On urgent need of solving issues regarding decrease in annual mortality of many millions of urban citizens due to automobile transport operation

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Abstract. Currently, the greater part of the planet population is frightened of the deaths of about 1 million people from coronavirus as they do not know that more than 7 million of the population die annually in silence from atmospheric pollution by hazardous substances from transport operation and from the industry. The article shows the results of Russian studies proving that current urban pollution shall be defined not by the vehicle exhaust (emission) gases regulated by the international UN Regulations but by particulate matters from wear of tyres, brake systems and asphalt roadway which are not legally regulated either by nations or at the international level (UN Regulations) yet.

1. Introduction

According to the new data (2018) of the World Health Organization (WHO), 9 out of 10 people around the world breathe air with high concentration of pollutants. For that very reason, 7 million people die annually because of the consequences of breathing the air containing particulates which are able to penetrate deep inside the lungs and cardiovascular system, causing such diseases as stroke, cardiac diseases, lung cancer, chronic obstructive pulmonary disease and respiratory infections, including pneumonia \cite{1}. Figure 1 provides the WHO information on elevated concentrations of particulate matters (PM) in the air by regions and continents of our planet as early as in 2008-2013.

![Figure 1. Global average annual PM concentrations in the air (over 2008-2013) \cite{2}.](image-url)
Figure 2 shows the nature of changes in emissions of hazardous substances in the Russian Federation during the period of 2000-2018 [2].

![Graph showing changes in emissions of hazardous substances into the air, for 2000 = 100%](image)

**Figure 2.** Changes in emissions of hazardous substances into the air, for 2000 = 100%.

2. **Results**

The stage-by-stage introduction of standards in the last 35 years by the International UN Regulations tightening the Euro standards for emissions of hazardous substances (HS) in vehicle exhaust gases (EG) naturally resulted in complication of engines and vehicles design and their cost increase. A challenging question appears: is there economic and environmental expediency of introducing Euro 6 emission standards and higher for additional reduction of HS emissions and especially of particulate matters in the EG? Figure 3 shows the efficiency of reduction of environmental damage and economic losses while toughening the UN Regulations standards from Euro 0 up to Euro 6. Over the last fifty years, several stages of works on reduction of vehicle fuel consumption i.e. reduction of hazardous substances emissions were carried out.

![Graph showing reduction of damage from HS emissions in vehicle EG](image)

**Figure 3.** Reduction of damage from HS emissions in vehicle EG.

Figure 4 shows the efficiency of works on improvement of mass-produced passenger cars and their engines in particular. Specifically since 1970 to the present day, the fuel consumption has been reduced from 12.5 l/100 km to 4.7 l/100 km, i.e. almost by 3 times, which means the greenhouse gas emissions (CO₂) as well as hazardous substances and particulate matters emissions have also been significantly reduced.

Timely application of exhaust gas after-treatment systems has become an effective measure and allowed to reduce the total emissions of hazardous substances, despite the steep increase in the vehicle
fleet of the Russian Federation since 2000 by 2020 by almost 2 times and to estimate the prospective changes by 2030 (Figure 5).

However, it should be noted that during this period, there was a sharp limitation of particulate matter emissions in EG introduced by UN Regulations for vehicle engines by more than 10-20 times since 1992 to the present day.

Figure 4. Achieved and forecasted fuel efficiency levels for passenger cars of conventional mass of 1000 kg

Figure 5. Growth of vehicles number in Russia over 2000-2020, forecast until 2030, and change of the total weight of emitted HS in EG per year during vehicle operation complying with Euro 0 emission standard and in case of changing the standards from Euro 0 up to Euro 5 given the vehicle fleet renewal in 15 years (1) and in 10 years (2).
Despite such advances in science and industry, the WHO proposed to prohibit the usage of diesel vehicles under the urban operating conditions in 2012.

According to our research conducted in FSUE "NAMI" and also based on a number of foreign studies, the WHO statement was unreasonable and partially erroneous as WHO experts and international legislators do not pay due attention to other hazardous particulate matters of non-exhaust origin emitted by vehicles during operation due to the wear of vehicle systems and units, such as brake systems (pads and discs), clutch plates and especially tyres [3].

Previously, based on Russian studies, it was known that up to 60% of air pollution accounts for particulate matters due to the tyre wear caused by vehicles operation in the urban environment [4].

The studies conducted in NAMI over 2011-2012 defined the emissions of particulate matters due to the tyre and brake mechanism wear by calculation based on their warranty life and confirmed the considerable excess of the emissions in exhaust gases in comparison with the limits of UN Regulations No. 49 and 83 by more than 40 to 60 times and as for buses, trucks and public transport by more than 200 to 300 times [3].

Due to the abovementioned varying situation, according to the assessment of causes of air pollution, there has risen a global energy and environmental conflict between the transport, the community and the environment which by the current time period has become critical both by its level and its violent growth. Against the backdrop of the intense searching (or sometimes its imitation) for the transport environmental problem solution by means of electric vehicles (EV) and alternative fuels, for the development of which large economic and energy resources were allocated and spent, the allocation of money for the explicit threat to the health of urban citizens from urban air pollution has not yet been provided.

Figure 6 shows the final results summarizing the research carried out in FSUE "NAMI", the Russian Federation, on comparative analysis and forecast for change of PM emissions within the period from 2000 to 2030 caused by other vehicle systems (brake systems, tyres) and by roadway wear with the limits of UN Regulations No. 49 and 83 on PM emissions in EG through the example of the growth of Russian vehicle fleet [5, 6].

So, highly convincing and important data should be especially noted in the document which was provided at GRPE international sessions by European Tyre & Rubber Manufacturers Association (ETRMA), in which the results of the PM chemical analysis are given for the content of polycyclic aromatic hydrocarbons (PAH) in tyres and roadway that contain highly hazardous cancerogenic substances causing human cancer diseases. The values are expressed in parts per million (ppm) in the matters mix, sampled behind the moving vehicle, i.e. by wear of tyres, roadway and in exhaust gases (Table 1) [7, 8].

Figure 7 provides the comparative results of the research of PM emissions caused by various vehicle systems according to the materials of the research conducted in the Russian Federation and the UK for the period of 2015. Different values in percentage terms in the UK research are determined by the lag of the Russian Federation by ≈ 8 years concerning the introduction of Euro emission standards of UN Regulations for EG and a softer asphalt-concrete surface of the roadway with gravel content from 30% to 50% in relation to the UK roads that have 60-80% of gravel.

Thus, it can be concluded that today we can state the following percentage rate of PM emissions: with EG - 28%; from brake systems wear - 7%; from tyre wear - 12% and from roadway wear - 53%.

That is why the most important issue currently in the Russian Federation and other countries is taking urgent measures to reduce PM emissions not only with exhaust gases, but, first of all, from roadway and tyre wear, as the mass of PM emissions from roadway wear is currently twice as big as PM emissions with exhaust gases and considering tyre and brake systems wear, the excess is almost 3 times, and these very non-exhaust emissions will predetermine air pollution in urban environment with PM that are highly hazardous for the health of urban citizens and that contain cancerogenic substances, causing cancerous diseases first of all today and especially in the future.

In view of the above, it is incomprehensible why there are such a slow reaction and an unfair delay in the intensification of investment in developments (projects) and the acceptance of the necessary
measures to effectively reduce urban air pollution with hazardous substances caused by transport operation.

Figure 6. Dynamics and forecast of annual PM emissions from wear of tyres, braking mechanisms and asphalt roadway in the Russian Federation, in tons, compared to the emissions of and emissions limits (standards) for PM with EG.


| Chemical substance                  | Road particles (RP) | Tyre wear particles (TWP) | Tyre (tread) particles (TP) |
|-------------------------------------|---------------------|---------------------------|-----------------------------|
| Acenaphthene                        | 4.08                | 0.04                      | 0.13                        |
| Phenanthrene                        | 53.4                | 1.66                      | 1.21                        |
| Pyrene                              | 54.84               | 4.77                      | 0.06                        |
| Anthracene                          | 7.36                | 0.1                       | 0.11                        |
| Benzenanthracene                    | 38.65               | 0.18                      | 2.87                        |
| Benzo(a)pyrene                      | 12.51               | 0.28                      | N.D.                        |
| Benzo(k)fluoranthene                | 7.4                 | 0.02                      | 0.92                        |
| Chrysene                            | 17.72               | 0.36                      | 2.95                        |
| Dibenz(a,h)anthracene               | 2.56                | 0.1                       | 0.87                        |
| Fluoranthenne                       | 82.13               | 0.98                      | 1.62                        |
| Indeno-1,2,3(c,d)                    | 5.36                | 0.21                      | N.D.                        |

Figure 7. Nowadays distribution of PM emissions ratio from vehicle operation.

It should be emphasized that even if 100% of the vehicles in the urban environment are replaced with electric vehicles in the next 10-15 years, which seems unlikely, then this quite expensive activity might reduce PM emissions by no more than 25%, while in the same 10-15 year period there will also be progress in reducing PM emissions in EG of conventional vehicles with internal combustion engines! This circumstance indicates the need to re-define the opinion & attitude of governmental and legislative bodies on speed-up of investment in more efficient areas (programs) for reduction of PM emissions and of their content of cancerogenic substances causing cancerous diseases of urban citizens.

So, today we face the poorly understood and wrong standpoint of international and national legislation – for more than 50 years, intensive research is being performed on decreasing emissions of hazardous substances (HS) and PM in EG, i.e. significant investments are made to the development of engine and vehicle designs, but, until the present, there are no investments in reduction of PM emissions from wear of roadway and tyres. Thus, it is essential to point up injustice, improvidence and maybe even incompetence of the decision by the WHO and the European Union – transition to electric vehicles only.

Worth recalling in this regard is that the International Organization for Standardization (ISO) gave a response and started developing standards on definition of PM emissions from wear of tyres and roadway - so, in 2017 and 2018, five standards were published prescribing the laboratory methods of collecting particles from wear of tyres and roadway with their subsequent physical and chemical analysis.
Finally, in concluding the long-term (2012-2019) discussion of the problem of PM emissions, the abovementioned materials of Russian studies (Figures 3, 4, 5, 6, 7) were presented & taken up again at the 179th session (11-15 November 2019) of the World Forum (WP-29) of the UNECE ITC with the following summary and proposals:

1. We are kept guessing, why no similar studies are performed in other countries except Great Britain after the reports of the Russian Federation made from 2013 till 2019. Is it possible that scientific and legal specialists are not informed or even indifferent to the issue under consideration that predetermines the present-day urban air pollution with cancerogenic PMs causing significant shortening of our lives and lives of our generations, and specifically of our children, grandchildren and great-grandchildren?

2. In the current situation, where the urban atmosphere is polluted by hazardous PMs, it is necessary for our Governments to initiate and sponsor serious research developments related to reduction of the content of very hazardous cancerogenic substances in materials used for production of tyres and roadway, while the international community shall immediately start to develop the respective regulatory requirements.

3. Tyre manufacturers and road construction services shall revise the existing technology for production of tyres and roadway considering the potential of ongoing research and development in terms of new materials and technologies in order to exclude from tyre and roadway manufacture any materials containing cancerogenic substances for avoidance of millions of annual population deaths in the large cities of our planet.

The results of materials of our studies described in the reports of the Russian Federation during the 2013-2019 period within the World Forums (WP-29) finally convinced specialists from more than 100 countries and allowed them to make a decision on the need to regulate PM emissions just from wear of tyres at the 179th session of the WP-29 in November 2019.

Of particular note is that, on 27 July 2020, Viktoria Abramchenko, Deputy Prime Minister of the Government of the Russian Federation, put the Ministry of Natural Resources and Environment and Federal Environmental, Industrial and Nuclear Supervision Service of Russia in charge of updating the current procedures for calculation of environmental damage due to breach of the environmental legislation, water right and Subsoil Law by 1 October. Besides, by this time, a procedure to calculate the atmospheric air damage because of man-made accidents and industrial impact shall be created from scratch.

Special studies performed by NAMI in 2019 on searching for effective solutions to reduce PM emissions in vehicle exhaust gases defined that, in order to reduce PM emissions twice more when operating transport in cities with restrained urban conditions, this vehicle speed limit shall be 40 km/h in one-way (single-lane) streets. Figure 8 makes it clear that PM emissions decrease twice when lowering vehicle speed from 50 to 40 km/h.

Thus, PM emission with EG, when decreasing the vehicle speed from 60 km/h to 40 km/h (activity proposed by us), will already amount to no more than 13% in comparison with the amount of general emission of particulate matters from other sources: tyres, roadway and brake mechanisms ~ 87% at vehicle operation for the present time.
3. Conclusions
Based on the performed studies of present issues of complex environmental safety of the existing and new vehicle designs, it is necessary to draw the following conclusions:

1. The studies performed in 2014-2016 and focused on defining the basic causes of smog formation first in the European cities stated that emissions of particulate matters (less than 10 micron) from wear of tyres and roadway exceed the damage from exhaust gases of passenger cars by 60 times and of trucks by 300 times respectively that does not confirm the high-priority need in the ban established in Europe on use of diesel-engined vehicles.

2. Nevertheless, the progress & success of the scientific and production world community achieved regarding the sharp reduction of emissions of hazardous substances with exhaust gases in the last 30 years do not allow manufacturing an environmentally friendly automotive transport for the urban environment and for people in the coming decades, even by means of the electric vehicles due to their increased emissions of very hazardous particle matters and harmful cancerogenic substances from wear of tyres and asphalt roadway.

3. The abovementioned present-day state of problem-solving, as well as all that is currently happening, show a need to re-define the opinion & attitude of governmental bodies on speed-up of investment of necessary funds in more efficient (than electric vehicles) programs for real reduction of PM emissions and of their content of cancerogenic substances that cause today silent deaths of more than 7 million population of our planet, which is out of mass media line compared with the coronavirus fatalities that have been happening from the beginning of 2020.

4. In order to solve the serious challenge on reduction of emissions of highly hazardous particle matters caused by wear of tyres and roadway, special works shall be organized for study and use of the most efficient technologies on decrease of the content of cancerogenic substances in tyres and asphalt roadway (possible only when increasing content of gravel and concrete).

5. A very simple and easy-for-implementation solution on reduction of PM emissions in the cities is imposing the 40 km/h speed limit in one-way streets that will provide reduction of PM emissions by more than 2.5 times in comparison with the speed of 60 km/h.

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