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EFFECT OF EMISSION MEASUREMENT OF TOXIC EXHAUST COMPONENTS OF AUTOMOTIVE VEHICLES EQUIPPED WITH SPARK-IGNITION ENGINES ON THE ENVIRONMENT DURING MANDATORY CHECK TESTS AT VEHICLE INSPECTION STATIONS

The article describes aspects related to the impact of toxic components of exhaust gases from motor vehicles, which are equipped with spark-ignition engines for environmental pollution and a negative impact on human health. The paper presents aspects related to the structure of passenger cars in Poland and the European Union, which are in operation and subject to mandatory control tests. The methodology of performing mandatory periodic check-ups in diagnostic stations and on the basis of the developed research results also includes a group of vehicles that does not meet the legal requirements for the measurement of exhaust emissions. The results of passenger car tests in selected European Union countries have been presented.

1. THE IMPACT OF TOXIC EXHAUST COMPONENTS ON ENVIRONMENTAL POLLUTION

Significant impacts on environmental pollution are motor vehicles powered by spark ignition engines and self-ignition engines which are in service. Sources of harmful substances that pollute the atmosphere are: exhaust gas system from the engine, fuel supply system and chassis. Emissions of exhaust gases such as carbon monoxide, hydrocarbons, nitrogen oxides, solids, and substances in low concentrations of sulfur, phosphorus, etc. are emitted to the atmosphere. The automotive industry is recognized as a dynamically developing field and therefore the number of vehicles in use is also increasing. The problem is the lack of road infrastructure in urban and non-urban agglomerations, especially in developing countries. The dynamic development of industry and new technologies results in an increase in energy demand, triggering hazards that include the effects of burning all fuels. In the process of combustion, chemical compounds are created that negatively affect the atmospheric environment and the health of humans and animals. By emitting large amounts of gases into the atmosphere, mainly CO_2 produces a greenhouse effect, which results in an increase in the average temperature of the ecosphere and associated undesirable meteorological phenomena. [1].

Fig.1. *Environmental pollution by cars [2]*

The danger to people is the emission of solid particles, which is a barrier to the development of modern combustion engines. The effect of particulate matter on climate change is a complex problem, in the global view the particles in the atmosphere exert an influence on the slowing down of atmospheric warming. Estimation of the global impact of PM particles on global climate and local meteorology and subsequent health and environmental effects due to specific changes in particulate emissions at local level are uncertain. In Poland, preliminary air quality assessment results indicate that particulate matter emissions For years, systematically decreasing is still a very important component of air quality [3]. Communication pollution in large urban agglomerations accounts for 75-80% of total contamination. Unfavorable phenomena, especially in the urban environment, are exacerbated by the reduction of the role of public transport with a constant increase in the number of used cars [4].

2. STRUCTURE OF TRANSPORT

In Poland, in the period since 1990, with the economic growth, there has been a continuous increase in the number of motor vehicles in continuous use. In December 2016. All vehicles, trucks, buses, motorcycles and other vehicles listed in Table 1 were registered. The largest group is 21675388 passenger vehicles, which accounts for 75.6% of the overall condition of vehicles in Poland. There is a problem of ensuring proper technical condition of vehicles that are in service for many years. The average age of passenger cars in service in December 2016 in Poland it was 15.5 years. Over the last period, a significant increase in the number of vehicles registered per 1000 inhabitants has been observed in Poland [5].

Tab.1. *Structure of vehicles[4]*

	1990	1995	2000	2005	2010	2014	2016
Personal Cars	5261000	7517000	9991000	12339000	172398	20003863	21675388
Truck Cars	1045000	1354000	1879000	2305000	2981616	3340616	3179655
Buses	92000	85000	82000	80000	97044	106057	113139
Motorcykles	1356000	929000	803000	754000	1013014	1189527	1355625
Another	1287000	1301000	1351000	1337923	1705675	1832211	2277230
Total	9041000	11186000	14106000	16815923	23037149	26472274	28601037

Fig. 2 presents the structure of car transport in Poland in the period from 1990 to 2016. In the presented period, the number of vehicles increased by 19560037 units in the group passengers cars increased by 16414388 units and the significant increase of trucks by 2134655 units in The remaining groups of buses and motorcycles also increased the number of vehicles. In Poland the number of passenger cars was 539 units per 1000 inhabitants, the largest number of vehicles was in the Wielkopolskie Voivodship 627 more than the national average and the lowest in the province. Podlaskie 485 units [5]. Tabele 2 shows the vehicle stock of diesel and petrol cars in European Union. Development of the vehicle passenger cars for the time period from 2015 to 2030. In the analyzed period, the number of passenger cars will increase by about 50 million, cars with a diesel engine of about 37 million and a gasoline engine about 7 million [https://www.vdtuev.de].

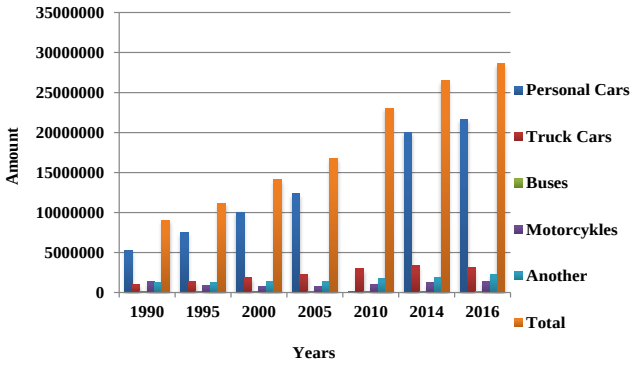

Fig.2. *Structure of vehicles [2]*

Tab.2. *Structure of vehicles[9]*

Year	Total Passenger cars	Total Petrol	Diesel Total
2015	249477960	143830976	105646984
2030	293529136	151425324	142103812

Fig. 3 presents the structure of car transport in European Union (EU), in the period from 2015 to 2030. The graph presents an increase in the number of passenger cars in the EU by about 50 million in the analyzed period.

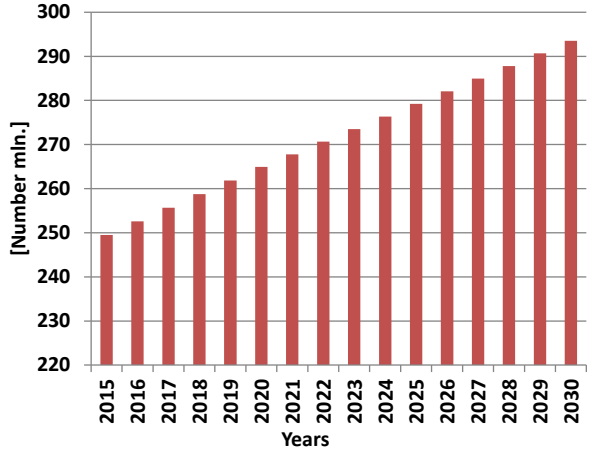

Fig.3. *Structure of vehicles in E.U. [9]*

3. CAR VEHICLE TESTS IN VEHICLE CONTROL STATIONS

Vehicles that are in service are subject to mandatory periodical inspections that are per-formed at the Vehicle Inspection Station and consist of verifying that the vehicle meets the technical specifications set forth in the legislation. Control is mandatory and is performed for new passenger vehicles after three years of operation followed by two and subsequent tests taking place after another year of operation in accordance with the legislative regulations of the legislator. Exhaust gas emission measurement was performed when the engine was heated above 70 °C for engine oil and above 80 °C for coolant. The exhaust gas analyzer was introduced into the engine exhaust system immediately before the measurement at a depth of at least 30 cm. The engine's crankshaft rotational speed was maintained for more than 15 seconds and then lowered to idle speed [6].

Fig.4. *Diagnostic Station [7]*

Tab.3. *Levels of gaseous pollutants and air excess coefficient λ [6]*

Lp	Vehicle	Engine speed	CO content in% volume of exhaust gas HC in ppm (particles per million) and λ for a vehicle						
			Until Sept. 1986	From 1 October 1986 to 30 June 1995	From 1 July 1995 to 30 April 2004			Since May 1 2004	
1	2	3	4	5	6	7	8	9	10
			CO	CO	CO	CH	λ	CO	λ
1	Motorcycle	Idle	5,5	4,5	4,5	-	-	*4,5*	-
2	Another motor vehicle	Idle	4,5	3,5	0,5	100	-	*0,3*	-
		2000 min^{-1} to 3000 min^{-1}	-	-	0,3	100	0,97-1,03	*0,2*	*0,97-1,03*

3.1. FINDINGS

The study was conducted under real conditions at the Diagnostic Vehicle Station (DVS) during mandatory screening tests. The study involved a group of 400 spark-ignited cars with a 3.5 DMC rating that measured engine exhaust emissions, carbon monoxide (CO), hydro-carbons (HC), and lambda excess (λ). Table 4 presents vehicle test results [6].

Tab.4. *Study results[8]*

	Up to 1995 Year	1995-2004 Years					Over of 2004 Year		
	CO idle	CO idle	CO h.s.	HC idle	HC h.s.	λ	CO idle	CO h.s.	λ
Cars	60	209	209	209	192	209	143	118	138
P.R.	52	157	118	109	113	91	118	79	112
N.R.	8	52	91	100	79	118	25	39	26

Fig. 5presents the results of a study of 60 vehicle groups produced before 1995 that did not meet the 8-volume emission requirements (CO), after the 1995 production year, participated in 209 (negative) and 52 (negative) tests. Which were produced in the

years 1995-2004, did not meet the 118 lambda (λ) emissions requirements. The 209 and 192 groups were involved in the HC (HC) study. The negative result for the 79 increased and idling 100 Pcs After the year of manufacture 2004 participated in the study of coefficient (λ) 138 pcs negative result 26 pcs.[8]. Fig. 6 shows the results showing that vehicles manufactured before 1995 did not meet the emission requirements (CO) in 13.3%, after the 1995 production year at 24.88% and 47.84% respectively. 33.06%. Cars that were produced between 1995 and 2004 do not meet the emission requirements for lambda (λ) at 56.46%, produced after 2004 do not meet the requirements at 18.84%.

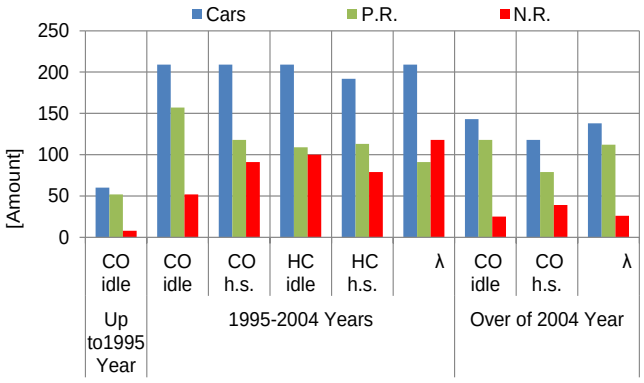

Fig.5. *Study results [8]*

Fig. 6 shows the results showing that vehicles manufactured before 1995 did not meet the emission requirements (CO) in 13.3%, after the 1995 production year at 24.88% and 47.84% respectively. 33.06%. Cars that were produced between 1995 and 2004 do not meet the emission requirements for lambda (λ) at 56.46%, produced after 2004 do not meet the requirements at 18.84%.

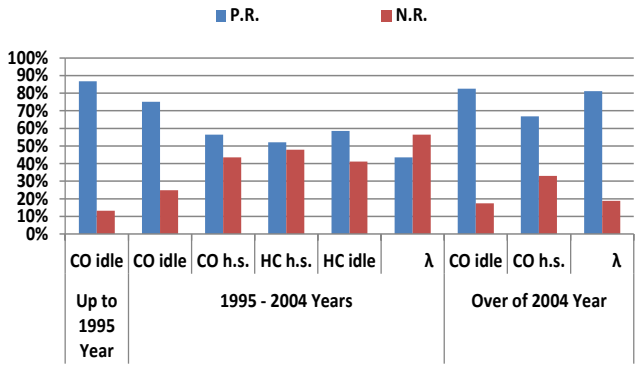

Fig.6. *Study results [8]*

Fig. 7 presents the of tests carried out by three people, the results show different values and are not repeatable. The test performed indicates that the human factor has a significant impact on the test results. Car tests carried out by several people have shown that the highest emission level of the toxic exhaust component occurred at 3000 revolutions of the engine crankshaft per minute.

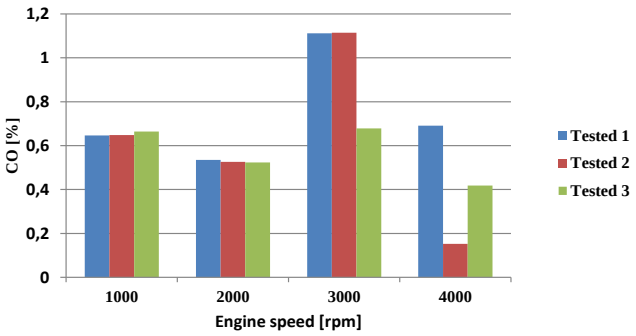

Fig.7. *Study results [8]*

The conducted research in selected countries in the European Union presented in Tabele 5 was carried out on a group of passenger cars with spark ignition in the number of 1374. From the tested group, it did not meet the requirements regarding the permissible emission values of toxic components of the exhaust gas of 113 vehicles, which accounted for 8.22% of the group of passenger cars tested.

Tab.5. *Study results [9]*

	Number tested	Number Failed
Europe	1374	113
Spain	355	16
Belgium	350	42
Netherlands	151	19
Germany	268	22
Sweden	228	7
France	22	4

The presented results on the graph (Fig. 8) show selected countries in which the tests of admissible values of toxic components of exhaust gases and the number of passenger cars that took part in research in selected countries in the European Union were carried out.

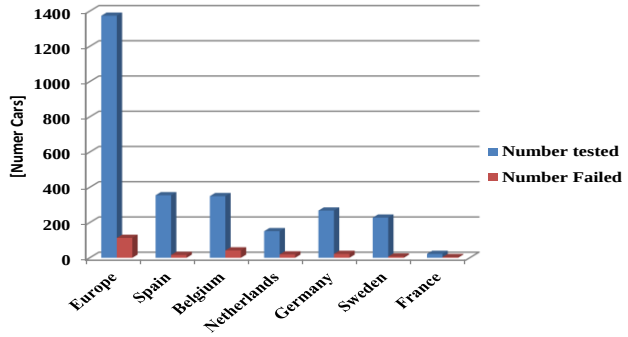

Fig.8. *Study results in EU. [9]*

SUMMARY

The article describes problems related to the impact of environmental pollution on car transport. For the reasons for atmospheric pollution, one of the main sources is the technical state of the fuel supply systems, flue gas exhaust gas purification equipment, which directly affects the reduction of toxic emissions of CO, HC and particulate matter from cars in service. Essential sources of environmental pollution are consumables, gasoline and diesel oils, and lubricants that contain many toxic compounds, sulfur and particu-

lates. Analysis of the transport structure in Poland shows that from 1990 to 2016, There were an increase in the number of all cars in operation by 19560037 units and passenger cars by 16414388 units. The European Union is experiencing a dynamic growth in the number of passenger cars in operation in the analyzed area until 2030, the number of cars will increase by about 50 million. pieces. The increase of such a large number of motor vehicles will have an impact on the increase of environmental pollution and increase in population incidence. the results showing that vehicles manufactured before 1995 did not meet the emission requirements (CO) in 13.3%, after the 1995 production year at 24.88% and 47.84% respectively. 33.06%. Cars that were produced between 1995 and 2004 do not meet the emission requirements for lambda (λ) at 56.46%, produced after 2004 do not meet the requirements at 18.84%. The European Union is experiencing a dynamic growth in the number of passenger cars in operation in the analyzed area until 2030, the number of cars will increase by about 50 million pieces. The increase of such a large number of motor vehicles will have an impact on the increase of environmental pollution and human health.

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Wpływ pomiaru emisji toksycznych składników spalin pojazdów samochodowych wyposażonych w silniki o zapłonie iskrowym na środowisko podczas obowiązkowych badań kontrolnych na stacjach kontroli pojazdów

W artykule opisane zostały aspekty związane z wpływem toksycznych składników gazów wylotowych z pojazdów samochodowych, które są wyposażone w silniki o zapłonie iskrowym na zanieczyszczenie środowiska oraz negatywny wpływ na zdrowie ludzi. W pracy przedstawione zostały aspekty związane ze strukturą samochodów osobowych w Polsce i Unii Europejskiej, które znajdują się w eksploatacji i podlegają obowiązkowym badaniom kontrolnym. Opisano również metodykę wykonywania obowiązkowych okresowych badań kontrolnych w stacjach diagnostycznych oraz na podstawie opracowanych wyników badań wyodrębniona została grupa pojazdów, która nie spełnia wymagań prawnych w zakresie pomiarów emisji spalin. Przedstawione zostały wyniki badań samochodów osobowych w wybranych krajach Unii Europejskiej.

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