

### Real release of particulates by transport vehicles

An impressive progress has been made to reduce the emissions of harmful substances (HS) with the exhaust gases (EG), including particulate matter (PM) with active contribution of the regulatory group on pollution and energy saving (; GRPE) of the World Forum for Harmonization of requirements for vehicles UNECE ITC in the last twenty years. Tables 1 and 2 show how the environmental damage is reduced with a phased introduction of the Euro norms with assessment according to the Russian sanitary norms for day-average HS content in the air in different areas taking the examples of a car and a truck.

Table 1. Prevented damage from cars per 300 thousand km

Changes by regulation stages	Roubles	Euro
Euro-0 - Euro-1	200781	5019,5
Euro-1 - Euro-2	22190	554,8
Euro-2 - Euro-3	8730	218,3
Euro-3 - Euro-4	9081	227,0
Euro-4 - Euro-5	1782	44,6

Table 2. Prevented damage from trucks per 1 million km

Changes by regulation stages	Roubles	Euro
Euro-0 - Euro-1	1669699	41742,5
Euro-1 - Euro-2	317404	7935,1
Euro-2 - Euro-3	344712	8617,8
Euro-3 - Euro-4	288418	7210,5
Euro-4 - Euro-5	222998	5574,9

This means that the prevented damage for the entire life of a vehicle converted from Euro-0 to Euro-1 was ~ 5019,5 €, and transition from Euro-4 to Euro-5 saves only ~ 44,6 €

The environmental damage reduction indicator for trucks are greater. The switch from Euro-0 to Euro-1 brings the value of prevented damage for the lifetime of a single vehicle to 41740,5 € and the switch from Euro-4 to Euro-5 still saves extra 5574,9 €.

Table 3 quotes for comparison the maximum permissible concentration (MPC) of major pollutants in the air accepted in the Russian Federation, the European Union and the United States and adopted by the World Health Organization (WHO).

Table 3.

Pollutant	Averaging length	Russia, mg / MH	WHO, mg / MH	USA, mg / MH	EU, mg/m <sup>3</sup>
CO	15 min.	-	100	-	-
	30 min.	5	60	-	-
	1 h	-	30	40	-
	8 h	-	10	10	10
	24 h	3	-	-	-
NO <sub>2</sub>	30 min	0,2	-	-	-
	1 h	-	0,2	-	0,2 (Must not be exceeded more than 18 times a year)
	24 h	0,04	-	-	0,125 (Must not be exceeded more than 3 times a year)
	Yearly average	-	0,04	0,1	0,04
O <sub>3</sub>	30 min.	0,16	-	-	-
	1 h	-	-	0,235	-
	8 h	-	0,12	0,157	-
	24 h	0,03	-	-	-
SO <sub>2</sub>	10 min	-	0,5	-	?
	30 min	0,5	-	-	-
	1 h	-	-	-	0,350 (Must not be exceeded more than 24 times a year)
	24 h	0,05	0,125	0,365	0,125 (Must not be exceeded more than 3 times a year)
	Yearly average	-	0,05	0,08	0,02
PM <sub>10</sub>	30 min.	-	-	-	-
	24 h	-	-	0,15	0,5 (Must not be exceeded more than 3 times a year)
	Yearly average	-	0,05	0,08	0,02
Benzene	30 min	0,3	-	-	-
	24 h	0,1	-	-	-
	Yearly average	-	-	-	0,005
		-	6 * 10 <sup>-6</sup>	-	-

PM 10 are solid particles with sizes less than 10 microns. They can easily penetrate the lungs and accumulate there.

It should be noted that the Russian MPC norms for short-term and long-term effects of most pollutants except benzene are stricter than air quality standards

recommended by WHO and set by the EU Directives.

The concerns about the need to further reduce harmful emissions and, above all, PM are based on their content of highly dangerous carcinogens that cause cancer in humans and animals.

The EU countries regulate the emission limit values for the key stationary air pollution sources (plants, refineries, utilities), and also for all mobile sources: road vehicles, airplanes, locomotives, sea and river vessels.

However, the emphasis placed by the World Health Organization on further tightening of the requirements for reduction of PM in the exhaust gases (EG) of diesel vehicles is not conclusive against the actual existing emissions of PM in tire dust as a result of tire tread wear, brake pads.

The research carried out in Moscow, shows that fine tire dust is the main pollutant of urban air. Up to 60% of pollutants and hazardous substances in the air is the fine dust from tires and brake pads.

The analysis of tires from different manufacturers present at the Russian market, allows to determine the average wearing rate of tire treads per kilometer. It ranges from 0.13 g / km for cars and 0.32 g / km for vehicles under 3.5 tons to 1.5 g / km for trucks and buses. This exceeds the Euro-6 norms on PM emissions with the exhaust gas by 26, 60 and 150 times, respectively.

It should be emphasized that the tire dust constitutes more than 60% of PM and contains carcinogens.

It should be noted that Russian, American, Swedish and other researchers documented a large number of highly dangerous pollutants, including carcinogens in tire dust. Harmful substances: polycyclic aromatic hydrocarbons, and N-nitrosamines contained in the fine aerosol produced by car tires, are no less dangerous to human health because after getting into the bronchi and lungs, they get transferred directly into the blood and lymph in the course of several days due to their high solubility in water and biological fluids. The consequences of the presence of carcinogenic substances in the tissue fluids are well known in medicine and often leads to death.

Brake pads also produce a lot of harmful substances during their life.

Brake pads contain friction material, which are worn by slide friction. Each kind of vehicles utilizes brake pads of different thickness and form. But production plants manufacture brake pads of different types using almost the same technology from the same raw material but with different combination of components (the forming mix contains phenolic resins, rubbers and metallic inclusions in the form of powders and flakes).

Calculation of the wear intensity of brake pads for disc and drum mechanisms used in passenger cars showed the following:

- the average wear of the brake pads in disc brakes is 55 grams at gamma-percent life of (90%) - 50000 km, and drum brakes at 133.4 g gamma-percent life of (90%) - 80000 km;

- the average wear rate of disc brake pads is 0.0011 g/km, and drum brakes - 0.0017 g/km, respectively.

The calculation of particulate matter emissions by passenger cars was carried out with various designs of the car brake system. It shows that:

- the combined wear of brake pads in vehicles with disc brakes at front and rear axles is 0.0088 g/km;

- the combined wear of brake pads in vehicles with disc brakes at the front axle and drum brakes at the rear axle is 0.0112 g/km;

The results of these studies are illustrated in Figure 1.

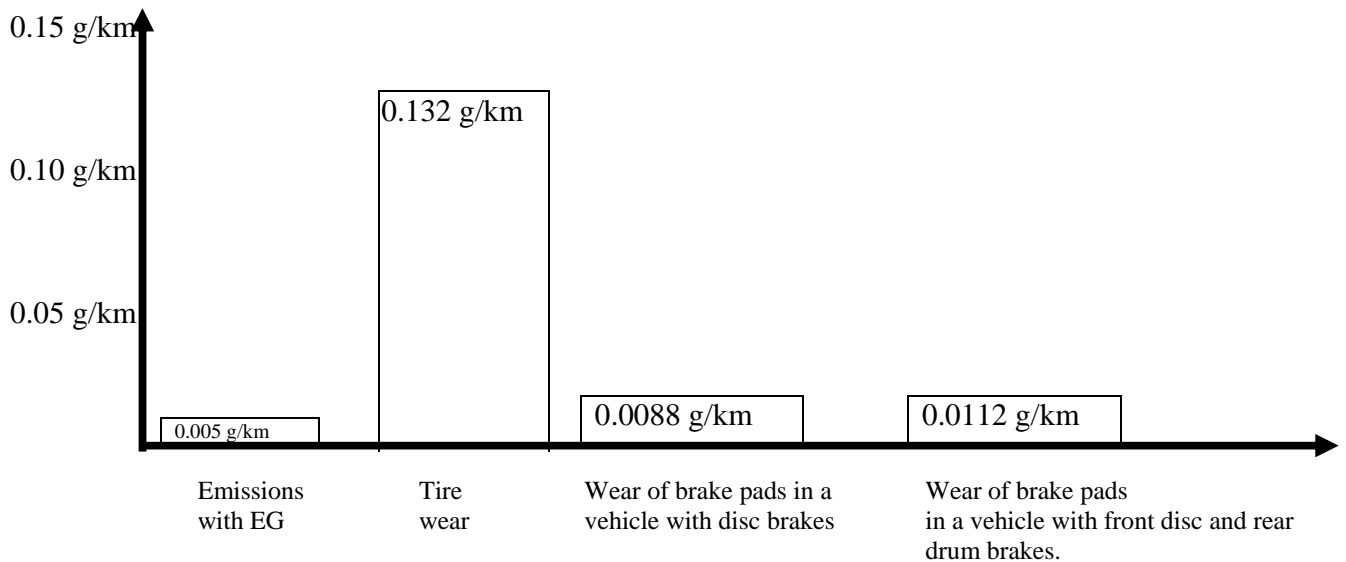


Figure 1. The actual emissions of particulate matter with EG as well as tire and brake pads wear during operation of passenger cars, g/km

The submitted papers show that the actual particulate emissions caused by tire and brake pads wear exceed the particulate emission norms for passenger cars set by UNECE Regulation 83: tires - 26.4 times, brake pads - 1.76 - 2.24 times.

The brake pad wear rate calculation for drum brakes in buses demonstrated the following:

- the average wear of drum brake pads is 1124.5 g at gamma-percent life of (90%) - 80000 km;

- the averaged wear rate of a drum brake pad is 0.014 g/km.

Calculation of particulate emissions for an articulated city bus was conducted with the following conditions: the bus, there has three axles with 10 tires.

The total intensity of brake pads wear in this case is 0.168 g/km.

The results of the study are quoted in Figure 2.

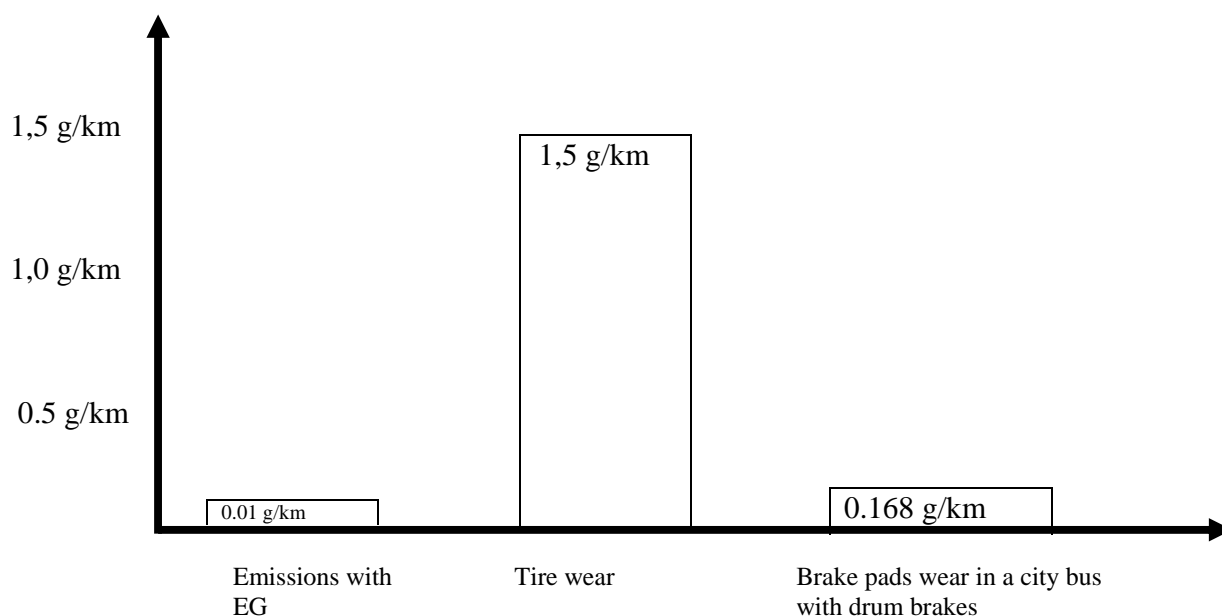


Figure 2. The actual emissions of particulate matter with EG and from tire and brake pads wear during the operation of city buses in g/km

The submitted documents give reasons to expect that particulate emissions caused by tire and brake pads wear in trucks and buses may exceed the particulate emission norms for the exhaust gas by 100 - 150 times for tires and 10 - 16 times for brake pads.

The above information enables us to state that:

1. The particulate emission caused by tire tread and brake pads wear during the vehicle lifetime exceeds the particulate emission norms for the exhaust gases:
  - a) passenger cars: tires - 26 times, brake pads - about 2 times;
  - b) trucks and buses: tires - 100-150 times, brake pads - 16 times.
2. The proposal by WHO to ban the use of diesel vehicles in European cities as a priority, introduced in the end of 2012, which assumes that they play key role in urban air pollution by particulates in the diesel exhaust gases has no scientific ground.
3. It is necessary to set up work to develop technical regulations limiting the emission of particulate matter and carcinogens into the city air caused by tire and brake pads wear.