

Air Pollution by Construction Vehicles

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Abstract. The article presents the calculation of air pollution by construction machines in the reconstructed buildings. It is considered the measures of reducing the amount of harmful substances that have a negative impact on the workers employed in the production process during the production of construction and installation works inside reconstructed buildings and the environment in general. This article presents methods for solving problems to reduce the amount of pollution. Particular attention is paid to the use of machines with internal combustion engines in the conduct of works inside the reconstructed premises, when a temporary system of collection and purification of exhaust gases is arranged for their operation. The replacement of machines with internal combustion engines with machines and mechanisms with an electric motor is considered in detail. This article is designed for specialists who monitor the negative effects of air pollution by construction machines in reconstructed buildings. The article provides a detailed bibliography on the issue of air pollution by construction machines in the reconstructed buildings, shows the normative documents used in the reconstruction, as well as in the development of environmental measures that reduce the natural and technological environment within implementation of construction projects.

1. Introduction

Modern reality is hard to imagine without vehicles and various construction mechanisms that have long replaced the hard manual labor. The construction industry involves the use of a large number of transport vehicles and a variety of construction equipment, which justifies increased emissions of harmful substances into the atmosphere. Considering the problem of environmental pollution, it is important to pay attention to the provision of protective measures in the construction of new facilities, as well as the reconstruction of buildings and structures, as in compliance with the whole range of environmental measures aimed at protecting the environment, the negative impact is reduced to the minimum. [1,2,3,4,5,6]

2. Relevance, scientific significance of the issue with a brief review of the literature

Every year, the situation with the emission of harmful substances into the atmosphere at the stages of construction and reconstruction only increases, due to the increase in the number of facilities and their complexity. Currently, the processes of the construction industry are running at such high speeds that it is almost impossible to reduce them, using the same mechanisms and machines as now. Therefore, it is important in the development of organizational and technological solutions at the facility to be guided not only by the feasibility of using different construction units in terms of technical and economic indicators, but also on the part of their safety for the environment. [5,7,8,9,10,11]

3. Objective

The main task is to determine the nature of the negative impact of construction vehicles and the comparison of several types of engines of construction machines used in the reconstruction of buildings and structures and consideration of the technology and organization of work in special conditions, i.e. indoors or inside poorly ventilated premises of industrial and civil buildings. [2,12]

4. Theoretical section

Construction in special conditions indoors or inside poorly ventilated industrial and civil buildings should begin with preparatory work. At the first stage, it is necessary to plan the algorithm of proper actions, as a result of air pollution level measurements by special calibrated devices. According to the results of measurements, a list of organizational and technological measures should be determined to bring the level of air pollution to the required values. Organizational and technological activities should be carried out in the following areas:

- organization of exhaust ventilation of the required capacity;
- arrangement of special pipe systems for discharging exhaust gases from internal combustion engines (ICE) of machines working indoors for a long time;
- organization of handling operations for cargo delivered by motor transport in order to use the maximum number of mechanization with electric and pneumatic motors while construction and installation works, working indoors. [5,13,14,15,16,17]

During operation, internal combustion engines (ICE) emit many harmful substances during the warm-up period, during idling, and when driving across the territory and inside the reconstructed building. The main pollutants are carbon monoxide, nitrogen dioxide, hydrocarbons and sulfur dioxide. During the operation of construction machines with electric motor harmful substances are not released indoors and into the atmosphere.

The maximum single emission from ICE vehicles comes to:

$$M = 10^{-3} \times \sum_i^n \frac{g_{ij} \times L \times A_3 \times K}{t \times 3,6}, \text{ where}$$

M_i - mass of emission of i-th pollutant by a vehicle of j-th type, g/sec;

N - number of vehicles' groups;

g_{ij} - specific emission of i-th pollutant by a vehicle of j-th type, g/km;

L - conditional mileage of a vehicle per cycle in the parking lot, taking into account the time of engine start, movement on the territory, work in parking zones, km.;

A_3 - operational number of vehicles;

k - coefficient taking into account the influence of vehicle mode and method of its storage;

t - release time and drop-off locations, hours;

Amount of annual emissions of air pollutants:

$$M = 10^{-6} \times \sum_i^n g_{ij} \times L \times A_3 \times k \times D, \text{ where}$$

M_i - mass of emission of i-th pollutant, t/year;

N, g_{ij}, L, A_3, k – see above;

D - number of working days per year. [18,19,20,21]

5. Practical relevance, results of experimental studies

To obtain reliable data, consider the reconstructed object and calculate the maximum single emission of various hazardous substances into the atmosphere. In the premises of the reconstructed building operates 70 vehicles of the middle class. The method of vehicle storing is manege one at rush hour parking lot leaves (enters) 50% of vehicles list. A reference path length in accordance with the ONTP01-91 is taken equal to 0.8 km.

The annual operating mode is 365 days.

The coefficient taking into account the uniformity of vehicles exit and entry is equal to 0.7. [22,23,24]

The maximum single emission will come to:

Carbon monoxide

$$m_{CO} = 10^{-3} \times \frac{29 \times 35 \times 0,8 \times 1,2}{1 \times 3,6} = 0,1704 \text{ g/sec,}$$

Nitrogen dioxide

$$m_{NO} = 10^{-3} \times \frac{0,67 \times 35 \times 0,8 \times 1,2}{1 \times 3,6} = 0,0040 \text{ g/sec,}$$

Hydrocarbons

$$m_{CH} = 10^{-3} \times \frac{2,67 \times 35 \times 0,8 \times 1,2}{1 \times 3,6} = 0,01566 \text{ g/sec,}$$

Table 1. Composition of exhaust gases of gasoline, diesel and electric motors (g/min)

No.	Composition of exhaust gases	Gasoline motors	Diesel motors	Electric motors
1.	Carbon monoxide_CO (II)	0,035	0,017	0,0
2.	Carbon monoxide_CO2 (IV)	0,217	0,2	0,0
3.	Nitrogen oxide (NO, NO2)	0,002	0,001	0,0
4.	Soot	1,1	0,0	0,0

6. Summary

When using vehicles on electric motors, environmental pollution is not produced, which is especially important for indoor work while reconstruction of buildings. Electric motors, in turn, have both advantages and disadvantages.

Electric motor disadvantages:

- small shoulder on one charge;
- long charging;
- low battery life;
- large volume and weight of battery.

Electric motor advantages:

- low weight;
- maximum torque available at 0 rpm;
- no need for gearbox;
- high efficiency;
- energy recovery capability.[13,14,18,25]

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