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Road transport, traffic emission, technical condition of the vehicles

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THE INFLUENCE OF THE TYPE OF ROAD, THE TYPE OF VEHICLE AND THE AGE STRUCTURE ON THE ROAD TRANSPORT EMISSION

Summary. The total emission level is heavily dependent on the number of vehicles. Additionally, the type of vehicles and their age structures are very important. The structure of vehicles also depends on the type of the road. The article presents the results of calculations of the pollutants emission from the road transport. Total emission was calculated with combination of the investigation results i.e. the type of vehicles and their age structures for different types of roads. The investigations have been made for different classes of roads with different types of vehicles. The traffic line has been recorded in the same length of time. On the basis of analysis of the recorded traffic line, the number and the type of vehicles have been estimated. The classification of vehicles have been made according to the level of emission i.e. passenger cars, light duty vehicles, heavy duty vehicles, busses and others, taking into consideration the age structures of vehicles. The level of total traffic emission has been calculated on the basis of results. There has been used the Copert programme methodology. The results of the calculations have been made with combination of the type of road, the speed of vehicles, the type of vehicles and their age structure, are presented.

WPŁYW RODZAJU DROGI, TYPU I STRUKTURY WIEKOWEJ POJAZDÓW UCZESTNICZĄCYCH W RUCHU DROGOWYM NA POZIOM EMISJI SPALIN

Streszczenie. Poziom emisji zanieczyszczeń zależy przede wszystkim od liczby pojazdów poruszających się po drodze. Dodatkowo istotne są struktury rodzajowa oraz wiekowa pojazdów. Struktura pojazdów zależy natomiast w dużym stopniu od rodzaju drogi. W pracy przedstawiono wyniki obliczeń poziomu emisji wybranych składników spalin emitowanych w ruchu drogowym. Obliczenia zostały przeprowadzone z uwzględnieniem wyników badań struktur rodzajowej i wiekowej pojazdów dla różnych typów dróg. Badania strumienia pojazdów wykonano na drogach różnej kategorii, przy różnej strukturze pojazdów. Rejestrowano strumień pojazdów w określonych odcinkach czasowych. Na podstawie analizy obrazu zarejestrowanego strumienia określono liczbę i rodzaj pojazdów. Pojazdy podzielono na kategorie według poziomu emisji, tj. samochody osobowe, samochody dostawcze, ciężarowe, autobusy i inne, uwzględniając strukturę wiekową. Na podstawie uzyskanych wyników oszacowano poziom emisji szkodliwych składników spalin. Obliczenia zostały wykonane za pomocą metodyki przyjętej w programie Copert. Przedstawiono wyniki szacunkowego poziomu emisji spalin w zależności rodzaju drogi, prędkości jazdy, struktur wiekowej i rodzajowej pojazdów.

1. INTRODUCTION

The motor vehicles are a significant source of air pollution. The total emission level is heavily dependent on the number of vehicles. The number of vehicles is on the increase all the time. It causes that emission from road transport increases.
Total emission depend on the type of road, the number of vehicles, the type of vehicles and their age structures, average speed per vehicle type and per road, the fuel type and the fuel consumption etc. It is very important problem to determine emission from road transport thoroughly. In Europe, reports about the calculations of vehicle emission have come into existence [1].

There are a lot of different programme to calculate emissions from road transport [2-4]. That programmes calculate the vehicle emission with combination of data i.e. the type of road, the type of vehicles and their age structures for different types of road, the average speed of vehicles etc.
The existed programmes are extended all the time. The programmes calculate instantaneous traffic emission [5], concentration of car exhaust pollutants in street canyons [6] and other. There are a lot of comparisons of different models, what have had a positive effect on development of programmes to calculate emissions from road transport [7, 8]. There are also determined an influence of traffic produced turbulence on car exhaust pollutant concentration [9].

Nowadays, there are developed, the way of determination the effect of age and technological change on motor vehicle emissions [10] and the influence of the engine construction and engine technical condition on traffic emission [11].

2. METHODOLOGY

This article presents the results of calculations of the pollutants emission from road transport. Total emission was calculated with combination of the investigation results i.e. the type of vehicles and their age structures for different types of roads. The investigations have been made for different classes of roads. There was chosen different classes of roads with different types of vehicles.
Firstly, the investigations have been made for the A4 Motorway Katowice – Gliwice. Next, the investigations have been made for the DTŚ expressway Katowice – Zabrze and for the DK 79 road in Katowice.

The A4 motorway is polish motorway between East and West, occurred in the south part of Poland. It is a rather transit type of road. The DTŚ expressway Katowice – Zabrze is road rather for residents of Silesia. The DK 79 road is national road. The research for that way has been made in Katowice. For each road there are different number of vehicles, different vehicle structure and their age structure.

The traffic line has been recorded in the same length of time (15 minutes). On the basis of analysis of the recorded traffic line, the number and the type of vehicles have been estimated. The classification of vehicles have been made according to the level of emission i.e. passenger cars, light duty vehicles, heavy duty vehicles, busses and others, taking into consideration the age structures of vehicles.

Next, that data have been used for calculation of traffic emission. Total traffic emission, for each road, has been calculated using methodology from the computer programme COPERT [2].

3. THE RESULTS OF THE RESEARCH AND THE CALCULATIONS

Tab. 1 shows results of the investigations, which were made for different classes of roads. There was chosen different classes of roads with different types of vehicles. The largest number of vehicles has occurred in case of A4 motorway.

Table 1

The number of vehicles for chosen roads in the same length of time (15 minutes)

Name of road	The numer of vehicles						
	Gasoline passenger cars	Diesel passenger cars	Light duty vehicles	Heavy duty vehicles	Buses	Other	**Total number of vehicles**
A4 motorway	769	85	205	154	5	0	**1218**
DTŚ expressway Katowice – Zabrze	440	97	111	71	0	0	**719**
DK 79 road in Katowice	357	78	51	18	3	1	**508**

Figure 1 shows the vehicle structure for chosen roads. The investigations have been made for three roads i.e. the A4 Motorway Katowice – Gliwice, the DTŚ expressway Katowice – Zabrze and the DK 79 road in Katowice.

There are different structures of vehicles for each road. For the A4 motorway Katowice – Gliwice and for DTŚ expressway the number of the gasoline passenger cars constituted above 60% of all vehicles. For DK 79, the number of the gasoline passenger cars is larger, it constituted above 70% of all vehicles. For that road the number of passenger cars is the largest. The number of gasoline and diesel passenger cars constituted about 86%.

The largest number of the heavy duty vehicles is for the A4 motorway. The number of light duty vehicles is also the largest for A4 motorway.

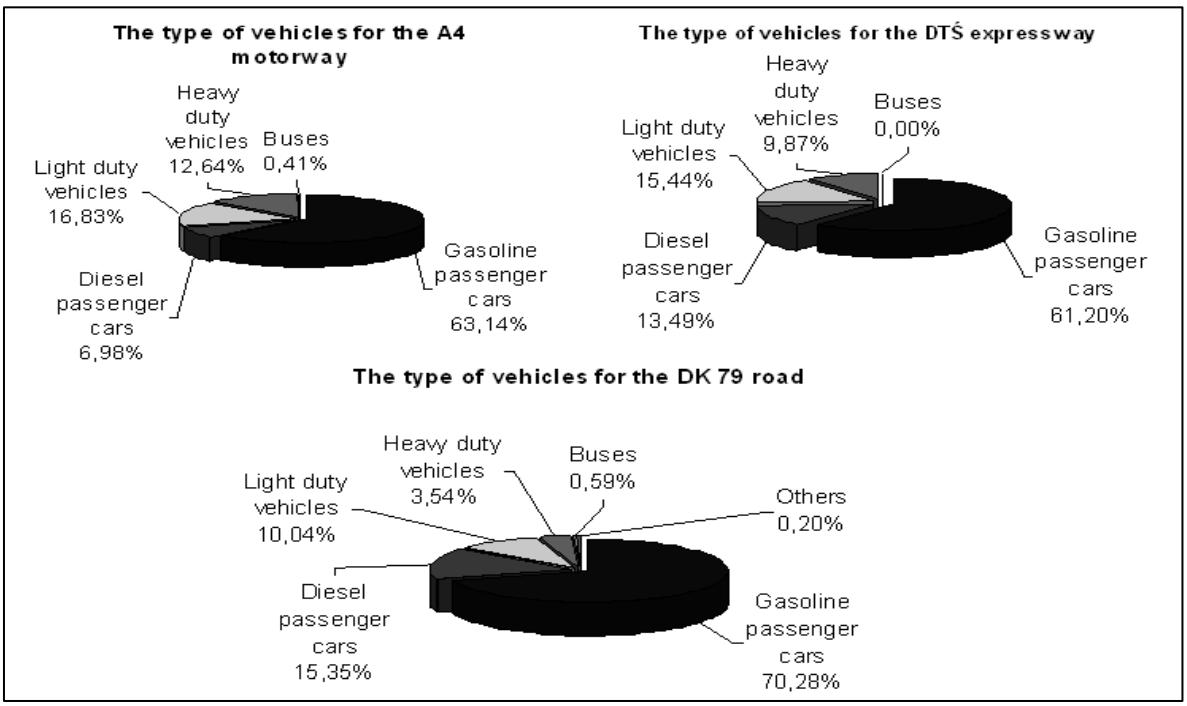

Fig. 1. The vehicles structure for different types of roads
Rys. 1. Struktura pojazdów na badanych drogach

Next, for the vehicles from three chosen roads i.e. the A4 Motorway Katowice – Gliwice, the DTŚ expressway Katowice – Zabrze and the DK 79 road in Katowice, vehicle emission has been calculated.

Firstly, vehicle emission was calculated for number of cars on each road in the same length of time (15 minutes). Fig. 2 shows the results of calculations of the CO emission for gasoline passenger cars. The largest emission is for A4 motorway. It is caused by large number of cars on that road.
For each road emission is the smallest for a speed of 70 km/h.

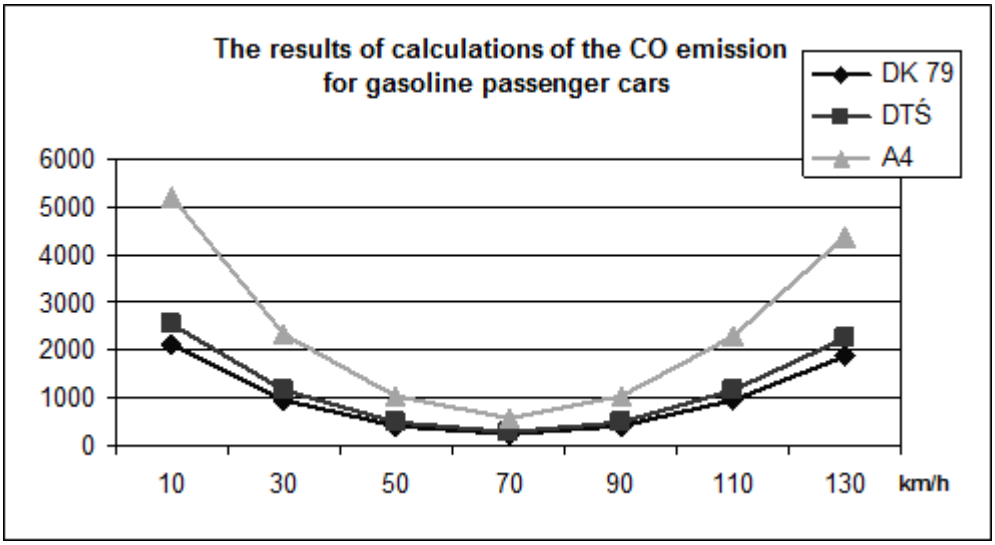

Fig. 2. The results of the calculations of the CO emission for gasoline passenger cars
Rys. 2. Wyniki obliczeń emisji CO dla samochodów osobowych z silnikami o zapłonie iskrowym

Fig. 3 shows the results of calculations of the HC emission also for gasoline passenger cars. In this case the largest emission is also for A4 motorway. For DTŚ expressway and for DK 79 emission is similar.

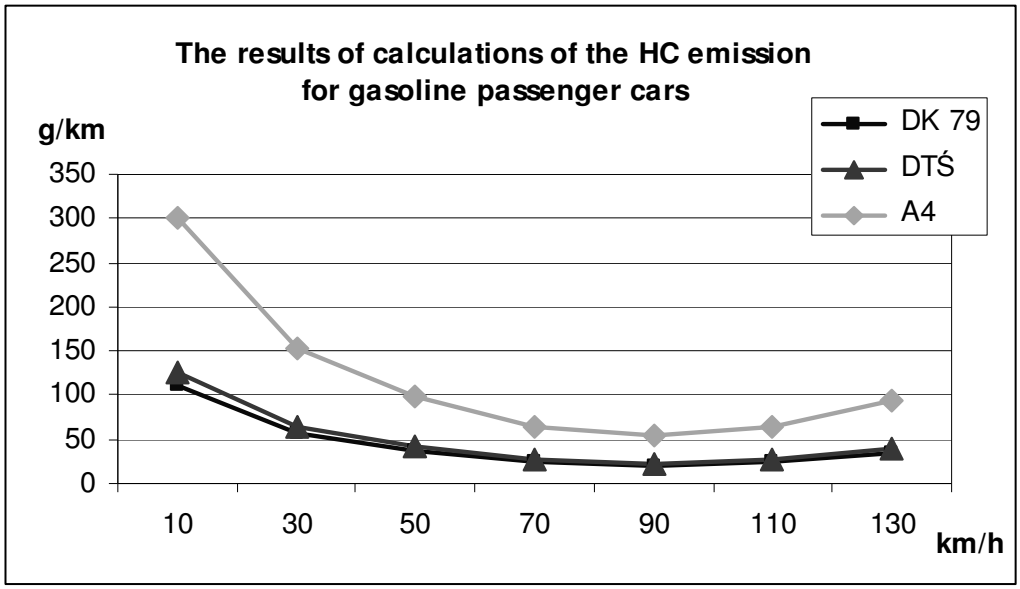

Fig. 3. The results of the calculations of the HC emission for gasoline passenger cars
Rys. 3. Wyniki obliczeń emisji HC dla samochodów osobowych z silnikami o zapłonie iskrowym

Fig. 4 shows the results of calculations of the NO_x emission also for gasoline passenger cars. Also in this case the largest emission is for A4 motorway. For DTŚ expressway and for DK 79 emission is similar.

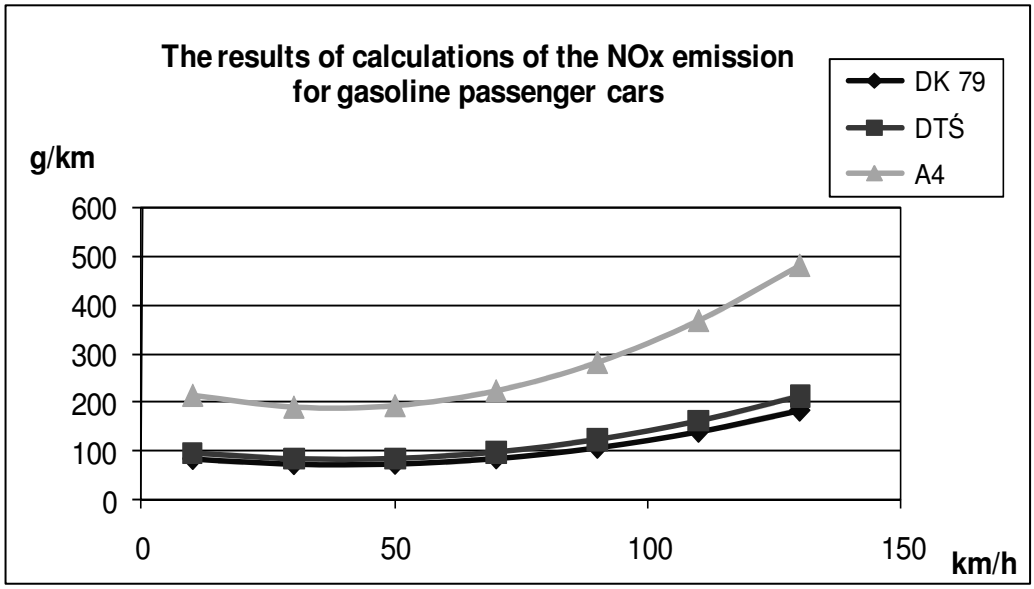

Fig. 4. The results of the calculations of the NOx emission for gasoline passenger cars
Rys. 4. Wyniki obliczeń emisji NOx dla samochodów osobowych z silnikami o zapłonie iskrowym

Next, the calculations have been made for the vehicle structure for each road, but calculated for 10000 vehicles. The vehicle percentage structure has been reflected in 10000 vehicles. For each road the emission has been calculated for 10000 vehicles. Figures 5, 6, 7 and 8 show the results of calculations.

Fig. 5 shows the result of the calculation of CO emission for all chosen roads. The emission has been calculated for 10000 vehicles. The largest emission is for vehicle structure characteristic for A4 motorway.

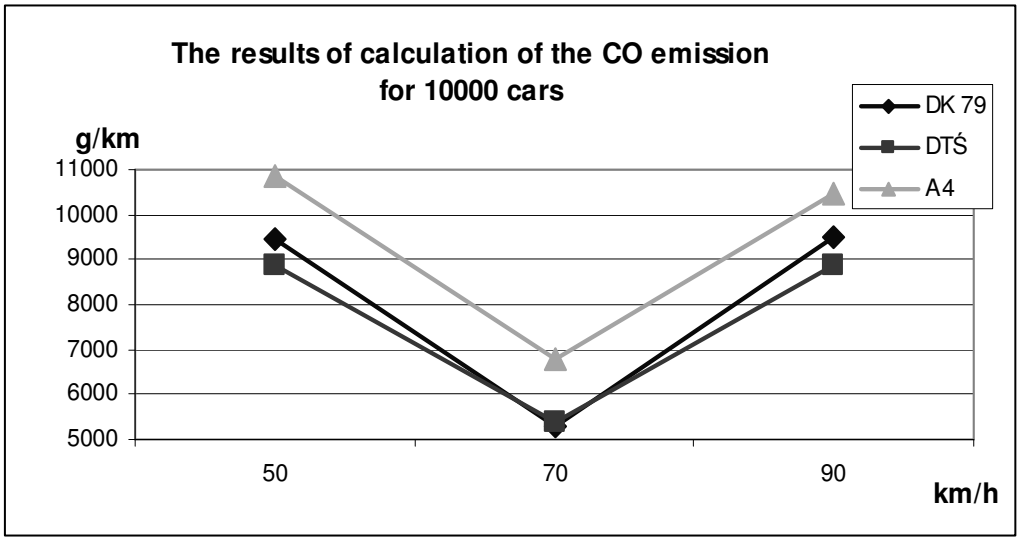

Fig. 5. The results of the calculations of the CO emission for 10000 cars
Rys. 5. Wyniki obliczeń emisji CO dla 10000 pojazdów

Fig. 6 shows the result of the calculation of HC emission for all chosen roads for 10000 vehicles. Like previously, the largest emission is for A4 motorway.

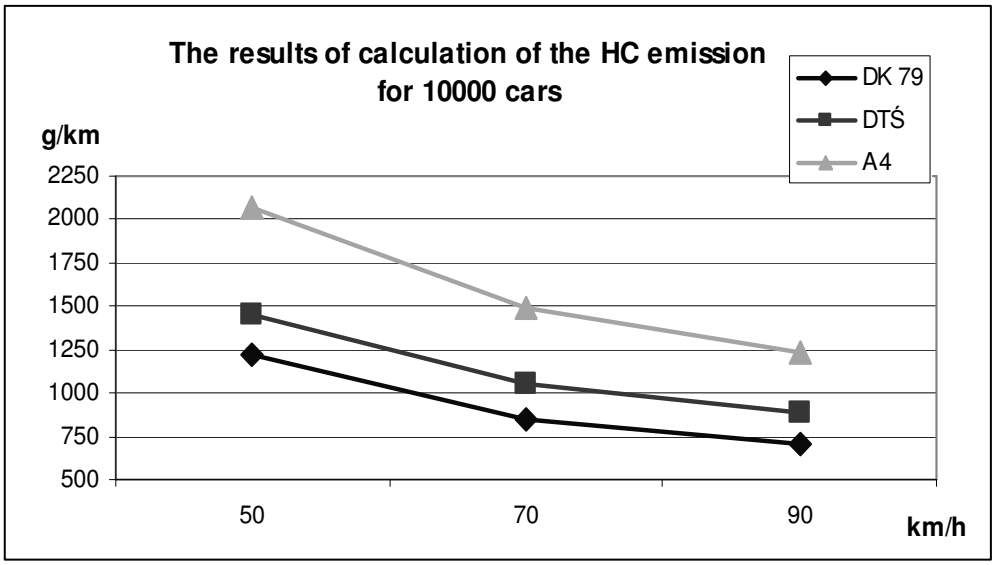

Fig. 6. The results of the calculations of the HC emission for 10000 cars
Rys. 6. Wyniki obliczeń emisji HC dla 10000 pojazdów

For calculation of the NOx emission, there is the same situation as in the case of CO emission. The largest emission is for A4 motorway.

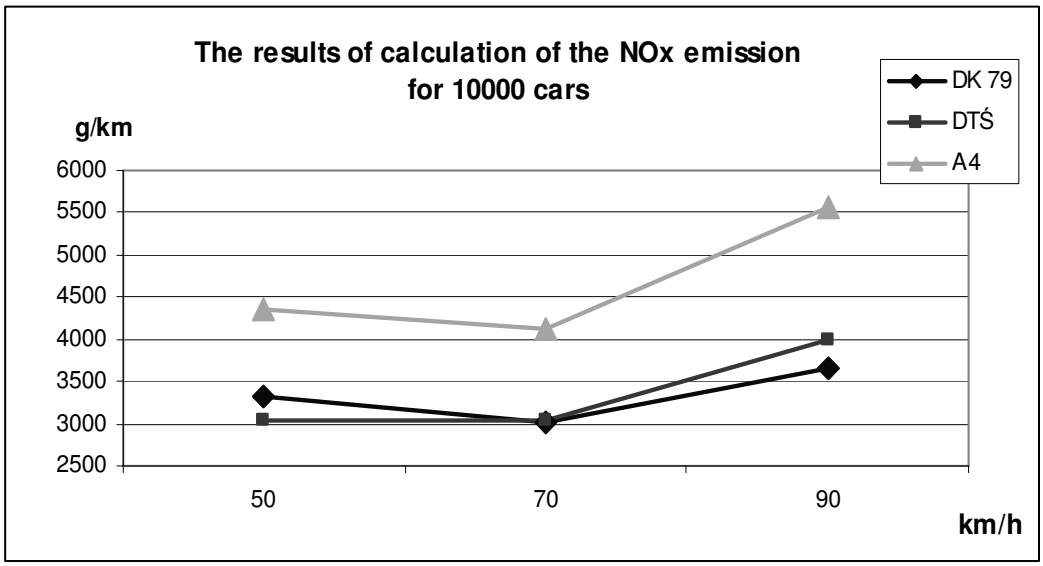

Fig. 7. The results of the calculations of the NOx emission for 10000 cars
Rys. 7. Wyniki obliczeń emisji NOx dla 10000 pojazdów

For all vehicles also the amount of PM (particulate matter) has been calculated. The largest emission is also for A4 motorway. But in this case the amount of PM for DTŚ expressway is also high. The emission of the PM for 10000 vehicles is presented on picture 8.

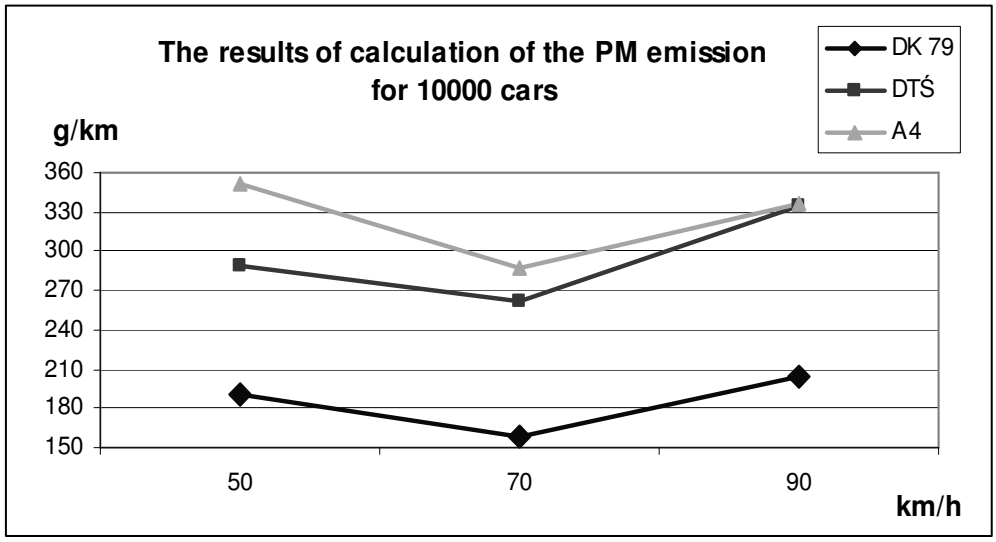

Fig. 8. The results of the calculations of the PM emission for 10000 cars
Rys. 8. Wyniki obliczeń emisji PM dla 10000 pojazdów

4. SUMMARY AND CONCLUSIONS

This article presents the results of calculations of the pollutants emission from the road transport. Total emission has been calculated with combination of the investigation results i.e. the number of emission, the type of vehicles and their age structures for different types of roads. The investigations have been made for different classes of roads. There was chosen different classes of roads with different types of vehicles i.e. A4 Motorway Katowice – Gliwice, the DTŚ expressway Katowice – Zabrze and the DK 79 road in Katowice.

For chosen roads the traffic line has been recorded in the same length of time (15 minutes). On the basis of analysis of the recorded traffic line, the number of vehicles, the type of vehicles and their age structure have been estimated. For each road there were different number of vehicles, different vehicle structure and their age structure. The largest number of all vehicles has been for A4 motorway.
Next, the vehicle structure on the basis of results of investigation has been described. In this case, the percentage amount of heavy duty vehicles and light duty vehicles was the highest for A4 motorway.
For each individual road the calculation of vehicle emission has been made. The calculation has been made for number of vehicles, which was noticed during 15 minutes. That results of calculation showed that the emission for A4 motorway was the largest.

Next, using vehicle structure characteristic for each road, the number of each type of vehicles in group of 10000 cars has been described. Then, for each road the emission for 10000 vehicles has been calculated. In this case, the figures show how the vehicle structure has influenced on the total vehicle emission. The emission was highest also for A4 motorway.

The results of the investigations and the calculations show that the vehicle emission depends on the type of road, the type of vehicles and the age structure of vehicles.

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