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Environmental Regulation of Pollutants of Enterprises for Extraction and Processing of Non-Metallic Rocks

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Abstract

The article contains environmental regulation of emissions and discharges of pollutants on the environment by establishing standards for maximum allowable concentration (MAC) and maximum allowable discharges (MAD). Also, the generation and disposal of production and consumption waste by establishing standards for maximum allowable waste (MAW). Environmental regulation of pollutants of non-metallic rock mining and processing enterprises is considered. The procedure for the implementation of environmental regulatory projects and the calculation methods for determining pollutants, specific indicators, generation standards and waste disposal limits are presented. The results of the study are data from the project of MAC standards of the Djam's field for the production and processing of marble developed according to the proposed method of implementation and calculation..

Keywords- Environment, pollutants, emission sources, discharge sources, production waste, environmental rationing, quota, surface concentration, placement limit.

INTRODUCTION

Along with the intensification of the use of natural resources, environmental pollution by industrial waste increased rapidly. Pollution increased at a disproportionate pace also because imperfect technologies were used in the first stages of scientific and technological progress in the field of industrial production. The massive release into the atmosphere, hydrosphere and soil-plant cover of harmful substances and compounds has become dangerous, which can cause irreversible environmental changes.

Therefore, environmental protection from emissions, discharges and waste from national economic enterprises is an urgent task of global importance.

One of the leading areas of environmental protection work is a detailed study of the sources and processes of environmental pollution and environmental regulation of emissions and discharges of pollutants and waste generation.

Non-metallic rock mining and processing facilities are one of the major sources of environmental pollution. The main sources of pollution, which are quarries for the extraction of non-metallic rocks, as well as factories and enterprises for the processing of these rocks. In addition, in many cases, rock mining is carried out by blasting the rock mass. Bulky amounts of pollutants are released into the environment. Therefore, the environmental regulation of pollutants and the development of environmental regulatory projects for pollutants, as well as the generation and disposal of waste from the production of enterprises for the extraction and processing of non-metallic rocks is a very urgent issue. To solve these problems, it is necessary to carefully study production processes, types of used equipment and process equipment, as well as existing methods for calculating pollutants and methods for developing regulatory environmental projects.

Environmental regulation of pollutants and production waste. The purpose of environmental regulation of pollutant emissions is to ensure compliance with the air quality criteria regulating the maximum allowable content of pollutants in it for public health and the main components of the ecological system, as well as the conditions under which maximum allowable (critical) loads on the ecological system outside the boundaries of the enterprise or its sanitary protection zone are provided.

At the same time, an inventory of sources of atmospheric pollution is first carried out in accordance with the requirements of Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 14 of January 21, 2014 "Regulation on the procedure for developing and coordinating draft environmental standards."

MAC (maximum allowable concentration) is determined under the most unfavorable conditions. The MAC value is set in g/s and t/year. This is the amount of pollutant per unit time, the excess of which leads to adverse effects in the environment or is dangerous to human health.

The main criterion for establishing MAC of pollutants is quotas for pollutants for various ecological and economic areas [1].

The regulation of pollutant emissions into the atmosphere is established based on the results of calculations of their ground-level concentrations outside the industrial site, obtained considering climatic and meteorological characteristics, taken as initial data for calculating the dispersion of pollutants, with further identification of compliance of the obtained results with the established standards for each pollutant and the compilation of a list of pollutants.

Rationing of pollutant discharges into the environment is carried out by establishing the MAD (maximum allowable discharges) of these substances with wastewater into water bodies or onto the terrain.

At the same time, an inventory of wastewater generation sources is first carried out in accordance with the requirements of Resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 14 of January 21, 2014 "Regulation on the procedure for developing and coordinating draft environmental standards."

When calculating the MAD for pollutants discharged from wastewater after treatment at structures (mechanical, physicochemical, biological, etc.), technically achievable indicators (TAI) are used.

The MAD standards are established by calculation or by design data based on the analysis of the organization's water-material balance, taking into account the composition of the source water and the components used in the used technology, taking into account background concentrations.

The draft environmental standards for waste generation and disposal are developed based on the project "Inventory of sources of waste generation and disposal" for this production facility.

Normalization of waste generation is carried out in accordance with the technological features of the main and auxiliary production.

Waste generation standards are determined in terms of mass (volume) in relation to the quantity of raw materials used or the quantity of products produced.

The waste disposal limit determines the maximum values of the mass, area and duration of temporary disposal of waste generated in the processes of main and auxiliary production on the territory of the organization. The design limit is the standard for waste disposal on the territory of the organization.

Environmental standards and methods for calculating pollutants from non-metallic rock mining and processing enterprises. Non-metallic rock mining and processing enterprises include quarries for the extraction of crushed stone, sand, bentonite and loess soils, marbles, granite, limestone, etc., as well as factories and enterprises for the processing of these non-metallic rocks.

Design methods for determination of emissions (emissions) of pollutants into the atmosphere. According to instruction [2], pits are considered as uniform sources of emissions evenly distributed over the area from motor vehicles, excavation and loading and blasting operations.

1. Discharges from rock dumps and face cleaning. The volume of inorganic dust emission during formation of dumps of empty rocks by bulldozer according to [2] is determined by the formula:

$$M = q * t * 3600/10^6, \quad t/year, \qquad (1)$$

where: M - total amount of released pollutants;

q - specific index of dust emission; g/s;

t - bulldozer operation time, hour/year.

2. Emissions from excavation and loading operations. During the operation of an excavator, loading crane or loader, dust is released mainly when material is loaded into dump trucks. Dust emission objects can be described by the equation:

$$Q_2 = P_1 *P_2 *P_3 *P_4 *G*10^6/3600, \text{ g/s}, \qquad (2)$$

where: P_1 -dol, dust fraction in the rock, is determined by washing and sieving of the average sample with extraction of dust fractions of size 0-200 μm;

P_2 is the proportion of volatile dust with a particle size of 0-50 μm transferred to the aerosol with respect to all dust in the material (it is assumed that all volatile dust is transferred to the aerosol). The P_2 value is specified by taking dusty air at the boundaries of the dusty object at a wind speed of 2 m/s, blowing in the direction of the sampling point;

P_3 is a factor taking into account the wind speed in the excavator operation area. is taken in accordance with Table 1.4.26 [2];

P_4 - coefficient taking into account the material humidity is taken in accordance with Table 1.4.16 [2];

G - amount of rock processed by the excavator, t/h.

3. Dust emissions during motor transport operations. The movement of vehicles in the quarry causes the emission of dust, as well as gases from internal combustion engines; dust is released from the interaction of the wheels with the road and blowing from the surface of the material loaded into the car body.

The total amount of dust emitted by the vehicle can be characterized by the following equation:

$$q = C_1 * C_2 * C_3 * N * a_1 * q_1 /3600+C_4 *C_5 *C_6 *F_0 * n *q_2, \text{ g/s} \qquad (3)$$

where: C_1 is a factor taking into account the average load capacity of a vehicle unit and taken in accordance with Table 1.4.20 [2];

C_2 is a coefficient taking into account the average speed of transport in the pit and is taken in accordance with Table 1.4.21 [2];

The average transportation speed is determined by the formula;

$V = N * a/N$, km/h

C_3 is a factor that takes into account the state of roads and is accepted in accordance with Table 1.4.22 [2];

C_4 is a factor that takes into account the surface profile of the material on the platform and is defined as the ratio F_{fact}/F_0

where: F_{fact} - actual surface of the material on the platform;

F_0 is the average platform area. The C_4 value ranges from 1.3 to 1.6, depending on the size of the material and the degree of filling of the platform;

C_5 is a coefficient taking into account the rate of material blowing, which is defined as the geometric sum of the wind speed and the reverse sector of the average traffic speed. The value taken in accordance with Table 1.4.23 [2];

C_6 is a coefficient taking into account the humidity of the surface layer of the material equal to $C_6 = K_5$ equation (3) and taken in accordance with Table 1.4.16 [2];

N is the number of round trips of the entire transport per hour;

a_1 - average length of one walker within the pit, km

$C_1 = C_2 = C_3 = 1$, assumed to be 1450

q_1 - dust separation from the unit of the actual surface of the material on the platform, $g/m^2 * s$;

n is the number of vehicles operating in the quarry.

4. Release of pollutants during drilling operations. Calculation of air pollution volumes during drilling of wells and holes according to [2] is performed using the formula:

$$Q_6 = n * Z * (1-\eta) / 3600, \text{ g/s} \quad (4)$$

where: n - number of simultaneously operating drilling rigs;

Z - amount of dust emitted during drilling by one machine, g/h;

η - efficiency of the dust cleaning system, in fractions.

5. Release of pollutants during blasting operations. Blasting operations are accompanied by massive emission of dust. High dust emission power causes short-term atmospheric pollution, hundreds of times higher than MAC. To calculate one-time dust emissions during blasting operations, according to [2], one can use the equation:

$$Q_v = a_1 * a_2 * a_3 * a_4 * D * 10^6, \text{ g} \quad (5)$$

where: a_1 - amount of material lifted into the air during explosion of 1 kg of explosive (4-6 t/kg);

a_2 - fraction of volatile dust passing into aerosol with particle size of 0-50 μm, relative to exploded rock mass (on average 2 * 10-5);

a_3 - coefficient considering the wind speed in the explosion zone ($Q_3 = P_3$),

a_4 - coefficient considering the impact of water flooding of wells and
pre-humidification of the bottomhole

D - explosive charge value, kg.

Since the duration of dust emission during blasting operations is short (within 10 minutes), these contaminants should be taken into account, mainly when calculating bulk emissions of the enterprise.

6. Release of contaminants during welding operations. Calculations of pollutant emissions during welding operations are carried out according to [2] using the formula:

M = q * B * 10-6, t/year (6)

where: q - specific emissions of pollutants, g/kg.

B is the number of electrodes used, t/year.

7. Release of pollutants from fuel and lubricants storage. The amount of hydrocarbons released into the atmosphere per year from one tank or group of tanks is determined by summing up the losses of petroleum products calculated based on the Natural Loss of Oil and Petroleum Products during Intake, Release and Storage in Tanks [2].

$$\Pi = (n_1+n_2) : 2 * Q*10^{-3}, \text{ t} \quad (7)$$

where, n_1 is the rate of natural loss of petroleum products during reception, release and storage in the autumn-winter period;

n_2 is the rate of natural loss of petroleum products during reception, release and storage in the spring-summer period;

Q - quantity of petroleum products received in tanks during the year, t

8. Release of contaminants during sprinkling of dusty materials. Intensive unorganized sources of dust are filling of material, unloading of dump trucks into a hopper, filling of material into a warehouse. Calculations of pollutant emissions from these sources can be performed according to [2] using the formula:

$q = K_1 * K_2 * K_3 * K_4 * K_5 * K_7 * G * 106/3600$, g/s (8)

where: K_1 - weight fraction of the dust fraction in the rock. It is determined by washing and sieving an average sample with the extraction of dust fractions of 0-200 μm;

K_2 - fraction of dust (from the whole mass of dust, which turns into aerosol; Table 1.4.13 [2]);

K_3 is a coefficient taking into account local meteorological conditions, adopted in accordance with Table 1.4.14 [2];

K_4 is a coefficient taking into account local conditions, the degree of protection of the unit from external influences, dust generation conditions, is accepted in accordance with the data of Table 1.4.16 [2];

K_5 - coefficient taking into account the material humidity is taken in accordance with Table 1.4.16 [2];

K_7 is a coefficient that takes into account the surface profile of the stored material and is defined as the ratio F_{fact}/F; the K_7 value varies within 0.1-1.0 depending on the size of the material and the degree of filling, taken in accordance with Table 1.4.17 [2];

G - total amount of processed material, t/h.

9. Release of contaminants during rock processing. Calculations of pollutant emissions during crushing and grinding of stone materials are carried out according to [2] using the formula:

$$M = V * C * B * 10^{-3}, \quad t/year \qquad (9)$$

where: V - volume of pollutants, m3/kg

C - dust concentration in the flow, g/m3

B - amount of processed rock, t/year

10. Emissions from static storage of material. Calculations of pollutant emissions during static storage of material are performed according to [2] using the formula:

$$q = K_3 * K_4 * K_5 * K_6 * K_7 * q_1 * F, \ g/s \qquad (10)$$

K_3 is a coefficient taking into account local meteorological conditions, adopted in accordance with Table 1.4.14 [2];

K_4 is a coefficient taking into account local conditions, the degree of protection of the unit from external influences, dust generation conditions, is accepted in accordance with the data of Table 1.4.16 [2];

K_5 - coefficient taking into account the material humidity is taken in accordance with Table 1.4.16 [2];

K_6 is a coefficient that takes into account the surface profile of the stored material and is defined as the ratio F_{fact}/F; the K_7 value varies within 0.1-1.0 depending on the size of the material and the degree of filling, taken in accordance with Table 1.4.17 [2];

q_1 - dust entrainment from $1m^2$ of the actual surface in conditions when $K_3 = K_4 = 1$ is taken in accordance with the data of Table 1.4.18 [2];

F - dusting surface in planning view, m^2

Calculation of pollutant dispersion into the atmosphere considering climatic and meteorological characteristics of the area is carried out to *normalize pollutant emissions into the atmosphere*.

The calculation of the fields of ground-level concentrations of pollutants is carried out using a computer according to the universal program approved by the state enterprise. The physical inventory results are used as source information. Quotas for pollutants shall be adopted in accordance with the Instructions for inventory and regulation of pollutant emissions into the atmosphere.

Quarries and production workshops of the non-metallic rock mining and processing enterprise are mainly located in remote areas from the centralized water supply and drainage system. In many cases, there is practically no wastewater discharge to water bodies or to the terrain. Therefore, according to [1], in such cases, the environmental regulatory design of MAW is not developed.

Design methods for determining specific indicators, generation rates and waste disposal limits. Initial data for determination of parameters of production and consumption waste generation sources and calculation of quantitative characteristics are obtained in results of visual inspection of field production areas, detailed study, and inspection of technological processes of enterprise facilities.

The information of the relevant services of the enterprise on the consumption of material and raw materials is used as input data. To determine specific indicators and standards of waste generation, methods and guidelines are used, given in the list of references, and approved by both higher organizations and bodies of the State Committee for Ecology of the Republic of Uzbekistan. Waste hazard class is determined according to waste classification catalogue [1,3,9].

Waste disposal limits are calculated in accordance with the guidance documents. The amount of the allocation limit for each waste type (L) is calculated using the formula:

$$L = P_p * n_f * t_1 / t + K_1 * q_y \qquad (11)$$

where: P_p - planned quantity of production output, t/year;

n_f - specific amount of waste formation, t/t, kg/t, etc.;

t_1 - the time for which the limit is set (usually 3-365 days are accepted);

t - waste placement period, which is considered temporary - 365 days;

K_1 - coefficient of increase of the limit quantity of waste disposal in case of their disposal is accepted equal to 0.25;

q_y is the amount of waste to be disposed of, t/year.

The total maximum area of temporary waste disposal at the enterprise (S1) is calculated using the formula:

$$S_1 = K_s * S_2 *(1 + 0,5 * q_y / P_p * n_f) \qquad (12)$$

where: K_s is the ratio of the total area of temporary waste disposal on the territory of the enterprise to its total area (established according to Table 2 [9]);

S2 - total area of the enterprise, ha, m^2;

0.5 - coefficient of increase of maximum area of temporary waste disposal during their disposal.

The maximum areas for disposal of wastes of different toxicity classes are assigned based on the condition of equality of the potential danger of the disposed masses of wastes of individual groups differing in toxicity:

$$w_1 / d_1 = w_2 / d_2 = w_3 / d_3 = w_4 / d_4 \qquad (3)$$

and is determined by the formulas:

$$w_1 = S_1 * d_1$$

$$w_2 = S_1 * d_2$$
$$w_3 = S_1 * d_3 \quad (4)$$
$$w_4 = S_1 * d_4$$

where, w_1 - w_4 - limit areas of disposed waste masses 1,2,3 and 4 classes of toxicity/hazard, m^2;

d1 - d4 - average values of relative toxicity indicators (MAC, concentrations of water extracts), which determine the separation of waste into 1,2,3 and 4 toxicity/hazard classes (established according to Table 3 [9]).

According to [1], the generation and disposal of municipal waste is not regulated.

Study results. According to the above procedure for calculation and procedure of compliance with the standard, the draft standards of MPE of the Djam marble deposit were developed [12,13]. We give some results from the developed project.

The main production activity of the Djam deposit is the extraction of marble blocks and rubble to produce marble slabs and decorative marble crushed stone, and sand.

According to the data obtained from the environmental survey of the facility, as well as in accordance with the project, 23 sources of pollutant emissions will operate on the territory of the Djam's field of Samarkandmarmar JSC.

Sources of pollutant emissions into the atmosphere at the enterprise are: quarries for the extraction of marble blocks and rubble stone (source of emissions No. 1.2 of the area type); welding station (unorganized emissions, Ref. No. 3); Fuel and lubricants warehouse (fugitive emissions, Sheet No. 4); DSU (fugitive emissions, issue No. 5).

During the operation of the Djam's field, Samarkandmarmar JSC will receive 4 pollutants from all 5 stationary sources of emissions into the atmosphere. The total amount of emissions will be 2.886707 tons/year, of which gaseous and liquid substances will amount to 0.0012477 tons/year, solids - 2.8854545 tons/year. Consequently, the main part of the emissions of the Jam's field of Samarkandmarmar JSC is inorganic dust.

Emissions of pollutants during blasting operations (multiple emissions) will amount to 0.260806 t/year. The total emissions of pollutants (exhaust toxic gases) during the operation of quarry machines and process equipment will be 2.552 tons/year.

Based on the inventory of sources of pollutant emissions into the atmosphere, a draft MAC standards were developed.

The calculation of the fields of ground-level concentrations of harmful substances was carried out using computers according to the VARSA-RADUGA program. As initial information, the results of the inventory and quotas for pollutants were used. According to the results of the calculations of the fields of dispersion of pollutant emissions in the atmosphere, excess of ground-level concentrations outside the industrial site, no pollutants were found according to the considered pollutants.

Conclusion. Based on the detailed analysis of the mass and structure of emissions of pollutants given in the draft, as well as considering the current level of pollution, it is proposed:

1. Establish the regulatory status of the maximum allowable emissions of pollutants into the atmosphere in total for substances in accordance with the data listed in the table.

2. In case of significant changes in the parameters of pollutant emissions (change in technology; reconstruction of the enterprise, not provided for by this project, etc.), the established emission parameters lose their regulatory status, and rationing work is immediately carried out again.

Table. Summary Standards for Air Pollutant Emissions.

	Pollutant emissions	Excess emission

Substance name	Existing provisions		Maximum allowable concentration			
	g/s	t/y	g/s	t/y	g/s	t/y
1	2	3	4	5	6	7
Inorganic dust	0,81056	2,8854595	0,81056	2,8854595	-	-
Iron (III) oxide	0,0002198	0,000402	0,0002198	0,000402	-	-
Manganese (IV) oxide	0,000189	0,0003457	0,000189	0,0003457	-	-
hydrocarbons	0,000015	0,0005	0,000015	0,0005	-	-
Total for the enterprise	0,8109838	2,886707	0,8109838	2,886707	-	-

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