

## REDUCTION OF VEHICLES ENVIRONMENTAL POLLUTION IN URBAN AREAS ZVOGËLIMI I NDOTJES SË MJEDISIT NGA AUTOMJETET NË ZONAT URBANE

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### PERMBLEDHJE

Studimi synon të reduktojë ndotjen e mjedisit në zonat urbane, duke analizuar ndikimin e strukturës së automjeteve në qarkullim dhe gjendjen e tyre teknike gjatë përdorimit në një kryqëzim urban. Përcaktimi i ndotjes është bërë duke i ndarë automjetet në 4 grupe, në bazë të nivelit të tyre të ndotjes së dhënë nga fabrikat prodhuese. Llogaritja e ndotjes nga automjetet është kryer për një kryqëzim në qytetin e Tiranës, për tri raste të strukturës së automjeteve në qarkullim. Rezultatet tregojnë se për strukturën e propozuar me automjete të prodhuara pas vitit 2000, mund të arrihet reduktimi i ndotjes në kryqëzim deri 3 herë. Nga mirëmbajtja teknike e keqe automjetet i tejkalojnë kufijtë e lejueshme të ndotjes mbi 2 herë. Për këto raste propozohet vendosja e taksave shtesë, e cila nxit përdoruesit të kontribuojnë në uljen e ndotjes së mjedisit, nga e cila përfitojnë të gjithë qytetarët e zonave urbane.

**Fjalët çelës:** automobil, emisionet e gazeve, zvogëlim i ndotjes.

### SUMMARY

The study aims to reduce environmental pollution in urban areas, by analyzing the impact of the vehicle structure in circulation and their technical condition during use in an urban intersection. Determination of pollution is done by divided vehicles in circulation into 4 groups, based on their level of pollution given by manufacturing factories. The calculation of the pollution caused from vehicles is performed, for a junction in the city of Tirana, for the three cases of vehicle structure in circulation. Results show that, the pollution reduction can be reduced up to 3 times for proposed structure of produced vehicles after 2000. Vehicles exceed the permissible limits of pollution over 2 times from bad technical maintenance. For these cases the additional tax is proposed, which encourages users to contribute in the reduction of environmental pollution, which will be a benefit for all citizens of urban areas.

**Key words:** vehicle, gas emissions, pollution reduction.

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### INTRODUCTION

Actually the number of automobiles, which circulate in urban areas is increasing more. Currently, diesel and gasoline engine automobiles are widely used. Combustion gases are created, in the combustion chamber by burning reaction of fuel with air. These gases have toxic effects on human organisms and influence in the creation of greenhouse effect and global warming [1], [2]. In those conditions, the pollution caused by gas emissions is increased more, by turning the car in

the largest polluter of the environment in urban areas, especially at urban junctions where their negative effects are the maximum.

The challenge is done today, the replacement of existing automobiles with the most efficient versions and less polluting. While the focus of vehicle manufacturers is that people to buy a car for a better future for themselves and their children. [2].

The task of reducing environmental pollution has forced leading authorities of EU to guide the

management of scientific research, in terms of vehicle production with less pollution and less consumption of fuel. For this purpose, EU institutions have issued continuously directives, which require from vehicle manufacturing factories, to reduce the pollution level generated from vehicles and to enforce the strengthening of technical control. This is reinforced in 2009/40/EU directive [3].

The quantity of harmful gases emitted from vehicles into atmosphere depends on the quantity of burned fuel and the quality of burning process. In this respect the construction of engine combustion chamber has a great influence to realise a better combustion of fuel, which leads in increasing of efficiency and reduction of fuel consumption. This is shown in the technical criteria set by the CE, for the vehicle manufacturing factories [4], [5].

An important role in this case has the regular technical condition of vehicles in circulation, which affects directly in the increasing of fuel consumption and pollution level. Also, recent studies concerning the pollution reduction level have led to the usage of additional devices, which reduce the quantity of harmful gases in the atmosphere [6].

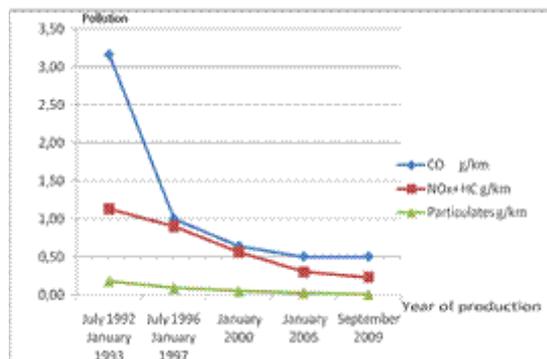
For this purpose, we have studied the impact of vehicles structure in circulation and vehicles technical maintenance, in an urban junction. In our country, the most of the vehicles in circulation have diesel engine, therefore in the following we will treat only the pollution caused by diesel vehicles.

### CAR GAS EMISSIONS

Gas emissions in exhaust system of diesel engines include: carbon dioxide  $\text{CO}_2$ , water  $\text{H}_2\text{O}$ , carbon monoxide CO, nitrogen oxides  $\text{NO}_x$ , unburned hydrocarbons HC and soot particles (PM) usually 2.5-10 micron [1]. The maximum values of pollutants CO, (HC +  $\text{NO}_x$ ), PM, that are allowed for vehicles in circulation are given in EC directive, according to standards Euro1, Euro 2, Euro 3, Euro 4 and Euro 5 [4], [5]. With these values we have constructed graphs shown in figure 1.

Graphs show to a pronounced decrease of the pollution level from vehicles produced after 2000, compared with those produced before 1996. Thus CO has a decrease 4.5 times,  $\text{NO}_x+\text{HC}$  2 times, PM 3 times and in total the pollution level has a reduction about 3 times.

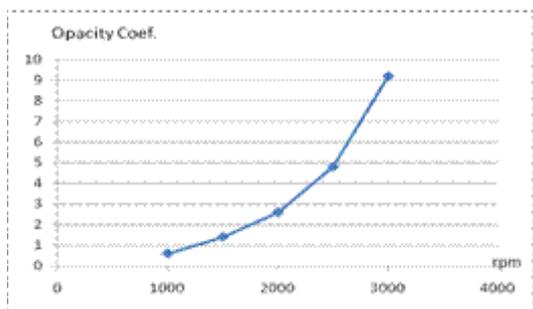
Ministry of Public Works and Transport has established standards to control the pollution level of vehicle.



**Figure 1.** Maximum values of diesel engines pollutant by production year

The technical control for diesel engines, consists in measuring of the opacity coefficient, which represents a complex indicator. Thus the allowed value of the opacity coefficient for produced vehicles up to July 2008, is  $2.5 \text{ m}^{-1}$  [7].

The evaluation methodology of the coefficient consists in the determination of average value of 3 measurements on different revolutions of engine up to 2500 to 3000 rpm/min, with electronic apparatus, where the reading is digital and can be printed. Thus, the values of opacity coefficient for car Benz 170 CDI manufactured in 2000 defined by the above methodology is  $9.1 \text{ m}^{-1}$ , many times more than allowed value. While the opacity coefficient dependent on engine revolutions, for the car Benz 170 CDI manufactured in 2000, is shown in figure 2.

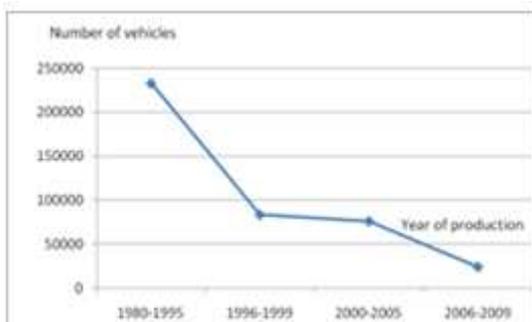


**Figure 2.** The opacity coefficient dependent on engine revolutions

Also, experimental measurements during technical control have shown that over 60% of vehicles, exceed pollution limits over 2 times. The main reason is bad technical maintenance of vehicles.

**STRUCTURE OF VEHICLES IN CIRCULATION**

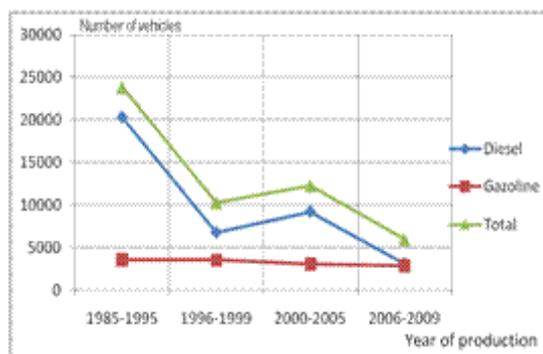
The number of vehicles in circulation in Albania is increasing; in July 2012 is reaching 155760 in Tirana and 497854 in the whole country [8]. Number of vehicles in circulation by production year is shown in figure 3.



**Figure 3.** Number of vehicles in Albania by production years

While, number of imported vehicles in Albania in 2011, according to production years is given in figure 4.

Graphs show that diesel vehicles constitute about 85-90% and mainly those produced before 1995 prevail 3 times, compared to produced vehicles during 1996-1999 and after 2000.

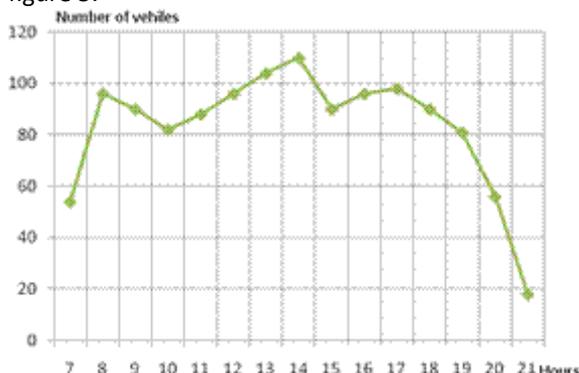


**Figure 4.** Number of registered vehicles in 2011 by production years

**DETERMINATION OF POLLUTION IN AN URBAN JUNCTION**

The calculation of pollution from vehicles is done for "Don Bosko" junction with 4 branches, located in Tirana city.

The number of vehicles in circulation is determined by the survey method. Observer at junction makes the counting of vehicles entering into any branch of the junction during a cycle of traffic light. (1.5 minute). Tests are repeated three times within an hour and obtained average value for 4 branches of the junction at different hours of the day. Accordingly, average number of vehicles in circulation in this junction for a traffic light cycle at different hours of the day is given in figure 5.



**Figure 5.** Number of vehicles in the junction for a cycle.

The average vehicles number in this junction for a cycle is 83, while average vehicles number for an hour Nh is 3310 vehicles/hour.

The movement speed at this junction is determined making measurements of the average way, that vehicles make for a cycle time 1.5 min. In this case it is about 45 m and the speed is 0.03 km/min.

The pollution quantity caused by vehicles in this junction is calculated, assuming that all vehicles are with diesel engine and the pollution level is within the limits of the EC standards. From the pollution values of CO, (HC + NOx) and PM in g/km given in fig 1, we have calculated pollution values in g/min for the speed 0.03 km/min, which are given in table 1.

**Table 1** Values of emissions for CO, HC + NOx and PM in g/min, by years of production

| Year of production       | CO (g/min) | (NOx+HC) (g/min) | Particulate PM (g/min) |
|--------------------------|------------|------------------|------------------------|
| July 1992 - January 1993 | 0.095      | 0.034            | 0.0054                 |
| July 1996 - January 1997 | 0.03       | 0.027            | 0.003                  |
| January 2000             | 0.02       | 0.019            | 0.0015                 |
| January 2005             | 0.015      | 0.009            | 0.0009                 |

For the current structure of vehicles in circulation and for created structure by the registration of vehicles made in 2011, the pollution quantity in the junction for each pollutants CO, (HC + NOx) and PM will be calculated:

$$G = (G_1 K_1 + G_2 K_2 + G_3 K_3 + G_4 K_4) 60 N_h \text{ [g/h]} \quad (1)$$

where:

-  $G_1, G_2, G_3, G_4$  - are the weights of pollution in g/min for each pollutant according to 4 groups of production years, respectively, before 95, 1995-1999, 2000-2005 and after 2005 given in table 1.

-  $K_1, K_2, K_3, K_4$  - are the percentages of vehicles in circulation according to 4 groups of production years respectively before 95, 1995-1999, 2000-

2005 and after 2005, for the current situation given in fig. 3, or for formed structure according to the registration in 2011, taken from fig. 4. For the actual structure it results:  $K_1 = 56\%$ ,  $K_2 = 20\%$ ,  $K_3 = 18\%$ ,  $K_4 = 6\%$ , while for created structure by registration of 2011:  $K_1 = 51\%$ ,  $K_2 = 18\%$ ,  $K_3 = 23\%$ ,  $K_4 = 8\%$ . If in circulation will be only vehicles manufactured after 2000, the pollution quantity will be calculated:

$$G = (G_3 K'_3 + G_4 K'_4) 60 N_h \text{ [g/h]} \quad (2)$$

where:

$K'_3, K'_4$  - are the new percentages of vehicles in circulation for production years 2000-2005 and after 2005. In this case we suppose, that is the registration percentage made in 2011 and we have:  $K'_3 = 75\%$ ,  $K'_4 = 25\%$

Pollution quantities are calculated according to formulas (1) and (2), for the current structure of vehicles in circulation, for the formed structure by registered vehicles in 2011 and for proposed structure, when in circulation will be only vehicles manufactured after 2000, which are shown in table 2.

**Table 2.** Values of pollutant gases for an hour, for 3 calculated variants

| Variants of vehicles in circulation                     | Pollution CO (g/h) | Pollution (NOx+HC) (g/h) | Pollution PM (g/h) |
|---|--------------------|--------------------------|--------------------|
| 1. Current structure of vehicles                        | 1120               | 506                      | 71                 |
| 2. Structure of vehicles by registration 2011           | 1076               | 496                      | 66                 |
| 3. Proposed structure with produced vehicles after 2000 | 325                | 265                      | 24                 |

From table 2, it is concluded, that the pollution quantity caused by vehicles at the junction taken in study, is almost the same for the existing structure of vehicles in circulation and for the

formed structure according to the registration of vehicles made in 2011. Thus, for the existing structure of vehicles in circulation, the total quantity of pollution caused by vehicles at the junction, reaches 1.7 kg/h or 25,5 kg/day. If we take the extra pollution that caused due to the bad technical maintenance, which occurs in over 60% of the vehicles, the pollution caused by vehicles at this junction is more increased.

While, for the proposed structure, when we have in circulation only produced vehicles after 2000, the pollution quantity will decrease over 3 times. The proposed structure of vehicles can be achieved, by limiting the importation of used vehicles, produced before 2000. This means that the customs tax have to reduced for vehicles manufactured after 2000 and should introduced the extra environmental pollution tax, for vehicles that exceed pollution level. The tax of used vehicles set in July 2011 [9] doesn't help to stimulate vehicles users, to increase the interest for technical maintenance and to contribute for reduction of environmental pollution. In this regard, tax should be proportional to the pollution caused, according to the principle, that everyone must pay for caused damage [10].

Currently, criterion of technical control allows the circulation of vehicles that exceed the pollution level. This means, that we have to pay taxes to poison ourselves.

In order to reduce vehicles pollution level that exceed pollution limits, the control of traffic police should be increased forcing them, to perform additional technical control exclusively for pollution [11]. The above provisions will force the drivers to maintain or to remove vehicles from circulation.

## CONCLUSIONS

- The largest pollution in urban junction is caused because of big amount of vehicles manufactured before 1996, which have 3,5 times greater pollution than the vehicles produced after 2000.
- The level of pollution in urban junctions can be reduced up to 3 times, if we limit the circulation of vehicles manufactured before 2000.

- The reduction of vehicles environmental pollution in urban areas can be achieved by reducing the customs tax for vehicles manufactured after year 2000 and by introducing the extra environmental pollution tax, for vehicles that exceed pollution limits in circulation.

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