TEKA Kom. Mot. i Energ. Roln. – OL PAN, 2011, 11c, 223–229

NEGATIVE IMPACT OF MOTORIZATION ON THE NATURAL ENVIRONMENT

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Summary. The paper presents a growing threat to the natural environment caused by the avalanche growth in the number of trucks and cars within the urban areas and beyond their borders. Based on the example of the Szczecin agglomeration - located at the crossroads of the east-west and north-south transit routes - selected harmful components associated with the use of trucks and their negative impact on the human lives and functioning of the ecosystem in Poland have been discussed.

Key words: engine, exhaust gas smokiness.

INTRODUCTION

The dynamic increase in the number of cars within urban agglomerations and beyond them and trucks in the domestic and international traffic have caused increasing threat to the environment. The situation has forced to adapt the existing motor transport infrastructure and the transport means themselves to the new needs and possibilities. New engine designs that meet the most stringent European standards and regulations are produced. Companies develop the existing designs and invent entirely new ones - different from the existing solutions.

These attempts are focused on meeting the three basic assumptions:

- low fuel consumption,
- low toxicity of exhaust gases,
- good dynamic properties (engine response),

The strong emphasis on the environmental protection, international arrangements and unusual weather phenomena and anomalies occurring in different parts of the world have indicated that this is the right way[1]. We cannot avoid the increased traffic of vehicles with conventional drive, and a gradual reduction of green areas determining the air quality and maintaining a balance in the ecosystem. Therefore, the research has been continued on improving the operational parameters, the quality of exhaust gases and increasing the pro-ecological awareness in the society [2,4].

1. SZCZECIN – URBAN AGGLOMERATION THREATENED BY MOTORIZATION

An efficient response to the growing environmental pollution as the result of impact of the transport means requires the necessary knowledge and reliable research. For this purpose, data about their harmfulness, expressed in measurable units, have been sought as well as the trends governing such interaction. On the basis of the example of a measurement system operating in Szczecin one can trace how such measurements of the area pollution and actions to minimise its effects are organised. The selection of measuring points is related to the intensity of traffic and the main transport routes passing through the urban agglomeration, which is a quite typical area as far as the organisation of transport designed to meet the needs of the population is concerned. Based on the previous experience with the operational testing carried out at the Faculty of Automotive Vehicles Operation of the Technical University of Szczecin, and now the West Pomeranian University of Technology, it has been found that apart from the traffic accident such impact is the most visible and felt in relation to trucks in the form of dust and exhaust gases production [4,10].

The selection of Szczecin is not accidental - its geographical location at the crossing of transit routes from the north to the south and from the west to the east already in the ancient times contributed to its dynamic development and great importance. Also at the present times, the existing and the planned routes passing nearby have provided opportunities for the development of the transport infrastructure, but at the same time the threats for the people and the environment have increased.

The phenomena occurring in Szczecin can be applied to other agglomerations, through which the transit transport goes, and that do not have ring roads to channel that traffic and divert it to the outskirts. That is why the experimental studies have been carried out on the express road S-3 (E 65) (Gorzow Wielkopolski - Szczecin in the direction of the port of Swinoujscie). The results of the operational studies, supported by the engine testing on test stands can be used in developing the future-oriented concept for the land connection of the Scandinavia with the Balkans, e.g. with the Swinoujscie - Jakuszyce motorway as the shortest connection from the Baltic to the Balkans.

A major reconstruction of the transport infrastructure of the city undertaken recently is precisely aimed at clearing the arteries, introduction of modern solutions and widely understood protection of the environment and the health and life of the residents.

2. MEASUREMENTS OF AIR POLLUTION IN SZCZECIN

In order to properly protect the environment, decisions have been taken as to constant measurements to monitor the pollution levels. For this purpose, automatic measurement stations have been installed in selected places. The place of measurement in Szczecin has been located in the immediate vicinity of the road with the traffic intensity of about 50 000 vehicles per day. The station measures the momentary concentration of nitrogen oxides, carbon monoxide and sulphur dioxide. An additional factor determining the location is the highest value of noise level at this point (Leq = 81…85 dB) on the road map of acoustic noise for the city of Szczecin [8,10]. The diagram of the measuring station operation is shown in Fig.1.

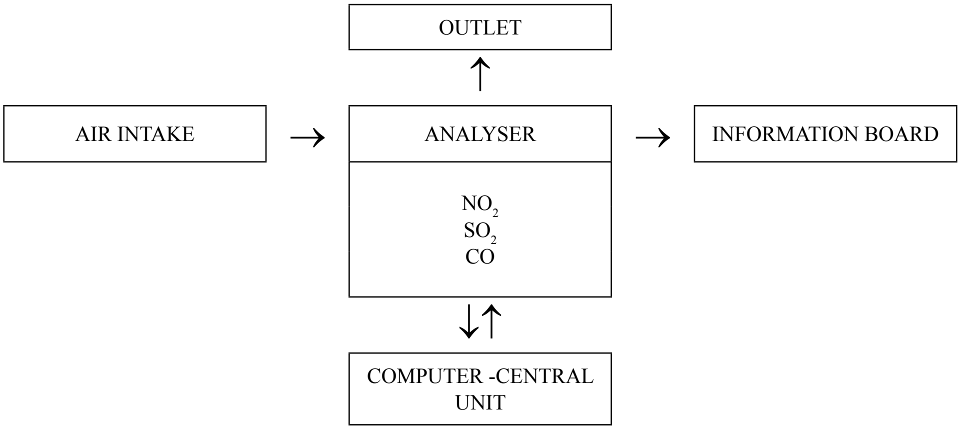

Fig. 1. Diagram of measuring station operation [8]

3. POLLUTION MEASUREMENT RESULTS

In 2005, three new automatic air-pollution monitoring stations were opened in Szczecin. The first station in the Andrzejewski Street, Fig.2.2, is designed to measure the urban background, where the representativeness of the measurement station is:

- SO_2 - several kilometres,
- NO, NO_2, NO_x - a few hundred metres,
- PM_{10} - a few hundred metres,
- O_3 – several kilometres.

Another station at the Rodła Square is the station for the traffic air pollution measurements, where the representativeness of the measurement station is:

- SO_2 - a few kilometres,
- NO, NO_2, NO_x - a few hundred metres,
- PM_{10} - a few hundred metres,
- C_6H_6, C_7H_8, C_8H_{10} - a few hundred metres,
- CO - a few hundred metres.

The last of them is in the northern part of the city, in the Łączna Street (impact of Z.Ch. “Police” Chemical Plant)

The representativeness of the measuring station in the Łączna Street is as follows:

- SO_2 - several km,
- NO, NO_2, NO_x - several kilometres,
- PM_{10} - several kilometres,
- CO - several kilometres.

a) b)

Fig. 2. a, b Measuring station in the Andrzejewski Street in Szczecin [9]

The presented results of the studies concerning the measurements of air pollution caused by the traffic of motor vehicles in Szczecin can be generalised by changing from the time density characteristics to the linear characteristics through calculation of the arithmetic mean value of the sum of the weighted average (Fig.3). This will allow to track the trends accompanying the composition of particular pollutants in the air over the recent years and to predict their possible contents.

Based on the previous studies, the characteristics has been carried out of the annual average air pollution in the agglomeration of Szczecin, which is shown in Fig.3.

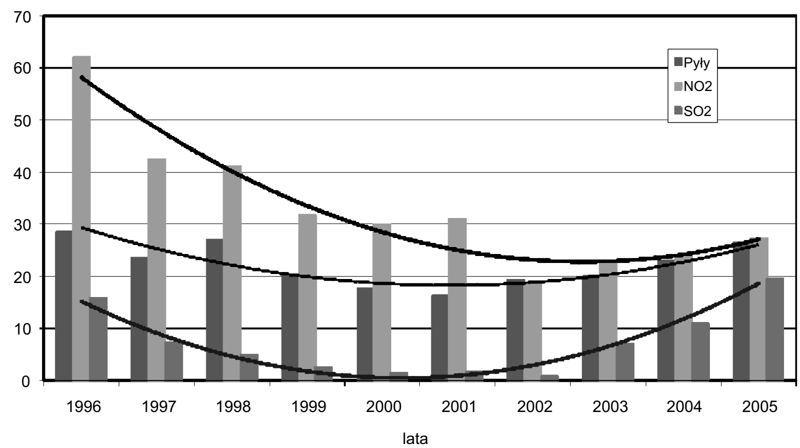

Fig. 3. Curve of annual air pollution in the urban agglomeration of Szczecin in μg/m^3 [5]

Legend: Pyły: dust Lata: years

All the curves representing the basic components of the air pollution show the decreasing trend and then the increasing one. With regards to the suspended particulates, their content in the air decreases till 2001, when it reaches the minimum and then increases, although it has not yet reached the permissible value. This situation has been caused by a growing number of trucks transiting through Szczecin and the lack of a ring road that would relieve the city centre areas.

4. OPERATIONAL PARAMETERS OF TESTED ENGINES

Operational fuel consumption is determined on the basis of road tests that are carried out in certain traffic conditions, with constant or variable speed. This value is dependant on the parameters of the vehicle and the engine as well as many operational factors, such as:

- technical condition of the engine, components and mechanisms of the vehicle,
- weight and distribution of carried passengers, luggage and cargo,
- properties of the road, its shape and type, the quality and condition of pavement,
- traffic conditions,
- atmospheric conditions.

The most general rate of the economic efficiency of the engine operation (economy of a vehicle) is the fuel consumption measured in dm^3/100 km. However, this is an indicative rate and not very precise one, which does not take into account the operating conditions such as speed, duration of driving, load, road condition and operation time. With regards to the engines, there is a more accurate rate - specific fuel consumption - which sometimes is also given in technical descriptions, especially of heavy-duty trucks [3,6,7].

The specific fuel consumption expressed in g/kWh (g/ HPh) indicates what fuel weight (and the chemical energy contained in it) is to be converted into mechanical work to produce one kilowatt-hour by the engine. This rate is advantageous as it is not dependant on the engine capacity (its size) and the type of used fuel, and thanks to that it is possible to compare different engines designed for different purposes, powered by both petrol and diesel fuel, or fuels of plant origin.

Dependencies between selected parameters determining the engines and pollution generated by them have been presented below [5].

Table 1. Dependence between the response of engines and content of particulates in the air

No.	Engine	Average response	Content of PM 10 $\mu g/m^3$	Correlation coefficient
1.	DAF	1.947	18	0.981446
2.	Volvo	1.982	17	
3.	Scania	2.021	19	
4.	Renault	2.053	20	
5.	Mercedes-Benz	2.212	23	
6.	IVECO	2.406	26	

The dependencies between the response of engines and content of particulates in the air are very strong and demonstrate strong relationship between the assessed parameters.

Table 2. Dependence between specific fuel consumption and SO_2 content in the air

No.	Engine	Average g_s g/(kWh)	SO_2 content µg/m^3	Correlation coefficient
1.	Renault	191.0	2.0	0.929226
2.	Mercedes	191.4	2.1	
3.	Scania	191.7	1.0	
4.	IVECO	191.9	7.0	
5.	Volvo	192.0	11.0	
6.	DAF	193.6	19.5	

The obtained correlation coefficient is as high as for the dependence g_e – PM10.

In turn, the dependence between the specific fuel consumption and the content of nitrogen oxides in the atmospheric air has been shown in Table 3

Table 3. Dependence between specific fuel consumption and NO_2 content in the air

No.	Engine	Average g_s g/(kWh)	NO_2 content µg/m^3	Correlation coefficient
1	Renault	191.0	30	-0.13388
2.	Mercedes	191.4	31	
3.	Scania	191.7	18	
4.	IVECO	191.9	23	
5.	Volvo	192.0	24	
6.	DAF	193.6	27	

The absolute value of the correlation coefficient indicates a very weak dependence between the assessed parameters, and the negative value indicates that along with the increase in the specific fuel consumption, the content of nitrogen dioxide in the air decreases as a result of combustion processes in automotive engines.

CONCLUSIONS

Increased truck traffic in urban agglomerations is characterised by high intensity of emission of harmful substances. There are many methods of protecting the natural environment - one of the most important ways is to reduce the traffic congestion by diverting trucks to ring roads, which prevents them from entering the city centres and residential districts. Combined with the proper organisation of the flow streams of vehicles as well as application of the "green wave" and acoustic screens it provides the expected results - maintained smoothness of traffic flow, stabilised speed of the stream of vehicles, reduction of fuel consumption and decrease in the number of accidents.

Based on the analysis of pollutants and operating parameters of the tested engines it can be stated that diverting the truck traffic to the outside of the urban centres is an effective and proven method of protecting the environment. The increase in the number of utility vehicles causes that this development trend is currently being implemented, but it requires expenditures for the development and reconstruction of the existing infrastructure of the road transport.

The example of other European countries has shown that the expenditures spent for the environmental protection will bring the expected benefits in terms of improving the functioning of the ecosystem and in solving problems of the road transport. The intended and achievable long-term effect is to protect the human health and environment in the region.

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NEGATYWNY WPŁYW MOTORYZACJI NA ŚRODOWISKO NATURALNE

Streszczenie. W artykule przedstawiono narastające zagrożenia dla środowiska naturalnego spowodowane lawinowym wzrostem ilości samochodów ciężarowych i osobowych w obrębie aglomeracji miejskich i poza ich granicami. Na przykładzie aglomeracji Szczecina- położonego na skrzyżowaniu dróg tranzytowych wschód –zachód i północ -południe omówiono poszczególne szkodliwe składniki związane z eksploatacja pojazdów ciężarowych oraz ich negatywny wpływ na życie ludzi i funkcjonowanie ekosystemu w Polsce.

Słowa kluczowe: silnik, gazy wylotowe.