EVALUATION OF THE EFFECT OF INDUSTRIAL ENTERPRISES ON THE ENVIRONMENT AND EFFICIENCY
EVALUATION OF ENVIRONMENTAL PROTECTION ON THE EXAMPLE OF «KHARKIV ELECTROMECHANICAL PLANT»
SE (UKRAINE)

Introduction

The development of scientific and technological progress, along with a general improvement in the quality of life of people, has an environment of powerful technogenic impact. First of all, this is expressed in air pollution, unsatisfactory quality of drinking water, soil pollution and waste accumulation. The production of electrical products is accompanied by a significant release of pollutants into the environment. All these pollutants during operation, getting into the atmosphere, in water basins and in the soil significantly worsen the environmental situation. To reduce the harmful effects on the environment, it is necessary to solve the issue of effective cleaning and regulation of emissions, calculation of maximum permissible emissions [1, 2]. The nature of the destructive effect of biosphere pollution on humans can be different. This, for example, the toxic effect of chemicals that lead to poisoning of the body, organ trauma (skin, vision, hearing, etc.). A number of substances can cause allergies. Some substances and radiation are carcinogenic or mutagenic, that is, they can cause cancer or genetic pathology [3–5]. In [6], it is noted that enterprise emissions are an important component of both environmental well-being and economic stability. The authors of the study [7] believe that it is the increase in emissions, especially carbon, characteristic of developing
countries. The study [8] analyzes the sources of the greenhouse effect enhancement, among which emissions from industrial enterprises occupy a significant place.

One of the sources of environmental pollution is the enterprises of the engineering complex. Therefore, on the example of one of them, an environmental impact assessment will be carried out – on the example of the State Enterprise «Kharkiv Electromechanical Plant» («KhEMP» SE, Ukraine). Thus, the object of research is the impact of an industrial enterprise on the environment. The aim of research is to assess the impact of an industrial enterprise on the environment and the effectiveness of environmental protection measures on the example of «KhEMP» SE.

2. Methods of research

«KhEMP» SE produces equipment for the energy, coal mining, metallurgical, chemical, engineering and shipbuilding industries. The company specializes in the production of electrical machines, low-voltage equipment and low-voltage complete devices, control station systems, components for machines and stations, thyristor converters, circuit protection monitoring equipment [9]. The main source of air pollution at the «KhEMP» SE is air handling units that remove contaminated air from the technological equipment of production sites, as well as from auxiliary units and services. Also the sources of pollution are:

1) machine shop, where the products are painted in the paint chamber, digestion with hydrochloric acid and tinning of copper parts;
2) hardware-station shop, where plating, soldering and welding, tinning of parts, as well as painting of parts are carried out, negatively affects the environment;
3) mechanical repair shop where the sharpening of the cutting tool, grinding of steel products and gas welding and gas cutting works, welding with electrodes are carried out, which are sources of pollution;
4) electric shop where electric welding in a welding cabin; impregnation of the winding of electric motors with subsequent annealing of insulation in an electric furnace, painting of electric motors are carried out, which negatively affects the environment;
5) tool shop, where metal cutting, thermal annealing of steel, heat treatment of steel in furnaces, grinding of steel products, welding are carried out, which negatively affects the environment;
6) production packaging shop, where the source of pollution is dust from woodworking machines;
7) model woodworking shop where wooden models for foundry are made and spray boards are used, which are a source of dust pollution;
8) motor vehicle shop where the source of air pollution is internal combustion engines, which are emitted into the atmosphere when heated: carbon oxide, saturated hydrocarbons, nitrogen dioxide, soot, sulfur dioxide, lead, benzo(a)pyrene.

According to the degree of danger, substances are divided into 4 classes. With pollutants emitted by the enterprise into the atmosphere, lead and benzo(a)pyrene are classified as hazard class I.

«KhEMP» SE refers to the IV category of danger. There are no accidental and volley emissions at the enterprise. Landfills and landfills for industrial solid waste are not available at the «KhEMP» SE.

The company does not have its own landfill. The removal of industrial waste should be carried out according to the permission of the city sanitary-epidemiological station.

According to the appendix 4 to the State Sanitary Rules for the Planning and Development of Settlements [10], the regulatory sanitary protection zone (SPZ) for industrial site of «KhEMP» SE is 100 m.

Since the object is a large enterprise, it accordingly emits various kinds of impurities in large volumes (Table 1). 131 sources of pollutant emissions into the atmosphere are allocated from all the shops of the enterprise. Of these, 130 are stationary sources, one source (No. 131) is non-stationary.

Data on the concentration of pollutants in the wastewaters of «KhEMP» SE when discharged into the city sewer network are presented in Table 2.

Therefore, as can be seen, the excess of the permissible values given in [11, 12] does not occur.

At the «KhEMP» SE, retail waste is generated in the production process. Their characteristics are given in Table 3.

### Table 1

| No. | Substance name | Hazard Class | Gross emission, t/year |
|-----|----------------|--------------|-----------------------|
| 1   | nitrogen dioxide | 2            | 0.442                 |
| 2   | nitric oxide    | 3            | 2.400                 |
| 3   | sulphurous hydride | 3          | 0.0042                |
| 4   | carbon monoxide | 4            | 0.5250                |
| 5   | benzo(a)pyrene  | 4            | 0.000385              |
| 6   | sparingly soluble fluorides | 2 | 0.00092 |
| 7   | silicon oxide   | SRLI 0.02    | 0.00092               |
| 8   | hydrogen fluoride | 2          | 0.00476               |
| 9   | phenol          | 2            | 0.0094                |
| 10  | formaldehyde    | 2            | 0.0050                |
| 11  | lead            | 1            | 0.01840               |
| 12  | tin oxide       | 3            | 0.0289                |
|   |   |   |   |
|---|---|---|---|
| 12 | hydrocarbons C12-C19 | 4 | 0.0115 |
| 13 | soot | 3 | 0.8717 |
| 14 | iron oxide | 3 | 0.5581 |
| 15 | manganese oxide | 2 | 0.0262 |
| 16 | aerosol oil | SRLI 0.05 | 0.2459 |
| 17 | sulfuric acid | 2 | 0.5025 |
| 18 | toluene | 3 | 18.2455 |
| 19 | ethanol | 4 | 18.1150 |
| 20 | aerosol | SRLI 0.1 | 1.2891 |
| 21 | solvent | SRLI 0.2 | 2.7680 |
| 22 | white spirit | SRLI 1.0 | 8.4246 |
| 23 | xylene | 3 | 14.4333 |
| 24 | kerosene | SRLI 1.2 | 0.8790 |
| 25 | wood dust | SRLI 0.1 | 1.1235 |
| 26 | PSK dust 20–70 % | 3 | 2.2696 |
| 27 | metal dust | SRLI 0.1 | 1.2896 |
| 28 | PSK dust >70 % | 3 | 0.3687 |
| 29 | abrasive metal dust | SRLI 0.4 | 1.5365 |
| 30 | fiberglass dust | SRLI 0.06 | 0.3531 |
| 31 | fiberglass plastic dust | SRLI 0.06 | 2.8357 |
| 32 | phenolic dust | SRLI 0.05 | 1.6414 |
| 33 | asbestos-containing dust | 1 | 0.0755 |
| 34 | CEM dust | SRLI 0.04 | 0.0488 |
| 35 | FR-2 dust | SRLI 0.1 | 2.7347 |
| 36 | ethyltoluene | SRLI 0.7 | 0.3484 |
| 37 | ozone | 1 | 0.00276 |
| 38 | aluminum oxide | 2 | 0.1306 |
| 39 | zinc oxide | 3 | 0.1295 |
| 40 | copper oxide | 2 | 0.1305 |
| 41 | vanadium pentoxide | 1 | 0.000647 |
| 42 | epichlorohydrin | 2 | 0.1687 |
| 43 | hydrochloric acid | 2 | 0.2593 |
| 44 | ammonia | 4 | 0.00064 |
| 45 | acetic acid | 3 | 0.06096 |
| 46 | chromium anhydride | 1 | 0.909752 |
| 47 | sodium hydroxide | SRLI 0.01 | 0.8802 |
| 48 | phosphoric acid | SRLI 0.02 | 0.00030 |
| 49 | nickel sulfate | 1 | 0.00343 |
| 50 | boric acid | 3 | 0.00857 |
| 51 | nitric acid | 2 | 0.03092 |
| 52 | vinyl chloride | SRLI 0.005 | 0.000001 |
| 53 | sodium carbonate | SRLI 0.04 | 0.12576 |
| 54 | trisodium phosphate | SRLI 0.1 | 0.25155 |
| 55 | sodium chloride | SRLI 0.15 | 0.85760 |
| 56 | copper sulfate | 2 | 0.01742 |
| 57 | potassium carbonate | 4 | 0.01742 |
| 58 | tin sulfate | 3 | 0.00311 |

Note: information on the materials of the "KhEMP" SE [9]; SRLI – safe reference level of impact
Table 2

Concentration of wastewater pollutants

| No. | Name of substance | Concentration of the substance in wastewater, mg/l | Permissible concentration of substances in wastewater, mg/l | The mass of the substance discharged, kg/year |
|-----|------------------|--------------------------------------------------|----------------------------------------------------------|---------------------------------------------|
| 1   | pH               | 7.7                                              | 6.5–9.0                                                  | –                                           |
| 2   | dry residue      | 702                                              | –                                                        | 58700.1                                    |
| 3   | suspended substances | 78                                            | 400                                                      | 1050.6                                    |
| 4   | chlorides        | 145.4                                            | 350                                                      | 7142.8                                    |
| 5   | sulfates         | 105.4                                            | 350                                                      | 8520.7                                    |
| 6   | oil products     | 1.85                                             | 5                                                        | 142.05                                    |
| 7   | iron             | 2.1                                              | 5                                                        | 141.1                                    |
| 8   | ammonia nitrogen | 4.53                                             | 27                                                       | 97.05                                    |
| 9   | copper           | 0.74                                             | 2                                                        | 54.55                                    |
| 10  | nickel           | 0.03                                             | 0.1                                                      | –                                         |

Note: information on the materials of the «KhEMP» SE [9]

Table 3

Characteristics of waste generated at the enterprise

| No. | Name of waste                        | Technological process of education care | Hazard class | Amount of waste, pcs/t/year | Disposal direction                                      |
|-----|--------------------------------------|----------------------------------------|--------------|------------------------------|---------------------------------------------------------|
| 1   | Used mercury-containing fluorescent tubes | Lighting and operating instructions SNTP 11-4-79 | 1            | 1000                        | Rent for disposal by specialized companies |
| 2   | Spent lead-free battery plates       | Motor transport                        | 1            | 0.909                       | Rent for disposal by specialized companies               |
| 3   | Slag of non-ferrous metals and alloys containing lead | Non-ferrous metal processing | 1            | 11.410     | Sent to scrap metal collection plants                  |
| 4   | Waste electrolyte acid battery       | Motor transport                        | 2            | 2.730                      | Neutralized                                              |
| 5   | Oil waste, engine oils               | Motor transport                        | 2            | 1.000                      | Accumulation                                              |
| 6   | Polishing waste                     | Production of electrical equipment      | 3            | 0.500                      | Landfill in the Derhachi (Ukraine)                      |
| 7   | Tannin raous (textiles)              | Metal machining                        | 3            | 0.500                      | Landfill in the Derhachi (Ukraine)                      |
| 8   | Aluminum waste                      | Production of electrical equipment      | 3            | 7.000                      | Sent to scrap metal collection plants                   |
| 9   | Copper waste                         | Production of electrical equipment      | 3            | 100.00                     | Sent to scrap metal collection plants                   |
| 10  | Tin waste                            | Production of electrical equipment      | 3            | 2.000                      | Sent to scrap metal collection plants                   |
| 11  | Ferrous metal waste containing iron and its compounds | Production of electrical equipment Metal machining | 3          | 5000.000    | Sent to scrap metal collection plants                  |
| 12  | Sludge after reagent and electro-coagulation treatment | Production of electrical equipment Metal machining | 3          | 0.508    | Landfill in the Derhachi (Ukraine)                      |
| 13  | Solvent compound: toluene, xylene, white spirit | Electroplating wastewater treatment | 3            | in fact                    | Reapplied for the preparation of primers                |
| 14  | Used battery housings               | Machine manufacturing                  | 3            | 2.730                      | Landfill in the Derhachi (Ukraine)                      |
| 15  | Sludge, emulsion                     | Motor transport                        | 3            | 3.333                      | Accumulation. natural drying                             |
| 16  | Waste materials (resin waste)        | Production of electrical equipment      | 3            | 13.158                     | Landfill in the Derhachi (Ukraine)                      |
| 17  | FR-2, CEM waste                     | Production of impregnagation machines   | 4            | 3.333                      | Landfill in the Derhachi (Ukraine)                      |
| 18  | Waste foundry mixtures without heavy metals | Making negative boards                | 4            | 10.000                     | They are used to repair roads, territories and avoid ice in winter |
| 19  | Abrasive metal dust                  | Foundry                                 | 4            | 1.630                      | The accumulation is exported to the landfill            |
| 20  | Spent refractory brick               | Gas cleaning                           | 4            | 2.500                      | Landfill in the Derhachi (Ukraine)                      |
| 21  | Wood shavings and dust               | Foundry                                 | 4            | 178.287                    | Transmitted to the public                               |
| 22  | Tires with steel cord                | Woodworking. gas cleaning               | 4            | 1.000                      | Rent for disposal by specialized companies               |
| 23  | Waste paper                          | vehicle maintenance                    | 4            | 200.000                    | Rent for disposal by specialized companies               |
| 24  | Garbage from the territory           | Finished Product Packaging             | 4            | 20.000                     | Landfill in the Derhachi (Ukraine)                      |

Note: information on the materials of the «KhEMP» SE [9]
Thus, it is possible to draw the following conclusion that the following types of waste are generated at the enterprise:

- foundry slags;
- petroleum products;
- various kinds of solvents;
- sludge neutralization of spent solutions;
- waste solutions of various kinds of galvanic production;
- waste primers, enamels, putties;
- dishes contaminated with chemicals;
- wastewaters of hydraulic locks of the painting chambers;
- waste metal machining;
- fluorescent lamps;
- wood shavings;
- garbage from the territory.

3. Research results and discussion

To reduce dust emissions at the «KhEMP» SE there are 20 gas treatment plants, including:

1) dust precipitation chambers;
2) cyclones;
3) filters and hydraulic filters.

Table 4 presents the characteristics of gas treatment plants (GTP).

| No. | GTP name | Pollutant Name | Entrance, m²/m³ | Treatment efficiency | Exit, m²/m³ |
|-----|----------|----------------|-----------------|----------------------|-------------|
| 1   | Dust chamber | Metal dust | 21.31 | 69.5 | 6.50 |
| 2   | TsN-15 cyclone (Russian Federation) | Fiberglass dust | 17.42 | 55.8 | 7.70 |
| 3   | Dust chamber | Abrasive metal dust | 4.15 | 51.8 | 2.00 |
| 4   | VNINOT No. 7 cyclone (Russian Federation) | Metal dust | 12.36 | 72.0 | 3.46 |
| 5   | TsN-15 cyclone (Russian Federation) | Abrasive metal dust | 53.13 | 76.0 | 12.75 |
| 6   | VNINOT No. 7 cyclone (Russian Federation) | Metal dust | 61.54 | 87.0 | 8.00 |
| 7   | BC cyclone (Russian Federation) | Phenolic dust | 18.56 | 68.9 | 5.77 |
| 8   | BC cyclone (Russian Federation) | FR-2 dust | 49.14 | 67.6 | 15.92 |
| 9   | BC cyclone (Russian Federation) | Phenolic dust | 42.70 | 71.9 | 12.00 |
| 10  | BC cyclone (Russian Federation) | Phenolic dust | 1.57 | 68.1 | 0.44 |
| 11  | BC cyclone (Russian Federation) | FR-2 dust | 63.29 | 68.4 | 20.00 |
| 12  | TsN-15 cyclone (Russian Federation) | Asbestos dust | 48.66 | 86 | 6.84 |
| 13  | TsN-15 cyclone (Russian Federation) | Abrasive metal dust | 163.54 | 77.4 | 36.96 |
| 14  | Hydraulic filters | White spirit | 53.70 | 18.1 | 45.80 |
|     |           | Aerosol | 19.74 | 53.6 | 9.16 |
| 15  | Hydraulic filters | White spirit | 75.21 | 17.7 | 61.90 |
|     |           | Solvent | 66.95 | 17.7 | 55.10 |
|     |           | Xylene | 65.30 | 17.7 | 53.74 |
|     |           | Aerosol | 26.82 | 56.0 | 11.80 |
| 16  | TsN-15 cyclone (Russian Federation) | FR-2 dust | 199.79 | 81.2 | 37.56 |
|     |           | Fiberglass dust | 199.79 | 81.2 | 37.56 |
| 17  | Hydraulic filters | White spirit | 44.86 | 21.4 | 35.26 |
|     |           | Solvent | 3.26 | 21.4 | 2.56 |
|     |           | Xylene | 7.58 | 21.4 | 5.96 |
|     |           | Aerosol | 9.43 | 56.5 | 4.10 |
| 18  | Fiber filters | White spirit | 0.0191 | 57.0 | 0.0082 |
|     |           | Solvent | 0.0191 | 57.0 | 0.0082 |
|     |           | Xylene | 0.0191 | 57.0 | 0.0082 |
|     |           | Aerosol | 0.0191 | 57.0 | 0.0082 |
| 19  | Dust chamber | Wood dust | 75.0 | 92.0 | 6.00 |
| 20  | Gidroderevprom cyclone (Russian Federation) | Wood dust | 137.93 | 94.2 | 8.00 |

Note: information on the materials of the «KhEMP» SE [9]
As a result, it is possible to conclude that the gas treatment plants work well, with high treatment efficiency. All dust and gas cleaning equipment is in good condition, in fact, the efficiency of the equipment corresponds to the data recorded in the GTP passport.

In general, the main sources of pollution affect the environment as follows:

**Atmosphere.** «KhEMP» SE is a source of many substances that negatively affect the atmosphere. The main source of exposure to atmospheric air is carbon monoxide. The dispersion calculation is carried out according to the procedure [13]. This technique allows calculating the dispersion of impurities emitted into the atmosphere by single, point and linear, as well as a group of sources, taking into account the influence of the terrain.

The maximum value of the surface concentration of a harmful substance \( C_n \) when a gas-air mixture is emitted from a single point source with a round mouth is achieved under adverse weather conditions at a distance of \( (x_n) \) and is calculated by the formula:

\[
C_n = \frac{A \cdot M \cdot F \cdot m' \cdot \eta}{H^{3/2}},
\]

where \( A \) – coefficient depending on the temperature stratification of the atmosphere; \( M \) – mass of the harmful substance emitted into the atmosphere per unit of time, g/s; \( F \) – coefficient taking into account the sedimentation rate of harmful substances in the air; \( m' \) – coefficient taking into account the conditions of exit of the gas-air mixture from the mouth of the emission source; \( H \) – height of emission source above ground level; \( \eta \) – coefficient taking into account the influence of the terrain.

Because \( \Delta T = T_0 - T_n, \Delta T = 0 \) °C, the release source is cold.

To obtain the value of the coefficient \( m' \), let’s determine the following intermediate coefficients:

\[
\omega_c' = 1.3 \frac{\omega_c \cdot D}{H},
\]

where \( \omega_c \) – rate of release of the gas-air mixture from the pipe, m/s; \( D \) – diameter of the chimney pipe, m.

\[
f_e = 800 (\omega_c')^2, \quad \omega_e' = 1.107,
\]

\[
f_e = 1086.46, \quad m' = 0.9.
\]

Since \( \omega_e' \geq 0.5 \) and \( f_e \geq 100 \), then let’s use the formula (1) and obtain the values:

\[
C_n = 0.0045 \text{ mg/m}^3.
\]

Since the maximum concentration limit is lower than MPC\(_{a.d.}\) (3 mg/m\(^3\)), it is impractical to calculate carbon oxide dispersion.

**Hydrosphere.** The company uses water from the city water supply. The total actual discharge of normalized substances in the sewage network is 1668.598 m\(^3\)/day (418820 m\(^3\)/year). Of these, 191.198 m\(^3\)/day – household and 1179.47 m\(^3\)/day – production. The enterprise consumes 1770.75 m\(^3\)/day of water.

According to the permission for wastewater discharges approved by the Kharkivkommunochystvod utility company, the volume of wastewater at the enterprise is 46819 m\(^3\)/month.

The wastewater of the research object is discharged into the city sewer system through one outlet into the city sewer \( d = 200 \) mm, which passes along Moskovsky Prospect of Kharkiv metro station and belongs to the Dykanovska biological treatment complex sewage basin (\( Q = 500,000 \) m\(^3\)/day).

Due to the fact that the company discharges wastewater into the city sewer, there are no sources of impurities in water bodies.

In wastewater there is always a complex set of various pollutants. Wastewater of an enterprise containing substances that are practically not disposed of in urban wastewater treatment plants should be treated at local treatment facilities of industrial enterprises. The degree of such concentration, which, taking into account the diversion of industrial effluents in the sewerage network and the receiving reservoir, will ensure the water quality in it that meets the regulatory, that is, established by environmental authorities.

**Groundwater.** Potential sources of increased additional infiltration may be water-bearing communications, production with a «wets» process, treatment facilities for local wastewater treatment.

The model of additional infiltration nutrition is 3.6·10\(^{-3}\) m/day. Sources of groundwater pollution at the industrial site are not found.

Since the regime network for monitoring groundwater pollution has not been implemented on the territory of the industrial site, it is not possible to conduct a predicted calculation of pollution.

**Soil.** Assessment of the aerogenic load on the soil is carried out for those indicators for which the value of background concentrations.

1. For the calculation, it is necessary to determine the concentration of sulfur and nitrogen:

\[
\frac{C_{SO}}{C_N} = \frac{M_{SO}}{M_N},
\]

\[
C_N = \frac{14 \cdot 0.03}{14 + 16} = 0.009 \text{ mg/m}^3;
\]

\[
\frac{C_{HSO}}{C_S} = \frac{M_{HSO}}{M_S},
\]

\[
C_S = \frac{32 \cdot 0.001}{98} = 0.0003 \text{ mg/m}^3.
\]

2. Assessment of the load on the territory, which is created due to emissions of sources of air pollution, is determined by the formula:

\[
P = C_i \cdot V_f \cdot K,
\]

where \( C_i \) – concentration of the substance in the surface layer of the atmosphere, mg/m\(^3\); \( V_f \) – fall rate, \( V_f = 0.125 \) cm/s; \( K \) – coefficient of proportionality between units, \( K = 864 \).

\[
P_N = 0.009 \cdot 0.125 \cdot 864 = 0.972 \text{ kg/m}^3\text{day};
\]

\[
P_S = 0.0003 \cdot 0.125 \cdot 864 = 0.032 \text{ kg/m}^3\text{day}.
\]
3. The critical load on the soil is taken in accordance with international environmental standards:

\[ P_S = 2 \text{ t/km}^2\text{year}; \]

\[ P_D = 1 \text{ t/km}^2\text{year}. \]

4. The assessment is made by comparing the relative load of nitrogen and sulfur by calculating the total load:

\[ K_i = \frac{P_i}{P_{ow}}, \quad (6) \]

\[ K_N = \frac{0.972 \times 365}{2000} = 0.177; \]

\[ K_S = \frac{0.032 \times 365}{1000} = 0.012; \]

\[ \sum K_i = 0.177 + 0.012 = 0.189 < 1. \]

Thus, the load on the soil does not exceed the permissible.

An approximate estimate of the specific load on the territory, which is created by the emissions of the enterprise with a radius of action \( R = 0.84 \text{ km} \), is determined by the formula:

\[ P = \frac{Q_i \cdot a \cdot K}{\pi \cdot R^2}, \quad (7) \]

where \( Q_i \) – annual emission of the \( i \)-th component, \( \text{t/year} \); \( R \) – radius of the enterprise influence, \( \text{km} \); \( a \) – coefficient characterizing the deposition of emissions in the zone of influence of the enterprise, \( a = 0.4 \); \( K \) – transition coefficient \( = 2.76 \).

The specific load on the territory that is created by dust emissions:

\[ P_{dust} = \frac{1.17 \cdot 0.4 \cdot 2.76}{3.14 \cdot 0.84^2} = \frac{1.292}{2.21} = 0.58 \text{ kg/km}^2\text{day} \]

Thus, the enterprise does not have a harmful effect on the soil.

4. Conclusions

Analyzing the emissions of harmful substances into the atmospheric air from the industrial site of the «KhEMP» SE, the following conclusion can be drawn: the concentrations of the ingredients emitted by the enterprise do not exceed the corresponding maximum permissible values. Emissions to the environment are local in nature and ensure a satisfactory state of the environment in the area where the facility is located and outside the sanitary protection zone. It is recommended to timely monitor emissions of pollutants into the atmosphere by direct measurements at the source, to verify the efficiency of dust and gas treatment plants. An analysis of the initial data and the results obtained showed that at the moment the composition of contaminants in the wastewater of the enterprise does not exceed regulatory requirements. It can also be concluded that the electromechanical plant does not damage the soil. Given the non-agricultural nature of the use of land in the plant’s sanitary protection zone, re-examination of soil for pollution, according to expert assessment with the existing production technology, is recommended not earlier than after 15–20 years. In order to reduce the technogenic impact of emissions on the environment, it is necessary to improve the production technology of the «KhEMP» SE.

The conducted studies will be useful for the implementation of environmental measures at enterprises of various industries that are sources of emissions of potentially hazardous substances.

References

1. Totai, A. V. et al.; Totai, A. V., Korsakov, A. V. (Ed.) (2016). Ekologiya. Moscow: Izdat. 450.
2. Stolberg, F. V. (Ed.) (2000). Ekologiya goroda. Kyiv: Libra, 464.
3. Ekzempliarkii, N. S., Bagayeva, O. I., Brazgovka, O. V. (2015). Vliianie khimicheskikh veshestv na organizm cheloveka i ikh giganicheskoy normirovanie. Aktualnye problemy aviacii i kosmonavtiki, 11 (1), 767–768.
4. Krasnenok, I. S. (2015). Vidy vrednych veshestv i ikh vozdeistvie na organizm cheloveka kak odin iz aspektov energeticheskikh normirovaniya. Epozhna nauki, 4, 424–428.
5. Klimina, N. Iu., Bezruchko, N. V., Rubcov, G. K., Chichkin, S. N. (2019). Ocenna vozdeistvii khimiiskogo zagryazneniya okruzhayushchei sredy kak faktorarika dlia zhorovia cheloveka: analiticheskii obzor. Vestnik Tomskogo gosudarstvennogo pedagogicheskogo universiteta. Ekologiya, 3 (93), 156–161.
6. Du, W., Li, M. (2020). Assessing the impact of environmental regulation on pollution abatement and collaborative emissions reduction: Micro-evidence from Chinese industrial enterprises. Environmental Impact Assessment Review, 82, 106382. doi: http://doi.org/10.1016/j.eiar.2020.106382
7. Ganda, F. (2019). The impact of industrial practice on carbon emissions in the BRICS: a panel quantile regression analysis. Progress in Industrial Ecology, An International Journal, 13 (1), 84. doi: http://doi.org/10.1504/pie.2019.098813
8. Sanchez, L. F., Stern, D. I. (2015). Drivers of Industrial and Non-Industrial Greenhouse Gas Emissions. SSRN Electronic Journal. doi: http://doi.org/10.2139/ssrn.2744335
9. DP «KhEMZ». Available at: https://khemz.kharkov.com
10. Dodatok No. 4. Pro zatverdzhennia Derzhavnykh sanitarnykh pravyl planuvannia ta zabudovy naselenykh punktiv (1996). Nakaz Ministerstva okhorony zdorovia Ukrainy. No. 173. 19.06.1996. Available at: https://zakon.tada.gov.ua/laws/show/50379
11. Obobschennyi perechen’ predel’no dopustimykh koncentracii (PDK) i orientirovnochbezopasnykh urovnei vozdeistviia (OBUV) vrednych veshestv dlia vody rybokhoziaistvennykh vodoemov (1990). Moscow, 49.
12. Obhachna okruzhayushchei sredy (1978). Leningrad, 506.
13. ODN-86. Metodika rascheta koncentracii v atmosfere v obusloviakh vrednych veshestv, soderzhashchikh raven vlyashenii predpriiatii. Available at: http://docs.cntd.ru/document/1200000112

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