Calculation of the economic effect of environmental measures

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Abstract. The article presents the problems of atmospheric air protection from industrial emissions and labor protection at polluting enterprises. A list of measures to protect the atmosphere from industrial emissions is disclosed. A technique is proposed for determining the economic effect by increasing labor productivity as a result of measures to prevent atmospheric pollution.

An extremely important feature of industrial emissions is that maximum concentrations of harmful substances are formed near sources of pollution. For this reason, the most adverse effect of industrial emissions on humans and the environment is on industrial sites and territories adjacent to the epicenter of pollution. Here there are the highest concentrations of harmful substances in the atmospheric air, and also in these territories their bulk is accumulated on the soil and the surface of water bodies.

Hence the unity of the problems of atmospheric air protection from industrial emissions and labor protection at polluting enterprises. At the moment, these emissions have not found the necessary reflection in the current regulatory and technical documentation on protecting people and the environment from industrial emissions.

For this reason, further development of scientific and technical documentation is necessary, since its existing types are not complex today, contain incorrect recommendations and errors, which in some cases lead to significant distortions in the effectiveness of protective measures. The consequence of this is the fact that for more than 20 years, design organizations have been developing environmental protection measures for industrial facilities using outdated methods for the development of scientific and technical documentation, which does not fully protect humans and preserve the natural environment. This leads to the following consequences at the commissioned industrial facilities:

1. Actual levels of air pollution in workshops, on adjacent sites and territories exceed permissible sanitary standards.
2. Reduced labor productivity.
3. Significant harm is caused to the health of workers at the enterprise and people whose homes are located nearby.
4. The period of working capacity is reduced and the proportion of pensioners in the total population of this territory is increasing.
5. The number of diseases among children is increasing.
6. The number of births decreases, the number of children with congenital malformations increases.
7. Damage to flora and fauna.

In addition, erroneous decisions in planning lead to an incorrect assessment of the required volumes of raw materials. All this leads to significant social and economic losses for the national economy, and
not in all cases these losses can be determined with reliable accuracy, since there are no corresponding, well-developed methods.

One of the main tasks in solving this problem is to improve scientific and technical documentation with the help of fundamentally new integrated and unified approaches that will provide an appropriate level of designing effective environmental protection measures, based on a unified scientific and technical policy to preserve human health and the environment, and as much as possible comprehensive accounting of economic indicators of enterprises related to environmental management.

The development of an ecological passport of an industrial enterprise is advisory in nature, this is what the letter of the Ministry of Natural Resources of the Russian Federation dated 06.09.2001 No. 33-01-8/3047 tells us about, and in the law dated 10.01.2002 No. 7-FZ “On Protection environment” there is also no requirement for the compilation of this document. Thus, we can conclude that the absence of an environmental passport in the organization is not a violation and it is impossible to bring to administrative responsibility for this.

In our opinion this important document allows us to systematize data on the environmental and economic activity of the enterprise, taking into account data on the costs of environmental protection measures and payments for environmental pollution. Thus, the development of this document allows us to draw a conclusion about the degree of danger of this enterprise, as well as to assess the economic damage associated with adverse environmental impacts in the form of payments for emissions both within the established limits and over limits.

An industrial enterprise suffers economic losses not only in the form of payments and fines, but also for a number of other components. The environmental passport does not take into account this part of economic damage, and therefore, in order to solve this problem, we consider it appropriate to propose a methodology for assessing economic damage as a result of a decrease in labor productivity at the enterprise as a result of air pollution of work areas and industrial sites.

Studies in various sectors of the economy indicate a relationship between the level of labor productivity and the parameters of the working environment. It has been established that the effect on the human body of harmful substances contained in the air will certainly lead to a decrease in labor productivity, and with a long period of exposure, possible disability and premature death.

Industrial emissions of enterprises contain a large number of various harmful substances, which can increase due to the introduction of new materials and technologies. As a rule, these substances affect the human body not in isolation, but in combinations, which significantly increases the danger to the human body. Under this harmful influence are employees of enterprises, because the most significant concentrations of industrial emissions are observed in work areas and on industrial sites [1].

Labour productivity of a worker from 100 to 120% can be achieved provided that the content of harmful substances in the air of the working zone is within acceptable limits (below the maximum permissible concentration). When exceeding this indicator three times, productivity decreases by 20%; if the concentration of harmful substances in the working environment exceeds ten times the maximum permissible concentration, then labor productivity is almost halved. The overall economic effect of increasing labor productivity by normalizing the parameters of the air environment can be calculated by the formula:

$$\mathcal{E}_{lp} = \Delta \mathcal{E}_{lp} + \Delta M - (\Delta K_B + \Delta K_m + \text{Снир})/Co$$

(1)

where $\mathcal{E}_{lp}$ – The overall economic effect of increasing labor productivity due to the normalization of air parameters, (rubles);

$\Delta \mathcal{E}$ п. т. - additional economic effect from increasing labor productivity due to the normalization of air parameters, (rubles);

$$\Delta \mathcal{E} \text{ п. т.} = \Delta \Pi \cdot N_m$$

(2)

where $\Delta \Pi$ – change in labor productivity by improving working conditions;

$N_m$ - enterprise productivity before the implementation of measures to normalize the parameters of the air environment (output, rubles)
\[ N_M = \text{Акп} \cdot \text{Pen} \]  
(3)

where \( \text{Акп} \) – average annual number of products per employee;  
\( \text{Pen} \) - average annual number of employees (people).  
\( \Delta M \) – reduction of material losses (rubles)  
\[ \Delta M = \Delta M_1 + \Delta M_2 + \Delta M_3 \]  
(4)

where \( \Delta M_1 \) – reduction in training costs by reducing their turnover (rubles);  
\( \Delta M_2 \) – cost savings and the termination or partial reduction of costs for the payment of benefits and compensation for harm (special allowances for harmful working conditions, etc.), (rubles);  
\( \Delta M_3 \) – cost savings in connection with the growth of labor productivity (rubles);  
\( \Delta Kv \) – capital investment to normalize the parameters of the air environment (rubles);  
\( \Delta Km \) – additional costs for new materials due to changes in production technology in order to optimize the parameters of the air environment (rubles);  
\( \text{Снир} \) – research and development costs (rubles);  
\( \text{Со} \) – standard payback period (years).

The above technique allows you to determine the economic effect by increasing labor productivity as a result of measures to prevent atmospheric pollution.  

If the enterprise pollutes atmospheric air, soil, water bodies, then this calculated value reflects the hidden costs of the enterprise as a result of harmful effects on the environment. These may include, for example, the amount of lost profits, which are calculated according to the previously considered criteria. However, for each real project, of great interest is not only the assessment of economic damage resulting from adverse environmental impacts, but also recommendations for preventing such impacts.

Measures to protect atmospheric air from pollution include technological processes that ensure the reduction of atmospheric emissions and their disposal, as well as means of monitoring the state of the environment. We will disclose a list of measures to protect the atmosphere from industrial emissions.

1. Technological measures:

- closed technological cycles that exclude emissions of pollution into the atmosphere;
- the use of new or improvement of existing technologies in which emissions of harmful substances are minimized;
- elimination of small boiler equipment;
- gasification and electrification of enterprises.

A large amount of raw materials used (up to 90%) goes to waste - ash, slag, etc. The costs of processing and disposal of waste with the existing requirements are 8-10% of the cost of production. Active development of non-waste or low-waste technological cycles is the most realistic prospect of solving the problem of environmental pollution by industrial waste.

2. Engineering and technical measures.

A large effect in the field of improving the composition of the air is provided by the installation of gas purification plants. Over the past decade, the total capacity of equipment for the capture of harmful substances and gases has been increased many times. In industry, more than 1.5 thousand names of various harmful substances are known. But an analysis of the existing equipment showed that only about 5-20% is withdrawn from them. Emissions may contain simultaneously up to 40 types of harmful substances with various concentrations. But cleaning, of course, is not carried out comprehensively, but selectively - for one or two substances. The rest are released into the atmosphere without purification. [2].

In this regard, new scientific developments in the field of environmental protection are of great practical interest. Promising in this regard may be collector systems for centralized removal and neutralization in the natural way of harmful components of industrial emissions of a certain group of enterprises.
Harmful substances are collected in an underground tunnel, which acts as a natural reactor, and cleaned up in it. The cleaning ratio is about 80-85%. The advantage of such systems is not only their high efficiency in comparison with traditional dust and gas purification devices at individual enterprises, but also the production of a number of related products that can be used in the national economy.

3. Aerodynamic activities.
They consist in the placement of an industrial site, taking into account meteorological factors and the terrain, while ensuring the maximum use of natural ventilation, taking into account the aerodynamics of air flows when wind flows around industrial buildings.

To maximize the use of wind energy in the natural ventilation of industrial sites, it is necessary:

- when designing the facilities of the structure, the same height should be provided, their long side should be located perpendicular to the prevailing air direction;
- at different heights of structures, they should be combined into groups with the same height, and arrange these groups as the height increases in the direction of the prevailing wind movement;
- to predict the total concentration of harmful substances from several sources, it is necessary to arrange them so that there is no overlap of factors.

4. Architectural events.
Aimed at reducing the size of the circulation zones that form when wind flows around structures. These include:

- focus on low facilities;
- the use of structures (if possible a simple form) without add-ons and the exclusion of structures of complex shape;
- the choice of the shape of structures and the installation of fairings at their acute angles.

5. Organizational activities.
Ensure the correct operation of technical and gas and dust cleaning equipment, control over the established values of the maximum permissible and temporarily agreed emissions into the atmosphere, the level of air pollution at the industrial site and the surrounding area.

Organizational measures are diverse, and their selection should be made in each case, depending on the nature of production, type of pollutants, as well as the location of the enterprise and other factors.

6. Economic losses of the enterprise and the industrial region as a result of environmental pollution.
Analysis of materials for the protection of atmospheric air from industrial emissions indicates that the existing organization of planning and coordination of work does not ensure the timely development of methods for protecting atmospheric air, methods for its control, and methods for predicting the level of pollution.

As a result, air pollution is practically not reduced, which causes great damage to the health of people and the surrounding area and is accompanied by significant economic losses. In our opinion, even a rough estimate of these losses could significantly affect the decision-making process of enterprises to reduce them. And this, in turn, would become a significant replenishment both for the budget of individual cities and regions. In this regard, it seems appropriate to include in the environmental passport of the enterprise a section that would reflect the economic losses of the enterprise as a result of its activities.

Thus, we can conclude that the processes of making managerial economic and environmental decisions take place, as a rule, in complex dynamic production and economic systems. Each decision concerns both technical, economic and environmental aspects of the functioning of the industrial and economic sphere and its individual elements. The combined impact and conditionality of these processes forms the main feature of modern production. The growing level of production complexity, the various consequences of decisions made by managers, lead to a decrease in the adequacy of classical decision-
making models in modern conditions. In this regard, there is a need to create synthetic models for making decisions that can be used in production, technological, economic and environmental processes.

References
[1] Zhigir A A 2013 Management of greening enterprises in the agricultural sector Economics and entrepreneurship 7 (36) 515-8
[2] Glukhov V V and Nekrasova T P 2003 Economic foundations of ecology (SPb.: PETER)