THE RELATION BETWEEN THE TECHNICAL STATE AND THE EXHAUST GASSES EMISSION FOR A GROUP OF PARTICULAR VEHICLE AGE

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Abstract

The article presents the results of investigations concerning the relations between the technical state of cars and the exhaust gasses emission for different groups of vehicles. First, the measurements of the test group of 4000 different vehicles have been made. Those measurements have been elaborated in order to define typical damages of vehicles. The percentage of faulty vehicles and the type of faults was estimated. The damages of vehicles have been carried out using typical diagnostic methods, electrical value measurements and exhaust gasses analysis. Those measurements also provided information about the number of vehicles with high level of gas emission. The results of investigations were compared to the requirements of each model of a given year.

Next, the measurements of the test group of 1000 vehicles have been made in accordance with ECE Regulations and the methodology of periodical car inspection. Those measurements also gave information about the level of emission from each vehicle. The results of investigations were compared to the requirements of each model of a given year and the percentage of high polluting vehicles has been presented. The vehicles have been divided into different exhaust emission legislation classes. Next, the relation between the number of faulty vehicles and the level of exhaust emission for the first and the second group of vehicles has been elaborated and presented. The results of investigations and analysis show the number of faulty vehicles and its influence on the level of emission.

Keywords: *Traffic emission, technical condition, vehicle inspection*

1. Introduction

The exhaust emission depends on the type of vehicle and the age structure of vehicles, the number of vehicles, the type of engine, its capacity, the fuel consumption and its quality, etc. There are different methods to reduce the level of exhaust gasses emission, e.g. more restrictive emission standards for new vehicles and the technical improvements. The reduction of exhaust gasses emission is difficult, because there are a lot of old vehicles. In Poland there are about 20 million vehicles. About 70% of them have been produced before 2000 [1]. The emission from these vehicles is much higher than from new vehicles and often das not meet the requirements of new emissions standards.

The estimation of exhaust emission is necessary for restricting of its level. At present, there are a lot of different methodologies to calculate exhaust emissions. These methodologies allow estimating the emission from different vehicles, from different types of engines and also for different types of road (e.g. street canyons, road tunnel portals, etc.) [2-5]. The construction of vehicles and the type and the quality of fuel have also been taken into consideration in the process of estimating [6-8].

Nowadays, the vehicle inspection and maintenance (I/M) programmes are used to identify high polluting vehicles. These programmes have been developed however there are still some problems to identify the faulty and highly polluting vehicles precisely [9, 10].

The influence of the engine construction and the engine technical condition on exhaust gasses emission has been developed [11, 12]. It is difficult to estimate the number of vehicles in poor

technical conditions and their influence on exhaust emission. There are more vehicles in poor technical conditions among older vehicles, but also faulty and highly polluting vehicles can be found in the group of new vehicles. It is a very important problem to determine the relation between the technical condition of the engine and the exhaust gasses emission for a particular vehicle age.

2. Methodology

This article presents the relations between gasses emission and technical states of cars for different groups of vehicles. First, the measurements have been made in order to define typical damages of vehicles. These measurements have been made for the test group of 4000 different vehicles. The percentage of faulty vehicles and the type of faults were estimated. The damages of vehicles have been carried out using electrical value measurements, signals from OBD systems and exhaust gases analysis. Those measurements also provided information about the number of vehicles with high level of emission. The results of investigations were compared to the requirements of each model of a given year.

Next, the measurements of the test group of 1000 vehicles have been made in accordance with ECE Regulations and the methodology of periodical car inspection. Those measurements provided information about the level of emission from each vehicle. The results of investigations were compared to the requirements of each model of a given year and the percentage of high polluting vehicles has been presented as well. The vehicles have been divided into different exhaust emission legislation classes.

3. Examination results

The measurements have been made for two groups of different vehicles. First, the diagnostic of faults and the measurements of exhaust gasses emission have been carried out for 4000 vehicles. Next, the measurements of exhaust emission have been made for 1000 vehicles. These measurements have been made in accordance with ECE Regulations and the methodology of periodical car inspection.

3.1. Types of vehicle faults

The part of results has been presented in the previous elaborations [13, 14]. The majority of vehicles were produced after 2000. 72% of vehicles met the requirements of Euro IV. 16% of vehicles met the requirements of Euro V. The remaining part of vehicles met the requirements of Euro III. The results have been presented in the Fig. 1.

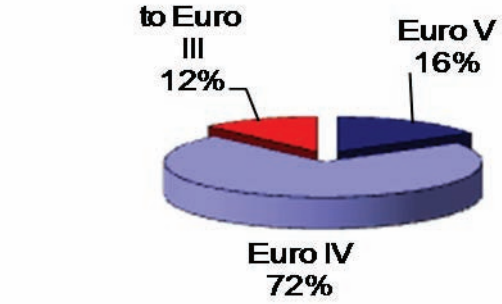

Fig. 1. The age structure of the first group of vehicles

The vehicles were examined and the number and type of faults have been estimated. About 18% out of the total number of vehicles which were examined were faulty. The faults have been classified in groups. The examination results have been presented in Fig. 2.

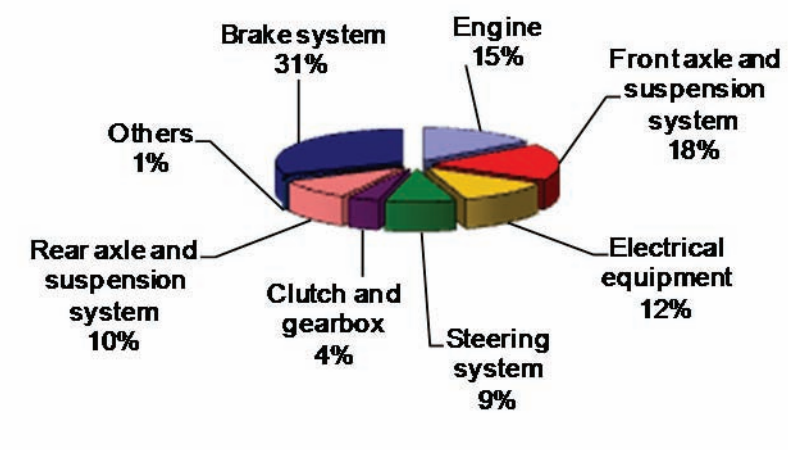

Fig. 2. Structure of vehicle faults

The structure of faults has been analyzed. The faults of the examined vehicles can be classified in the following groups: faults which cause higher emission of toxic compounds, faults which have a direct impact on driving safety (brake system, steering system, suspension system, etc.) and others. 28% of vehicles did not meet the requirements in the scope of fuel consumption and exhaust emission. The results have been presented in Fig. 3.

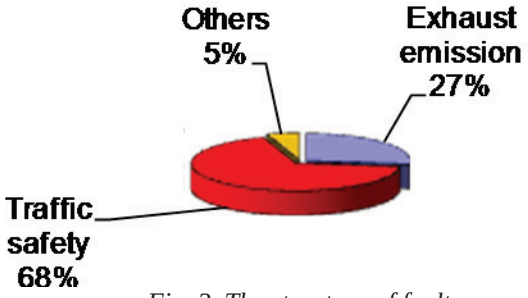

Fig. 3. The structure of faults

The following stage of elaboration was to estimate the types of engine faults. The results of estimation have been presented in Fig. 4.

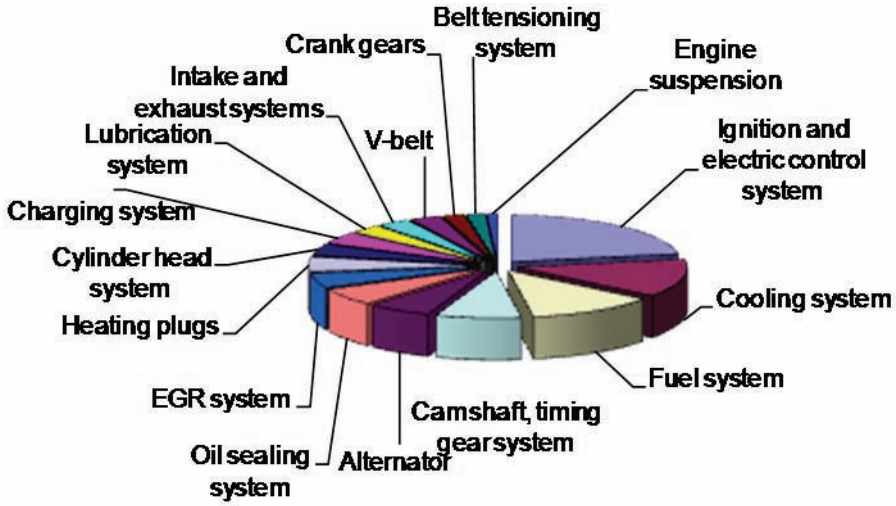

Fig. 4. Structure of engine faults

The types of engine faults have been analyzed. The carried out analysis have shown that about 75% of damages cause higher emission of toxic compounds.

The investigations have shown that about 30% of faults in vehicles and 75% faults of engine have influenced the level of exhaust emission. Most of the examined vehicles were produced before 2000.

3.2. The level of exhaust emission

Next, the level of exhaust emission, for the group of 1000 vehicles, has been estimated.

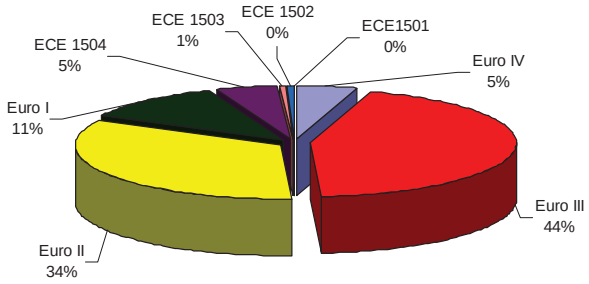

Fig. 5. The age structure of the second group of vehicles

About 34% of investigated vehicles met the requirements of Euro II, about 44% of vehicles met the requirements of Euro III.

The results of measurements of exhaust pollutants were compared with Polish legal regulations. The results of comparison of CO and HC emission for passenger cars with spark ignition engine have been shown in Fig. 6.

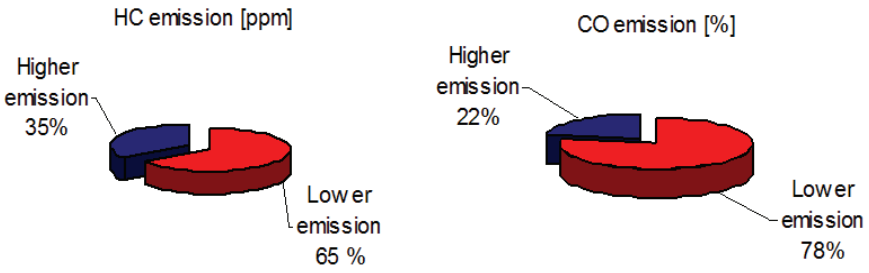

Fig. 6. HC and CO emission from the vehicles

The results of investigations prove that about 35% of vehicles have exceeded the permissible HC emission level. About 22% of vehicles have exceeded the permissible CO emission level.
The average CO emission for a particular vehicle age has been shown in Fig. 7.

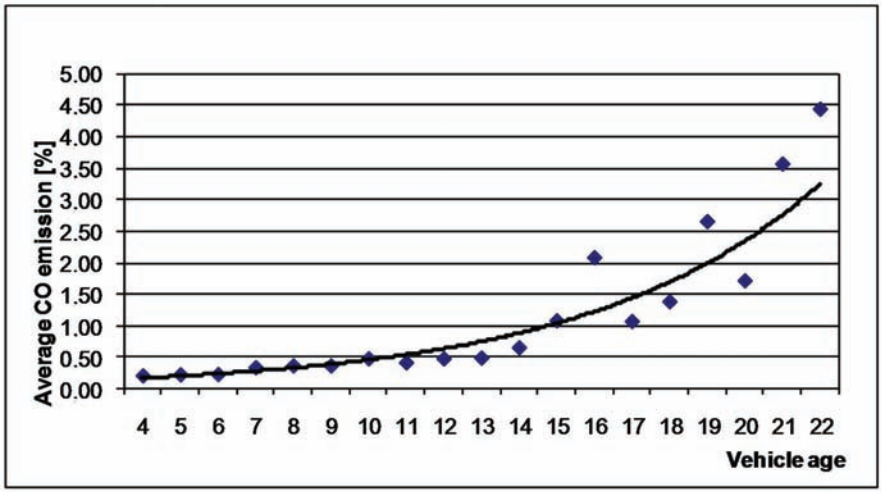

Fig.7. Average CO emission for a particular vehicle age (800 rpm)

From 1995 the permissible limit of CO emission for 800 rpm is 0.5%. The vehicles older than 10-years have exceeded the permissible emission level.

The average CO emission for a particular vehicle age for 2500 rpm has been shown in Fig. 8.

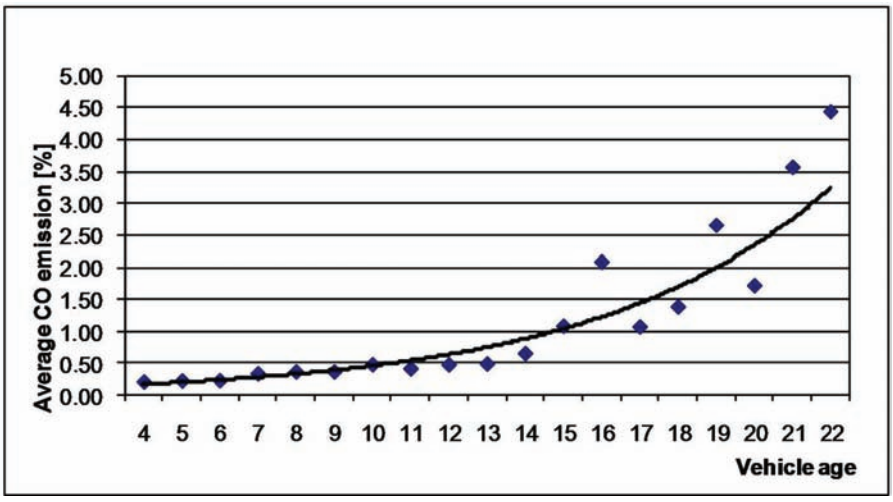

Fig. 8. Average CO emission for a particular vehicle age (2500 rpm)

From 1995 the permissible limit of CO emission for 2500 rpm is 0.3%. The vehicles older than 13-years have exceeded the permissible emission level.

The average HC emission for a particular vehicle age for 800 rpm has been presented in Fig. 9.

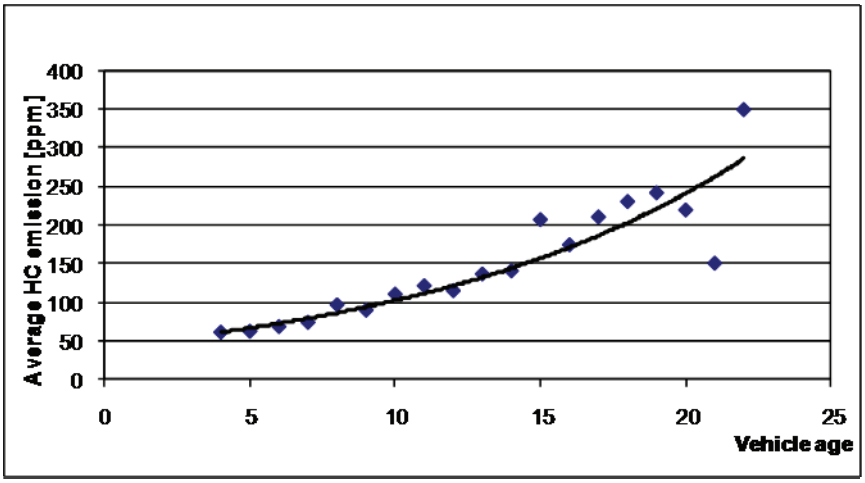

Fig. 9. Average HC emission for a particular vehicle age (800 rpm)

From 1995 the permissible limit of HC emission for 800 rpm is 100 ppm. The vehicles older than 10-years have exceeded the permissible emission level.

The average HC emission for a particular vehicle age for 2500 rpm has been presented in Fig. 10.

From 1995 the permissible limit of HC emission for 2500 rpm is 100 ppm. The vehicles older than 13-years have exceeded the permissible emission level.

4. Conclusions

This article presents the relations between the results of investigations of technical states of cars and emission level for different groups of vehicles. The examinations have been made in order to define typical damages of vehicles. These tests have been made for the test group of 4000

different vehicles. The measurements of the test group of 1000 vehicles have been made in accordance with ECE Regulations and the methodology of periodical car inspection. Those measurements provided information about the level of gasses emission from each vehicle.

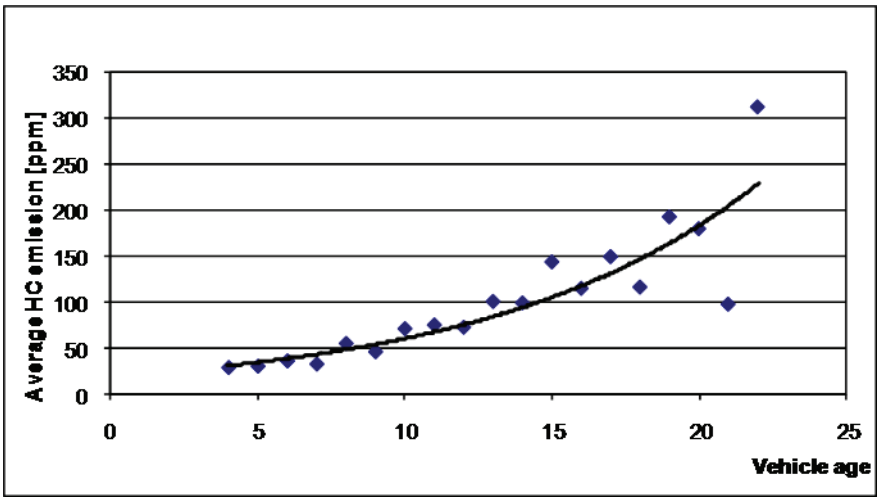

Fig. 10. Average HC emission for a particular vehicle age (2500 rpm)

Investigations gave evidence that about 18% of vehicles, which were not older than 10 years, were faulty. The results of the following investigations prove that for vehicles which are older than 10 years, the average exhaust emission is higher than the permissible emission level. The average CO and HC emission is increasing with vehicles' age. When vehicles become older the number of vehicles in poor technical conditions is growing.

The statistical Polish car is about 10 years old. It therefore can be assumed that majority of cars in Poland are in poor technical conditions regarding gas emission standards.

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