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# ECONOMIC FEASIBILITY OF VENTILATION CLEANING EMISSIONS IN UNDERGROUND PARKINGS

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**Abstract.** The expediency of purification of exhaust gases from vehicles in underground parking lots is shown. Methods of trapping harmful substances in the ventilation air of parking lots are considered. Equations are presented for calculating the index of environmental and economic damage to the environment from vehicles. The calculation of ecological and economic damage is given in the example of underground parking in the city of Anapa.

Every year the ecological situation in our country is aggravated. One of the main air pollutants is automobile exhaust. The most polluted car exhaust occurs during engine start-up and its warm-up, which means in car parks and parking lots. Manufacturers of cars year after year are trying to improve the design of engines and exhaust systems, but the problem of protecting the environment from harmful emissions is archival.

Due to the fact that the car most pollutes the environment at the time of starting and warming up the engine, the ground open car parks are not able to detain and purify air from exhaust gases, and the construction of ecological parking in our country is not as developed as in European countries. Thus, the most feasible is the construction of covered ground and underground parking lots [1, 2], including devices for trapping harmful gases.

Objective:

- assess the degree of air pollution when starting and warming up the engine;
- consider methods of air purification from harmful emissions;
- choose a way of quantitative assessment of environmental and economic damage to the environment from vehicles.

As already mentioned above, the most acute environmental situation occurs in the parking lot and car parking areas.

Such nonstationary regimes, including the heating of a cold engine, take no more than 3-5 minutes in a warm season and from 15-30 minutes to 1-2 hours during the cold season. At the same time, the operation of the engine in such modes is accompanied by a significantly greater emission of harmful substances with the exhaust gases (up to 8-10 times) than in stationary operating modes. The "cold" car consumes 27% more fuel than the "hot" car, and at the same time it selects more CO by 86%, CH - 40%, NO<sub>x</sub> - by 12% [3].

The composition of exhaust gases includes about 200-300 chemical compounds and substances (Table 1). Of these, only four in small concentrations do not harm the body (oxygen, nitrogen, carbon dioxide and water).

There are several methods for purifying air from vapor-gaseous pollutants, by the type of physico-chemical processes they are used, they are divided into five main groups [4]:

- 1) rinsing out solvent emissions of impurities (absorption);
- 2) washing solutions with solutions of chemicals that bind impurities chemically (chemisorption);
- 3) absorption of gaseous impurities by solid bodies with an ultra-microporous structure (adsorption);
- 4) thermal neutralization of waste gases;
- 5) absorption of impurities by using catalytic conversion.

For the purpose of complete purification of gas emissions, it is advisable to combine methods in which the combination of coarse, medium and fine purification of gases and vapors is optimal for each particular



case. In the first stages, when the content of a toxic impurity is large, absorption methods are more suitable, and for adsorption, adsorption or catalytic methods [5, 6]. The catalytic method differs from the thermal one, first, by the lower temperature of the oxidation process, 300-400 °C, and secondly by its high rate of flow, a fraction of a second, which makes it possible to significantly reduce the dimensions of the reactor. The catalysts can be platinum metals, oxides of copper, manganese, etc.

One of the most promising ways of protecting the environment and efficient energy use is the recovery of the heat of ventilation air in underground parking lots [7-10].

**Table 1. Composition of exhaust gases**

Exhaust gas components	Content by volume, %		Engine
	Petrol Diesel		
	Content by volume, %	Engine	
Nitrogen	74,0 - 77,0	76,0 - 78,0	No
Oxygen	0,3 - 8,0	2,0 - 18,0	No
Water vapor	3,0 - 5,5	0,5 - 4,0	No
Carbon dioxide	5,0 - 12,0	1,0 - 10,0	No
Carbon monoxide	0,1 - 10,0	0,01 - 5,0	Yes
Nitric oxide	0 - 0,8	0,0002 - 0,5	Yes
Hydrocarbons	0,2 - 3,0	0,009 - 0,5	Yes
Aldehydes	0 - 0,2	0,001 - 0,009	Yes
Sulfur Oxide	0 - 0,002	0 - 0,03	Yes
Carbon black, g / m <sup>3</sup>	0 - 0,04	0,01 - 1,1	Yes
Benzopyrene -3.4, g / m <sup>3</sup>	10 - 20×10 <sup>-6</sup>	10×10 <sup>-6</sup>	Yes

In connection with the arrival of a large number of polluting substances in the atmosphere, there is a need to quantify the impact of vehicles on the environment. Among the economic indicators that characterize the environmental problems of interaction between vehicles and the environment, the indicator of environmental and economic damage has been studied quite well. This indicator consists in determining actual and possible material and financial losses from changes in quantitative and qualitative parameters of the environment as a whole, as well as its individual natural components (water and land resources, atmospheric air, etc.) [11-13].

In accordance with the Temporary Method for Determining the Prevention of Environmental Damage, an estimate of the magnitude of environmental damage from air pollution is a [14]:

$$Y^a = Y_{sp}^a \cdot M_p^a \cdot K_e^a \quad (1)$$

where  $Y^a$  – is the value of the economic estimate of pollutant emissions into the atmospheric air, rub;  $Y_{sp}^a$  – specific environmental and economic damage from the emission (discharge) of one conventional ton of pollution, rub./ conditional tons;  $M_p^a$  – reduced mass emission of pollutants, conditional tons/ year;  $K_e^a$  – coefficient that takes into account environmental factors for the territory under consideration (for the North Caucasus Economic Region is 1.92).

The resulted mass of emissions is defined by the formula:

$$M_p^a = \sum_{i=1}^N m_i \cdot A_i \quad (2)$$

where  $m_i$  – the actual mass of the release of the  $i$ -th type of pollutant per year, ton/year;  $A_i$  – relative hazard index of the  $i$ -th type of pollutants, conditional tons/ ton [14].

Specific environmental and economic damage from the release of one conventional ton of pollutants is calculated by the formula [15]:

$$y_{sp}^a = y_{sp1998}^a(1 + r)^m \quad (3)$$

where  $y_{sp,1998}^a$  – environmental and economic damage from the release of one conventional ton of pollutants into the air for 1998 year, component for the North Caucasus region 53,2 rub./conditional tons;  $r$  – rate of inflation;  $m$  – number of years.

Thus, this method provides an assessment of the environmental and economic damage from the emission of pollutants into the atmosphere in the current period. Based on the example of the city of Anapa in the North Caucasus Economic Region, the environmental and economic indicator of environmental damage from underground parking for 106 parking places was 1 432 447 rubles per year. There are also other, more extensive, methods for determining environmental damage to the environment, the determining factor of which is, for example, the health and working capacity of the population [3].

In conclusion it should be said that the example of underground parking in the city of Anapa was used to calculate the environmental and economic indicator of damage to the air from car exhausts, which amounted to 1,432,447 rubles per year. To reduce environmental and economic damage, it is necessary to provide for the purification of vehicle exhaust fumes. At present, the most universal method is post-gas purification of gases by a sorption-catalytic method.

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