.8 thousand tones in 2008, out of which 5.2 thousand tones are calculated to have come from cars and taxies [14]. It is still early to define a clear trend for Tirana or Albania, for the benzene air concentrations in $\mu g/m^3$ and also for the total benzene emissions (in tones) because C_6H_6 in the air is only recently being monitored. However it is a fact that its levels are already very high on the heavy traffic sections [11].

In conclusion, because the present gasoline vehicles' fleet is quite mature regarding its age, it remains a responsibility of the Government to undertake all necessary measures to promote the purchase of brand new gasoline cars equipped with catalytic converters; to provide good gasoline quality complying with the EU standards; a proper traffic management; and a fair technical Inspection of vehicles, in order to lower the CxHy emissions in the air of Tirana.

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