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MAMMADOVA A. A.

ENVIRONMENTAL IMPACT ASSESSMENT

MINISTRY OF EDUCATION OF THE REPUBLIC OF AZERBAIJAN

AZERBAIJAN STATE OIL AND INDUSTRY UNIVERSITY

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Textbook

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TEXTBOOK

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CONTENT

PREFACE

Over the last four decades there has been a remarkable growth of interest in environmental issues - in sustainability and the better management of development in harmony with the environment. Currently, due to the serious aggravation of the environmental situation on a global scale, ensuring the environmental safety of existing facilities, including new ones being designed, has become one of the most important conditions. The purpose of this book guide "Environmental impact assessment": to provide the necessary theoretical knowledge about the tasks facing environmental impact assessment, its legal framework; to familiarize yourself with the rules for environmental impact assessment, the principles of drawing up an expert opinion.

The problem of environmental protection is one of the most urgent, since the life, health and well-being of all living things directly depend on its solution. Qualitative and quantitative assessment of environmental pollution is the most important procedure for establishing the degree of environmental safety, since it allows solving the problems of environmental monitoring and developing systems to protect ecosystems and humans from the negative effects of modern technological processes and energy sources. The publication contains significant computational material, the use of which will help students acquire the necessary skills to assess the state of the environment and develop a set of measures to ensure environmental safety.

1. ENVIRONMENTAL REQUIREMENTS FOR NEW PROJECTS AND OPERATING FACILITIES

1.1. Environmental requirements in the design and reconstruction of facilities

One of the main conditions when designing-planning and drafting project-estimate documents is the adoption of decisions that allow the formation of a normal environment that can ensure the optimal living conditions of people.

The environmental requirements for the projects and the measures to be implemented in this regard should be reflected in the special section "Protection of the environment and efficient use of natural resources" of the projects. This section includes economic zones, separate enterprises, transport and communication sectors, settlements, etc. These issues can also be noted in the materials assessing the current state of the environment, in the general plan of the facility, settlement or economic zone, in the documentation of provision of the area with engineering facilities.

When planning settlements and economic zones on the territory, the following sections should be included in the "Environmental Protection" documents:

- general ecological characteristics of the area;
- protection of atmospheric air;
- protection of surface and groundwater;
- protection of soil cover and plant kingdom, restoration of lands;
- protection of the animal kingdom;
- protection of the environment from noise, electromagnetic waves, radioactive radiation, high temperature and other physical effects;

- protection of natural monuments, historical monuments and cultural monuments;
- formalization of the Protected Areas System (reserves, national parks, etc.);
- protection of the geological landscape of the territory and its improvement;
- engineer-complex scheme of ecological zoning and Environmental Protection.

In the section ” General ecological characteristics of the territory", it is necessary to indicate the current state of the natural environment and optimal eco-economic parameters (for individual settlements and industrial facilities), natural links in this area and ways to increase (or restore) the natural potential of the territory.

It should also determine the maximum number of people who can be accommodated in this area, provided that the demographics of the area, i.e. the internal conditions of the area, meet the daily needs of people.

It should be noted that the demographic capacity (D_i) of the area is determined when the population density is 50-60 people/km^2.

For this, the following indicators are used.

1. Demographics of areas suitable for the construction of industrial facilities and residential buildings (formula 1.1.1.):

$$D_1 = T_1 * 1000 / H \qquad (1.1.1.)$$

here: T_1 – is the area of the territories with the highest level of assessment according to the points system, ha; H – is the required territory for 1000 population, taking into account the production base of the corresponding area (20-30 ha), ha.

2. Demographics of the territory by volume of surface and underground water resources (formula 1.1.2.):

According to surface water resources**:**

$$D_2 = \sum P * K * 1000 / p \qquad (1.1.2.)$$

here: P is the total volume included in the territory of river waters (mainly rivers with a water flow of 0.3 m^3/day), m^3/day; p - regulatory water supply to the population for 1000 m^3/day (taking into account prospects of development of the territory from 1000 m^3/day to 2000 m^3/day); K is the coefficient that takes into account the ingress of sewage into water bodies, taking into account their washing in the waters; the K – factor of 0.25 is taken (formula 1.1.3.).
According to the underground water resources:

$$D_3 = \sum E * T_p * 1000 / P_o \qquad (1.1.3.)$$

here: E is a module of operation of underground water source, m^3 /(day*ha); T_p – is an area of the territory under consideration, ha; P_o – is a special water supply norm for underground water supply for 1000 people and is taken mainly 40 m^3/day.

3. Demographics of the area suitable for cultural recreation:

It is considered that the number of vacationers in the summer season is up to 40% of the population of the region and 75% of them are located in the forest area, 25% in the rest areas outside the water basins, and 25% in the hot and dry climate zones are located in the forest area and 75% in the water basins. So, if the rest is organized in the forest area, then the demographics of the area (formula 1.1.4.):

$$D_4 = T_p * L * K * 1000 /(H * M) \qquad (1.1.4.)$$

here: Tp – is the area of the territory under consideration, ha; L – is the forest – covered area of the territory, %; K – is the coefficient taking into account the emission of artificial greenery in settlements (the price varies depending on the climatic zone of the area and is K = 0,5 for temperate climatic areas); H – is the territorial norm for normal recreation of the population = 0,3, for a warm climatic zone, m = 0,1 is taken.

When assigning demographics capacity for forest areas, T_p and L can be used instead of the general area (T_2, km^2) of suitable and partially suitable areas for rest of the region.

If the recreation is organized outside the watersheds, then the demographic capacity of the area (formula 1.1.5.):

$$D_5 = 2 * B * C * 1000 / (0,5 * M_1) \qquad (1.1.5.)$$

here: B - is the length of the beach zone, km; C – is the coefficient taking into account the possibilities of organizing the beach (C = 0.5 for green areas and C = 0.3 for desert areas); 0,5 - is the normative indicator of the demand of 1000 people for beach dissatisfaction, km; M_1 is the area coefficient for distribution of vacationers in the area (M_1 = 0,1 – 0,15 for mild climatic zones, M_1 = 0,3-0,4 for hot and dry climatic zones).

4. Demographic capacity of suburban areas and areas suitable for growing agricultural products.

The main condition for carrying out such a report is the availability of suitable areas for the organization of garden recreation or agricultural production on an individual basis (formula 1.1.6.).

$$D_6 = T * E * 1000 / R \qquad (1.1.6.)$$

here: on the basis of a comprehensive assessment of the T - area, the area of the most suitable and useful areas for garden recreation or agricultural production, ha; E-garden is a coefficient taking into account the possibility of using suitable areas for recreation or for agricultural production (its price varies from 0.1 -1.0 depending on concrete conditions); R-1000 is an indicator that reflects the demand of the population suitable for garden recreation or agricultural production (depending on the agro-economic indicators of the area, its price varies in a very wide range and is usually 500 -2000 ha).

5. The lowest of the individual demographic capacity indicators (D_1-D_6) is taken as the final indicator of the territory's demographic capacity.

However, the design and planning documentation should reflect the demographic indicators established for all criteria, and they should be interpreted in detail.

When carrying out design and planning work, the territory's ability to regenerate itself must be determined, that is, the possibility of restoring oxygen, water and air, which are the main elements of the environment. In this regard, we recommend that you keep the following reports.

According to the oxygen reserve (formula 1.1.7.):

$$P_o = \sum C * T_1 * K_1 \qquad (1.1.7.)$$

here: P_o - is the productivity of the area by oxygen, ton; C – is the amount of oxygen dissolved by the appropriate vegetation during the year, ton/(ha*year); (the price is 10 – 15 for mixed, coniferous and broad – leaved forest areas; n = 5 - 6 for plowed planting areas; 0,8 – 1,0 for highly landscaped cities; 4 - 5 for grazing areas); T_1 – is the area of the the coefficient of transition to oxygen was K_1 = 1,45.

According to water resources (formula1.1.8.):

$$P_s = \sum T_2 * \Upsilon * K_2 \quad (1.1.8.)$$

here: P_s - the productivity of the territory by water, m^3; T – the total area of the territory with surface water sources, ha; Υ – the surface water reserve per the territorial unit, l/m^2; K_2 - the coefficient of uneven distribution of water in the territory, the price varies between 0,1 – 1,0.

The productivity of the area is calculated in a similar way for underground water resources. But at the same time, the coefficient of extraction of groundwater with the coefficient of filtration of water from rocks should be taken into account.

The ability of the green cover of the territory to restore itself is determined by the current state of the plant kingdom of that territory and the possibility of increasing the greenery by carrying out landscaping work on unused lands. The self-recovery index of the area is defined as the ratio of the ability of the biosphere of the area to self-recovery to the consumption of the corresponding elements of the biosphere. The fact that the self-recovery index is equal to 1 indicates the balance of the corresponding component of the natural environment. The fact that the self-recovery index $\geq$ 1 indicates an unhealthy ecological situation in the corresponding area. In such cases, it is necessary to limit the construction work in the relevant areas and to adjust the parameters for the improvement of the ecological situation.

The total ecological capacity of the territory is equal to the total demographic capacity of the territory and the ability to self-recover. This indicator allows you to set optimal parameters related to the protection of the plant and animal kingdom of the territory.

"Sanitary-epidemiological conditions of the territory" projects are given in the form of a separate section. For this purpose, the sanitary-epidemiological situation of the relevant area is studied in detail and predicted how the situation will change after the implementation of the new project. This section includes:

1. Determination of areas in which specific diseases can arise due to the fact that certain microelements or chemical compounds are excessively or, conversely, much less than necessary for life.
2. Identification of urgent measures related to the abolition of epidemiological sources existing in the relevant areas (or settlements).
3. Analysis of sanitary and hygienic measures envisaged in the project.
4. Investigation of the requirements for sanitary and hygienic conditions of industrial facilities related to the application of low-cost and waste-free technologies.
5. Investigation of the requirements for sanitary and hygienic conditions of industrial facilities related to the application of low-cost and waste-free technologies.
6. The section “Protection of the environment” of the projects concludes with “Complex scheme of protection of the environment”. In this scheme, high temperature, noise, electromagnetic waves, radioactive radiation, along with completely critical, partially useful and useful areas, as well as other areas where environmental factors exist are noted. In the complex scheme of Environmental Protection, the following should be indicated: national parks, reserves and other

protected areas; forest areas, greenery in settlements; special engineer-technical installations and constructions (dams, chemical warehouses, high pressure pipelines, high voltage power lines, sliding and flood zones, etc.); areas intended for recreation, industrial zone, transport-communication lines, areas where the use of chemical preparations is prohibited, etc.

1.2. Objectives and basic principles of Environmental Impact Assessment. Stages of environmental impact assessment.

Environmental Impact Assessment (EIA) refers to the nature and extent of all potential environmental impacts as a result of human economic and life activities and is intended to determine the ecological, social and economic consequences associated with the implementation of the project. EIA is one of the main elements of all stages of design, allowing to discover the negative effects that can have on Natural Resources, people's health and living conditions now and in the future. All materials related to EIA must be submitted to the state environmental expert together with the project feasibility study materials and project-estimate documents.

The purpose of the EIA is as follows:

1) prevent the destruction of the natural environment;
2) restoration of natural systems that have been disrupted as a result of man's past farm activities;
3) ensuring the ecological and economic balance of the future development of the national economy;
4) creating satisfactory living conditions for people;
5) selection of measures to increase the degree of ecological safety of the intended farm activity.

The main principles of the EIA are:

1) integration of technical, ecological, social and economic indicators of project implementation;

2) multiple options for meeting environmental requirements;

3) ecological system and its resistance to expected impacts, socio-economic development of the region, history, ethnic, cultural, etc. taking into account features and regional features.

According to the results of the EIA, projects that meet the following requirements are selected and approved:

1) projects that do not pose a direct or indirect risk to human health, taking into account the distance of the survey placement of objects in localities;

2) non-environmentally hazardous projects in the processing and use of products, including destruction;

3) projects that do not cause dangerous changes that can't be restored in the natural environment during the construction, operation and liquidation of the object.

When preparing feasibility studies and project-estimate documents, the organization and organization of EIA is carried out by the customer organization. In this regard, the customer organization pays all costs and this is reflected in the technical and economic justification documents of the project. The project organization directly implements the EIA and prepares the necessary documents. Highly qualified and experienced personnel are involved in this work. The designer is responsible for the quality and objectivity of the EIA.

Before submitting the necessary documents to the state environmental expert, the client and the project organization together organize and carry out the initial discussion of the results of EIA. This work involves a team of experts of the relevant main department (ministry) on feasibility studies and representatives of public organizations interested in this project. The final stage of the EIA is carried out by the state environmental expert.

Stages of the EIA

The EIA has the following stages:

1) collection and analysis of necessary information;
2) determining the source and type of environmental impact, including the affected objects;
3) forecasting changes that may occur in the natural environment;
4) assessment of possible accident situations and their expected consequences;
5) assessment of economic, ecological and social consequences;
6) to determine methods of reducing the possible negative impacts on the environment and people's health;
7) determination of residual effects after an accident and elimination of its consequences and selection of methods for their control;
8) conducting an ecological and economic assessment;
9) analysis and implementation of alternative options of the project.

Collection and analysis of the following items is carried out during the EIA:

1) about the ways of project implementation (characteristics of construction works, operation and liquidation of the object, raw materials and energy sources, ways of technical solution of the planned work);
2) about the amount of all waste and their characteristics as a result of carrying out material balance reports for various working modes of the facility;

3) the situation of natural conditions in the construction District (characteristics of air, water, land allocated for construction, climate, flora, fauna, protected areas, etc.);

4) information about the socio-economic structure of the construction district.

According to the collected data, sources of environmental impact and their types, affected objects are identified. Concretely, the following are defined:

1) object of impact;

2) the volume of the effect;

3) geographical area that the effect covers;

4) the occurrence of environmental impact.

The sequence of implementation of these work is as follows:

1) preparation of the project;

2) collection and analysis of information about environmental consequences for existing analog objects;

3) systematization of collected materials;

4) analysis of the environmental situation.

Because of this, they use the method of comparative analysis of expert assessment, the method of analysis of errors and the methods of drip.

Then it is necessary to determine what geographical area the effect covers, the number of affected objects, the intensity of the effect (change in the degree of pollution of air, water, etc.), the duration of the impact (short-term, long-term, continuous, periodic, accident-term), is determined, the impact objects are indicated (health of the population, the nature of the use of natural resources of the area, etc.), the characteristic of the effect is given (direct, indirect cumulative, etc.), the expected "new" condition of the surrounding natural conditions is predicted.

When evaluating possible accidents and their consequences, the probability of occurrence, development and occurrence of accidents is analyzed and the possible causes of the accident (technical errors of the worker, fire, explosion, natural disaster, etc.) is determined. In addition, measures to protect the population, animal and plant world from possible impacts of the territory using special technical means, the impact of low-waste and waste-free technological process, processing and neutralization of all types of waste, warning about accident situations, prevention and elimination of accidents are also considered.

The EIA allows you to determine the following results that may arise from the implementation of the project:

1) changes that may occur in people's health, depending on the level and scale of the dangerous effects;

2) changes that occur in connection with the impact on the environment, its individual elements and in general a specific ecosystem;

3) socio-economic changes (demographic shifts, changes in social infrastructure, etc.).

After all, an eco-economic assessment is carried out, and its results are used for the ecologically economic justification of the environmental measures envisaged in the project. During the EIA, economic reports are as follows:

1) the full amount of public expenditure on the options under consideration is determined;

2) the amount of expenses is specified depending on the purpose and conditions of the report;

3) general ecological and economic assessment is carried out;

4) the results of the report are explained in terms of public interest.

At the feasibility stage of the project, the expected profitability of the facility is calculated taking into account the dynamics of changes in prices of raw materials and materials, their sources and methods. Here the following costs are taken into account:

1) costs of production and storage of social and household objects;

2) the cost of using natural resources;

3) cost of using the services of external organizations for waste treatment and disposal.

Then, the effectiveness of the costs incurred for the implementation of the project or options for its cancellation (taking into account all possible consequences) is calculated.

The results of the EIA should be reflected in the technical and economic justification materials of the project in the special section "Environmental impact assessment". Copies of the documents mentioned below should also be added here:

1) approval documents with state control bodies and the Ministry of health of the Republic in connection with the use of natural resources;

2) field expert opinion;

3) documents for discussion of the results of the project EIA with the participation of representatives of the public.

The following are included in the project EIA section:

1) justification of the requirements of the client and the public during the implementation of the project;

2) justification of the placement of the facility in accordance with the socio-economic development scheme of the region;

3) alternative options considered during pre-project studies.

The sources of information used for EIA are:

1) environmental constraints taken into account in the design process;

2) environmental and socio – economic evaluation criteria of the project;

3) short content of EIA (it is recommended to provide materials in the form of tables);

4) a list of alternative methods that were considered during the design, but were not included in the project to reduce the negative impact on the environment (including prices);

5) program for monitoring the safety of use and destruction of manufactured products.

All materials must be written in a concise and understandable form.

At the initial stage, when it is only necessary to justify the need for this activity, the purpose of the EIA is to show the environmental feasibility of the proposed activity and formulate the environmental prerequisites for the occurrence of certain environmental problems related to both the regional characteristics of the territory and the industry specifics of the activity. At the stage of the project stage, when both qualitative and quantitative loads on the environment are known, the purpose of the EIA is specific quantitative (or expert - qualitative) assessments of possible consequences, in order to provide such technical and technological solutions that allow either avoiding or minimizing undesirable consequences.

Despite the fact that the EIA is an integral part of the pre-project (or project) documentation, at the same time this section is a complete study that should be understandable to both specialists and a wide range of interested parties (administration and population of the area of activity) even without referring to the technical and technological details of the project.

2. CALCULATION OF THE AMOUNT OF HARMFUL WASTE LEAKING INTO THE ATMOSPHERE AIR.

2.1. Determination of the degree of pollution of the atmosphere with harmful wastes

Hydrodynamic, thermal, electromagnetic, chemical and photochemical processes are constantly occurring in atmospheric air under the influence of both external and internal factors. These processes directly affect the temperature, pressure, chemical composition of the atmosphere, and the speed of air flow. Without knowing the normal chemical composition of the atmosphere, it is impossible to determine the degree of pollution.

The natural chemical composition (volume %) of the atmosphere is given below.

Nitrogen... 78.084
Oxygen...20.9476
Water vapor..3 - 4
Argon..0.934
CO2..0.0314
Neon…..0.001818
Helium …...$524 *10^{-6}$
Krypton...$114 *10^{-6}$
Hydrogen...$50 *10^{-6}$
Ksenon..$8.7 *10^{-6}$

Ozone.......................................(2.0-7.0) * 10^{-6}

Atmospheric air is never fully clean. The total mass of atmospheric air mixtures covering our planet is 10 million tons per year. The reason why so many mixtures get into the atmosphere is both the production activities of people and natural processes.

Sources of atmospheric pollution can be conditionally divided into 2 groups:

*1. Sources of natural pollution***.** These include storms, cataclysms and hurricanes, volcanic eruptions, forest fires and other natural phenomena. The world ocean is also one of the sources of atmospheric pollution. During the fluctuation of ocean water, small droplets of water leaving the surface of the water evaporate instantly, and the salt contained in them fall into the atmosphere. During the eruption of volcanoes, a large amount of volcanic ash is thrown into the surrounding atmospheric air. In the composition of volcanic gases HCl, HF, NH_3, CO, CO_2, H_2S, etc. there are harmful substances. The atmosphere of our planet is also polluted by cosmic dust from interplanetary space.

2. Sources of artificial pollution. These include processes related to human activity. 70% of harmful mixtures falling into the atmosphere fall into the share of automobile transport. About 200 harmful substances were found in the composition of automobile flue gases. Practically in all areas of the industry, waste is taken into the atmosphere. There are no limits to anthropogenic atmospheric pollutants. Testing nuclear weapons causes radioactive contamination in the atmosphere of many countries. Radioactive dust can spread at a distance of 6000 km. Mineral fertilizers and chemical preparations used in agriculture are also sources of pollution of the atmosphere. Livestock and poultry farms, processing enterprises of agricultural products, agricultural machinery also produce the atmosphere. As a result of the pollution of the atmosphere, its natural composition changes seriously. As a result, climate change is occurring. Atmospheric pollution reduces 50% of light rays from the Sun to the Earth, 15% of heat energy, and 30% of ultraviolet rays. In industrial centers and large cities, as a result of changes in the microclimate, the air temperature increases, visibility decreases over long distances, precipitation increases, and so on.

The fall of harmful substances into the atmosphere can be due to the following physical and chemical processes:

- the difference between the pressure inside the equipment and the pressure outside, as a result of molecular diffusion;
- as a result of incomplete fuel combustion;
- as a result of mechanical processing of products;
- as a result of chemical reactions and physical transformations of substances, etc.

The amount of harmful substances released during the relevant processes and operations can be determined by the amount of waste per unit of product or raw material, by the gas-air balance of the relevant territory (mainly related buildings), and by special reporting methods. The method of determining the amount of harmful substances depending on the amount of waste per unit of production or raw materials is used only in special cases:

- lack of accurate statistical data on the amount and composition of gas waste generated in manufacturing industries;
- changing the range of products and the amount of gas waste generated by changing the production technology;

- it is impossible to determine the amount of waste that can be thrown out due to the fact that it is impossible to determine the exact amount of harmful gases emitted into the atmosphere at a time.

This method does not reflect the dynamics of harmful substances falling into the atmosphere during 1 year, 1 day, 1 work shift, nor does it allow to assess harmful substances falling into the atmosphere from a single equipment.

The method of determination of the amount of harmful substances by gas-air balance of the relevant area (mainly closed buildings) is the most common method of conducting inspections in industrial facilities. To use this method, there should be statistical data on air absorbers and ventilation installations available in the relevant facility, on the chemical composition of the air. However, this method does not allow to learn about the dynamics of the fall of harmful substances into the atmosphere in technological processes, which vary depending on the time.

Determination of the amount of harmful substances by the reporting method - from all elements of the equipment - from flange connections, thickening layer, logs, atmospheric contact lines, open liquid surface, fuel combustion process, etc. it is based on the theoretical determination of the amount of harmful substances entering the atmosphere.

Pollute the air two main normative indicators for harmful substances have been established:

1. The maximum one-time limit of viscosity — $LV_{m.o.}$ (mq/m^3). This indicator is determined by measuring the layer of harmful substances in the air for 20 minutes.

2. The average daily permissible concentration limit – $LV_{a.d.}$ (mq/m^3). This indicator is determined based on the long-term (even close to 1 year) measurement of the layer of harmful substances in the air.

The amount of harmful substances in atmospheric air is such that they do not directly or indirectly affect human health and sanitary conditions intended for normal life. Simultaneous concentrations C_1, C_2, in the atmosphere .... Cn and limit of viscosity LV_1, LV_2,......LV_n. If there are several harmful substances in the LV and their general effect on the human body is manifested in the aggregate of the individual effects of each harmful substance, in this case, the following inequality must be paid for security (formula 2.1.1.):

$$C_1/\ LV_1 + C_2/\ LV_2 + ...+ C_n/\ LV_n \leq 1 \quad (2.1.1.)$$

In order to regulate the quality of the environment, the limit of disposable waste, which is a scientifically justified technical indicator, was adopted for waste from waste sources of industrial enterprises into the atmosphere.

Atmospheric quality control is carried out by appropriate methods of analysis. Analysis of air samples is associated with certain difficulties. An example of this is the complex composition of polluted air that prevents the analysis of one harmful substance in the air for another, sometimes very few solutions in the air - for LV, making it difficult to accumulate samples taken, due to the limited time (no more than 30 minutes) of taking air samples, etc. Analysis of air samples in general consists of the following sequential operations:

- taking an air sample for analysis;
- addition of sample;
- sample preparation for analysis; LV_n
- analysis of a complex sample;
- processing of analysis results.

For air sampling, liquid and solid pharynx, membrane filters, closed glass jars of limited size (1-2 liters), and individual dosimeters are used. Preparation of the sample for analysis depends on the selected analysis method. The following methods are used to analyze air samples:

1. *Photometry.*

2. Polarizations.

3. Gas chromatography.

The photometry method is based on the ability of the solution to absorb light from the layer of the substance in the solution. In this method, light absorbers, photoelectron-calorimeters, spectrophotometers are used.

The polarization method is based on the relationship between the current strength and the polarization voltage during solution electrolysis.

The method of gas chromatography is the most widely used method, based on the variety of adsorption – desorption abilities of substances contained in one sample.

2.2. Determination of the amount of harmful substances released into the atmosphere

Sources of atmospheric air pollution can be conditionally divided into two groups:

1. *Waste sources from the inevitable*. As an example, production waste gases, air from ventilation facilities, smoke gases from smoke pipes, etc. can be shown.

2. *Waste sources from non- inevitable.* As an example of this, there is a violation of the quality of apparatus and communications, internal transport vehicles, semi-finished and finished product warehouses, waste disposal areas, atmosphere removal of apparatus, etc. can be shown.

It is very difficult to take into account environmental pollution from sources that are not indispensable during the design. Since the sources of waste included in this group are located on the Earth's surface or at a distance close to the Earth's surface, the distribution of waste in the atmosphere is of a limited (local) nature.

Most of the facilities and equipment in oil refining and petrochemical industry enterprises are located in the open air. Therefore, pollution of the surrounding atmospheric air is calculated as follows: the amount of harmful substances entering the environment, mainly as a result of the violation of the equipment and communications pollution (formula 2.2.1.):

$$G = \frac{G_i - G_S}{\tau} = \frac{1}{\tau}\left(\frac{P_i V}{RT_i} - \frac{P_S V}{RT_S}\right) \qquad (2.2.1.)$$

here, G – is the amount of harmful substances to the environment as a result of a violation of the quality of the equipment: G_i and G_S - the amount of initial and final gas inside the equipment: the time when the pressure inside the equipment changes from the initial price to the final price, V – the volume of equipment, T_i and T_S – the initial and final temperatures within the equipment, respectively, R - universal gas constant. İf $T_i = T_S = T$, then $G = \Delta PV/\tau RT$

In order to characterize the quality of equipment, assembly works, molding works, the coefficient of moldability is used. When testing equipment, the pressure drop over a single period of time is called the coefficient of viscosity (formula 2.2.2.).

$$m = \frac{1}{\tau}\left(1 - \frac{T_S P_S}{T_i P_i}\right) \qquad (2.2.2.)$$

here τ - is the trial period.

If we take into account both equations together, then we take the following expression (formula 2.2.3.):

$$m = G\frac{T_i R}{P_i V} \qquad (2.2.3..)$$

If the test work is carried out by air, then for T=293 K (formula 2.2.4..):

$$m = 8{,}3 \cdot 10^3 \cdot G\frac{1}{\eta P_i V}\sqrt{\frac{T_P}{M_p}} \qquad (2.2.4.)$$

here, $8.3*10^3$ is the coefficient taking into account the trial period and gas;

η – is the reserve coefficient taking into account the deterioration of gas;

in the inter-repair period, T_p – the working temperature işçi temperatur,

M_p – is the molecular mass of working gas.

İf a gas mixture is used for testing, then the mass of the medium molecule is calculated as follows (formula 2.2.5.):

$$M_0 = M_1 i_1 + M_2 i_2 + \ldots\ldots\ldots + M_n i_n \qquad (2.2.5.)$$

M_1, M_2 …… M_n – molecular weights of components in a gas mixture,

i_1, i_2 …… i_n – it is the mass fraction of the components in the mixture.

Equipment working at pressures below atmospheric pressure also plays the role of a source of environmental pollution. Despite the fact that the pressure inside the apparatus is less than the pressure of the environment, as a result of molecular diffusion, atmospheric air pollution of harmful substances occurs. The amount of harmful substances leaking into the environment from such devices is calculated as follows (formula 2.2.6.):

$$G = C_0 \, f \, D^2 / 2 \, m_1 \, \Delta P \qquad (2.2.6.)$$

here C_0 is the concentration of harmful substances inside the device,

D is the diffusion coefficient of atmospheric air in production conditions,

f is the surface area of diffusion,

m_1 is the coefficient of unevenness, the price is calculated as follows (formula 2.2.7.):

$$m_1 = \frac{L}{\Delta P} \qquad (2.2.7.)$$

here, L is the volume of gas consumed from the equipment over a single period of time, ΔP – residual pressure inside the device; L= f(ΔP) and G= f(ΔP) a graphic dependency is issued in its passport for each equipment.

Harmful substances in petrochemical and oil refining plants can leak into the environment from most flans compounds. The amount of harmful substances leaking into the environment by spoiling the quality of the plasticizing material used in the flans compounds is calculated as follows (formula 2.2.8.):

$$G = a \cdot \Delta P \cdot \frac{\delta}{g \nu} \qquad (2.2.8.)$$

here, ΔP – it is the pressure drop that occurs in the combination of flans,, g - when drawing the flanges, the special pressure shown on the clamp, δ - is the layer of the clamp, ν - the kinematic viscosity of the medium, a – the proportionality coefficient.

In general, the following reports are recommended to be carried out when designing and assessing the impact on the environment:

- the amount of harmful substances in the atmospheric air from the gas-filled volume of devices and equipment, pipeline;
- the amount of harmful substances entering the atmosphere from the liquid volume of devices and equipment, pipelines;
- the amount of harmful substances that spread to the environment from the open surface of the liquid;
- the amount of harmful substances that are released into the environment when burning various types of fuel;
- the amount of harmful waste generated during welding operations;
- calculation of the distribution of harmful substances in the air depending on the ventilation system inside the production premises.

To reduce and prevent air pollution, the following types of measures should be provided:

- technological measures;
- architecture-planning measures;
- sanitary-protective zones;
- cleaning of gas waste from harmful substances;
- distribution of harmful substances in atmospheric air;
- determination of the amount of waste that can be released for harmful substances released into the atmosphere.

Methods for cleaning gases from harmful substances include:

- dry (mechanical) cleaning of gases;
- cleaning of gases by the method of absorption;
- thermal neutralization of gases;
- cleaning of gases by adsorption method;

- methods of neutralization of foul-smelling substances.

2.3. Calculation of the amount of solid particles thrown into the atmosphere together with flue gases

Gas purification - separation from gas or transfer to a harmless state of a pollutant emitted by an industrial source. In the practice of gas purification, various methods and devices for removing dust and harmful gases are known. When choosing a method, the type of contaminants, their chemical and physicochemical properties, the nature of production, the possibility of using the substances available in the production as absorbers for gas, the feasibility of utilizing the separated impurities, and the cleaning costs are taken into account.

Devices for cleaning gases from solid particles (dust) can be divided into the following groups:

1. Devices for mechanical cleaning of gases in which dust is separated by gravity, inertia, or centrifugal force;
2. Wet gas cleaning apparatus in which solid particles are trapped in a liquid;
3. Filters from porous materials on which dust particles settle;
4. Electrofilters, in which particles are deposited as a result of ionization of the gas and its solid particles.

Devices for mechanical cleaning of gases from dust

The main advantage of these devices is the simplicity of design. They are suitable mainly for preliminary rough cleaning.

Dust chamber. It is intended for preliminary purification of gases with the capture of coarse particles from 50 to 500 microns in size. Dust suspended in the gas stream is precipitated by gravity (Fig.2.3.1.-2.3.2.).

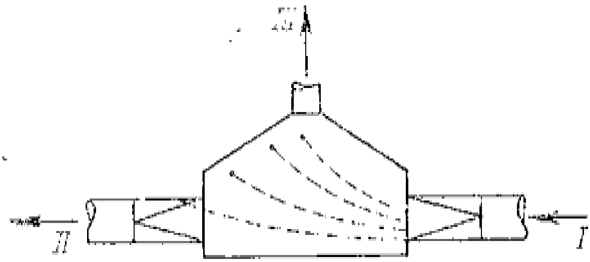


Fig.2.3.1. Dust chamber:
1 - dusty gas;
2 - purified gas;
3 - dust

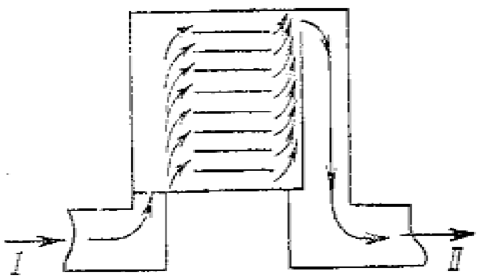


Fig. 2.3.2. Howard siege chamber:
1 - dusty gas;
2 - purified

Inertial dust collectors. In these devices, the direction of the gas flow changes sharply, the dust particles maintain the direction of their movement by inertia, hit the surface and are deposited in the hopper (Fig.2.3.3.).

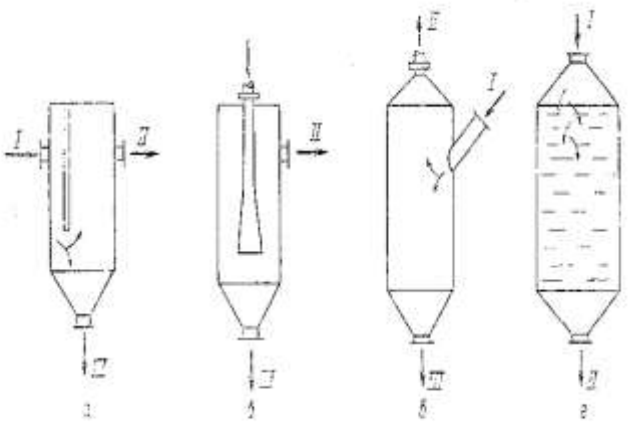


Fig. 2.3.3. Inertial dust collectors with different ways of gas flow supply and distribution

(1-dusty gas; 2-purified gas; 3-dust):

a) using a partition;

b) through the central pipe;

c) through the side pipe;

d) using dust-collecting elements.

Centrifugal dust removal device (cyclone). Dust particles are released in the cyclone under the action of centrifugal force during the rotation of the gas flow in the device body. Under the action of centrifugal force, dust particles are thrown against the walls of the cyclone and are lowered into the conical part. The efficiency of cleaning depends on the speed of the gas flow – the higher the gas speed, the higher its efficiency (Fig. 2.3.4).

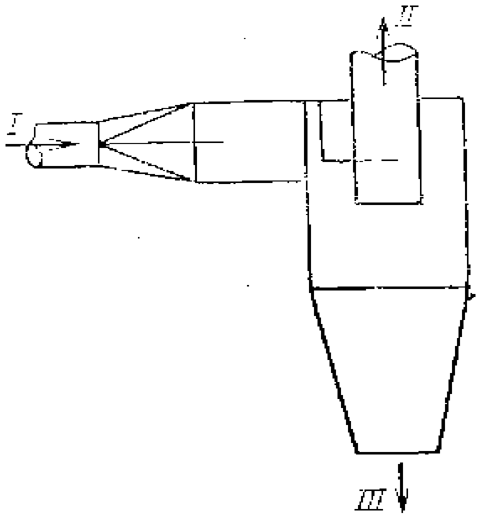


Fig. 2.3.4. Cyclone:
1-dusty gas; 2-purified gas; 3-dust

Devices for wet cleaning of gases from dust

These devices are used in cases where humidification of the gas being cleaned is possible. Dusty gas is in contact with the liquid or its irrigated surfaces.

Flushing towers. These devices are the simplest in design, they have a nozzle of Rashig rings irrigated with water or other liquid. Gas is supplied to the bottom of the apparatus, after cleaning it is removed from above. The disadvantage is the frequent clogging of the nozzle during gas cleaning (Fig.2.3.5.).

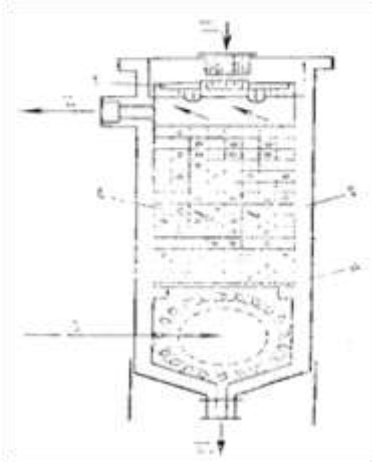


Fig. 2.3.5. Flushing tower
(I - dusty gas; II - purified gas; III - water; IV - sludge):
1 - water dispenser; 2 - case; 3 - nozzle; 4 - support plate

High-speed gas washers. In these devices, under the influence of a gas flow moving at high speed, liquid droplets are crushed and sprayed. As a result, the surface of their contact increases. The formation of small droplets and high turbulence of the flow contribute to the capture of submicron-sized particles (Fig.2.3.6).

*Bubbling and foam devices***.** In bubblers, the purified gases pass through the liquid layer in the form of bubbles. Due to the large contact surface with the liquid, the efficiency of cleaning gases from solid particles is high.

In foam devices, the purified gas moves through a layer of foam that is formed on the grid where the liquid is fed, when it is purged from below by air or when the air flow hits the surface of the liquid (Fig.2.3.7.).

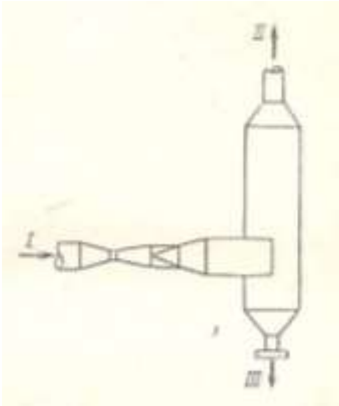


Fig. 2.3.6. Venturi Scrubber:
I – dusty gas; II-purified gas; III-sludge.

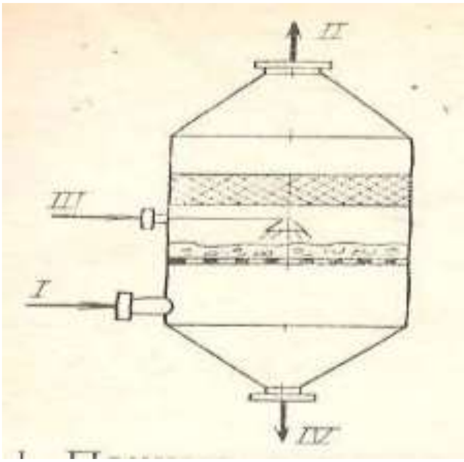


Fig. 2.3.7. Foam machine

Filters

Filtration through porous materials is one of the most advanced methods for purifying gases from solid particles. The gas stream passes through a porous material of various densities and thicknesses, in which the bulk of the dust is retained. Two types of industrial filters are used for gas purification: fabric and granular.

Fabric filters. Depending on the shape of the filtering surface, bag and frame filters are distinguished. Dusty gas enters the lower part of the apparatus and passes through fabric filters. Dust is deposited on the surface of the tissue and in its pores. Synthetic fabrics are used as filtering fabrics, which are less moisture-absorbing than natural ones, do not rot, stand at temperatures above 150 ° C, are thermoplastic (Fig. 2.3.8.).

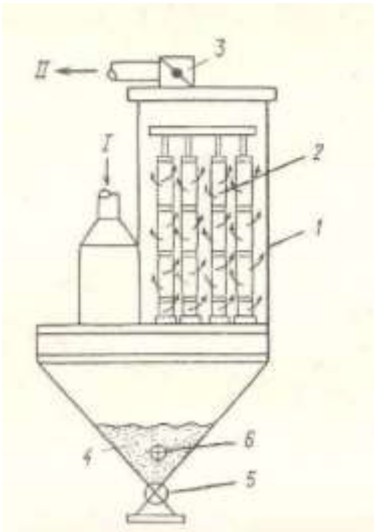


Fig. 2.3.8. Bag Filter:
1 - case; 2- sleeves; 3 - throttle; 4 - dust; 5 - shutter;
6 - auger.

Grainy filters. They can work at very high temperatures and aggressive environments, and can withstand heavy mechanical loads. There are bulk and rigid porous granular filters. In a bulk filters as a nozzle using sand, pebbles, smaller rocks, wood chips, crumb rubber, coke, graphite, etc.

Rigid porous filters (ceramic, metal-ceramic, metal-porous, etc.) are characterized by increased resistance to high temperature, corrosion and mechanical loads.

Electrostatic precipitators

An electrostatic precipitator is an apparatus or installation in which electric forces are used to separate suspended particles from gases. Electrofilters provide a high degree of gas purification at a relatively low energy consumption. The efficiency of gas purification by electrofilters varies from 96 to 99.7% and depends on a number of factors of the physico-chemical parameters of the dust and gas flow, the speed and residence time of the gas in the electrofilters, the design of the electrode system, the electrical mode of operation of the electrofilters, the mode of shaking the electrodes. (Fig. 2.3.9.).

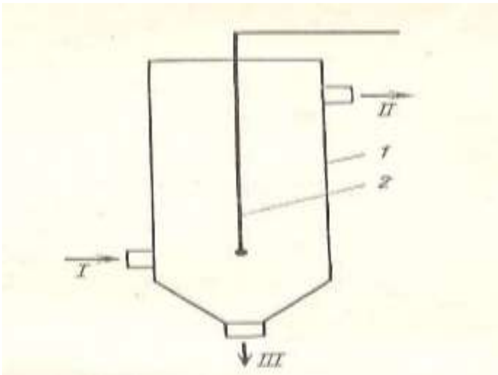


Fig. 2.3.9. Electrofilter: 1 - sedimentary electrode; 2 - electrode.

By design, electrostatic precipitators are divided into tubular and plate.

Calculation of particulate matter.

The amount of ash and unburned fuel emitted into the atmosphere with flue gases from the boiler when burning solid and liquid fuels is calculated by the formula (formula 2.3.1.-2.3.2.):

$$M_{TB} = BA^{P}f(1 - \eta_3) \qquad (2.3.1.)$$

here: B - is a natural fuel consumption, t / year, g / s;

A^P - is ash content of fuel in working condition,%;

η_3 - is the proportion of solid particles trapped in gold traps.

$$f = \alpha_{УН} /(100 - Г_{УН}) \qquad (2.3.2.)$$

$\alpha_{УН}$ - the proportion of ash carried away by flue gases;

$Г_{УН}$ - content of combustibles in entrained gases,%; in the absence of operational data, it is taken in accordance with the heat loss from mechanical incompleteness of fuel combustion,%, according to the norms of thermal calculation of boiler units (normative method).

The value A^P, $Г_{УН}$, $\alpha_{УН}$, η_3 taken according to the actual average.

2.4. Calculation of the amount of sulfur oxides released into the atmosphere together with flue gases

Sulfur oxides or SO_x are a group of pollutants that contain both sulfur and oxygen molecules.

Sulfur dioxide, SO_2 is the most common form in the lower atmosphere. Sulfur dioxide is colorless, but has a distinct smell that can be detected if the gas has a high enough concentration. Sulfur oxides dissolve readily in water, and result in the atmospheric formation of sulfurous acid or sulfuric acid - a component of acid rain.

The majority of sulfur oxides are produced when fuels that contain sulfur undergo combustion. As well, the roasting of metal sulfide ores is a major source. Natural sources account for anywhere between 35-65% of total sulfur dioxide emissions specifically Natural sources include volcanoes. Coal burning power plants that burn high-sulfur coal are some of the main sources of SO_x. Vehicles can also be a source of sulfur oxides.

There are several different ways to prevent SO_x from entering the atmosphere, and steps can be taken before, during, and after combustion to prevent its escape. Before combustion, coal can be "washed" to remove mineral matter and clean the coal. This is done at the mouth of the mine by floating crushed coal down a stream of water, allowing the lighter coal particles float to the top while heavier materials sink down. As well, coal can be gasified into synthesis gas, eliminating the sulfur and producing a gas that can be used in a power plant. Finally, oil can be desulfurized in refineries in a catalytic process known as the Claus process, in which hydrogen gas is blown through the oil to remove the sulfur.

During combustion, fluidized bed combustion can be used to remove sulfur. In this process, coal is crushed into small pieces and combined with a material such as limestone and blown over a grate in a cylinder. Then air is blown in beneath the grate, and the coal-limestone mixture burns while floating above the grate. The limestone acts as a sorbent and extracts the sulfur and other impurities from the coal.

After combustion, a wet scrubber can be used to treat flue gas with an aqueous mixture that removes the sulfur oxide from the gas before it is released into the atmosphere. Dry scrubbers can also be used, the only difference is that a dry powder is used to absorb the sulfur.

The amount of sulfur dioxide and sulfur trioxide released into the atmosphere along with flue gases generated by the combustion of liquid and solid fuels can be calculated as follows (formula 2.4.1.).

$$G_{SO_2} = 0{,}02 \cdot B \cdot S \cdot (1 - \eta^{/}_{SO_2})(1 - \eta^{//}_{SO_2}) \qquad (2.4.1.)$$

here: B – consumption of natural fuel (t/ year, m^3/year),

S – the composition of the fuel is the mass fraction of sulfur oxides released into the atmosphere (e.g. for gas combustion $\eta^{/}_{SO_2} = 0$, for diesel $\eta^{/}_{SO_2} = 0{,}02$, for the peat $\eta^{/}_{SO_2} = 0{,}15$, for coal $\eta^{/}_{SO_2} = 0{,}1$, etc.)

$\eta^{//}_{SO_2}$ - the amount of sulfur oxides contained in the solid residue captured in special holders (for electro-filters and cyclones $\eta^{//}_{SO_2} = 0$, and for moisture holders, the value $\eta^{//}_{SO_2}$ is taken from special nomograms, depending on the amount of water consumed , its base, the amount of sulfur in the fuel composition).

If the composition of the fuel includes hydrogen sulfide along with sulfur, then the additional amount of sulfur oxides formed is calculated as follows (formula 2.4.2.):

$$M_{SO_2} = 1{,}88 \cdot 10^{-2} \cdot (H_2S) \cdot B \qquad (2.4.2.)$$

here; *(H_2S)* - is the percentage amount of hydrogen sulfide in the fuel.

Example:

To determine the quantity of sulfur oxides removed from the flue gases from the boiler combustion therein of fuel oil with a calorific value kJ/kg (1000 kcal/kg) and a sulfur content of =1.5%.

Source data. Fuel consumption 3300000 m^3 / year, 700 kg / h. Flue gases after the boiler are washed with water with an alkalinity of 5 mg / (mol•l).

Decision. Given the sulfur content of the fuel:

$$(100 \cdot 1.5)/4200 = 0.36 \text{ kg/MJ}$$

Percentage of sulfur oxides bound by fly ash in the boiler, η'_{so_2}= 0.02.

The degree of capture of sulfur oxides in wet ash collectors at an alkalinity of 5 mg/(mol·l) ; η''_{so_2}= 2.0%.

The amount of sulfur oxides removed with flue gases:

$$G = 0{,}02 B S^P (1 - \eta'_{SO_2})(1 - \eta''_{SO_2})$$

For 1 sec: G_{SO2} = 0.02· 700 · 1.5 (1-0.02) (1-0.02)/3.6 = = 5.6 year

For 1 year: G_{SO2} = 0.02· 3300000 · 1.5 (1-0.02) (1-0.02) = 95 t.

2.5. Calculation of the amount of carbon dioxide release into the atmosphere together with flue gases

There are three ways to calculate the amount of carbon monoxide produced by fuel combustion and released into the atmosphere along with flue gases.

1.The amount of carbon monoxide absorbed during combustion of fuel in boiler furnaces with efficiency (according to fuel) 30 t/h can be determined as follows (formula 2.5.1.):

$$G_{CO} = 0{,}001 \cdot C_{CO} \cdot B \cdot (1 - \frac{q^{/}}{100}) \qquad (2.5.1.)$$

here; B – natural fuel consumption (t/year, m^3/year),

C_{CO} – output of carbon dioxide produced by fuel combustion (kg /t or kg /m^3) (formula 2.5.2.):

$$C_{CO} = q \cdot R \cdot Q \qquad (2.5.2.)$$

here; q– heat loss resulting from incomplete fuel combustion (%),

R – the heat coefficient, which depends on the amount of carbon monoxide in the flue gas composition (for coal R=1.0, for gas fuel R=0.5, for diesel R=0.65),

Q - low fuel heat transfer,

$q^{/}$ - heat losses associated with mechanical fuel losses (%).

If the practical values of q and q/ are unknown, you can also use the values defined experimentally or given in reference books.

Due to the approximate determination of the amount of carbon monoxide in flue gases, the following formula can be used (formula 2.5.3.):

$$G_{CO} = 0{,}001 \cdot B \cdot Q \cdot K_{CO}(1 - \frac{q^{/}}{100}) \qquad (2.5.3.)$$

here, K_{CO} – is a coefficient that takes into account the amount of carbon dioxide produced by burning fuel.

2. The amount of carbon dioxide in the flue gases can be calculated based on the fuel composition and the results of the flue gas analysis, as follows (formula 2.5.4.):

$$21 = RO_2 + O_2 + \beta \cdot RO_2 \qquad (2.5.4.)$$

In case of incomplete combustion of fuel, and in case of formation of carbon monoxide, the calculation is made according to the following formula (formula 2.5.5.-2.5.7.):

$$21 = RO_2 + O_2 + \beta RO_2 + (0{,}605 + \beta) \cdot CO \qquad (2.5.5.)$$

here, RO_2 – number of triatomic gases in the flue gas composition (%),

O_2 – oxygen content in flue gases (%),

CO – the amount carbon monoxide content of flue gases, (%):

$$RO_2 + N_2 + O_2 + CO = 100\% \qquad (2.5.6.)$$

$$RO_2 = \frac{V_{CO_2} + V_{SO_2}}{V_{q.q.}} = 100\% \qquad (2.5.7.)$$

here; $V_{q.q.}$ – volume of flue gases generated (m^3/kg),

β - coefficient depending on the fuel composition:

$$\beta = 2{,}37 \cdot \frac{"H"-0{,}126"O"+0{,}038"N"}{"C"+0{,}375"S"} \qquad (2.5.8.)$$

here; H, O, N, C – the fuel consists of the amount of the corresponding elements as a percentage of the mass (%),
S – sulfur content in fuel as a percentage of mass. (%).

There is the following relationship between the percentage and coefficient of triatomic gases β in the flue gas composition (formula 2.5.9.):

$$RO_2 = \frac{21 - O_2}{1 + \beta} \qquad (2.5.9.)$$

If O_2=0, then they get the maximum value in RO_2 (formula 2.5.10.)

$$RO_{2\max} = \frac{21}{1 + \beta} \qquad (2.5.10.)$$

For example, for natural gas β=0.01, RO_{2max}=20.79,
for fuel oil β=0.28÷0.35, RO_{2max} = 15.55÷16.4,
for the peat β=0.077, RO_{2max} = 19.49,
For the Donetsk coal β = 0.43, RO_{2max} = 20.13

The coefficient of excess air to ensure complete combustion of the fuel is determined by the results of gas analysis in the following way (formula 2.5.11.).

$$\alpha = \frac{1}{1 - \frac{79 O_2}{21 N_2}} \qquad (2.5.11.)$$

For incomplete combustion process, the excess coefficient of air is determined as follows (formula 2.5.12.):

$$\alpha = \frac{1}{1 - \frac{79}{21} \cdot \frac{O_2 - 0{,}5(CO + N_2) - 2CH_4}{N_2}} \qquad (2.5.12.)$$

The approximate value of the air redundancy coefficient can be calculated using the formula (formula 2.5.13.):

$$\alpha = \frac{RO_{2\max}}{RO_2} \qquad (2.5.13.)$$

To determine carbon monoxide, you can use the following formula (2.5.14.):

$$CO = \frac{21 - \beta RO_2 - (RO_2 + O_2)}{0{,}605 + \beta} \qquad (2.5.14.)$$

After using the above formulas to determine of carbon monoxide by percentage, you can also calculate of the heat spent on the absorption of carbon monoxide (formula 2.5.15.):

$Q = 0{,}238 \cdot Q_a \cdot n;$ kC or $Q = Q_a \cdot n;$ kkal (2.5.15.)

here, Q_a – low fuel heat capacity,

n - carbon monoxide content in flue gases (%).

The amount of carbon dioxide contained in the resulting flue gases can be determined as follows (formula 2.5.16.)

$$V_{CO} = \frac{Q}{Q_{aCO}} \qquad (2.5.16.)$$

here; Q_{aCO} – burning temperature of carbon monoxide under normal conditions (formula 2.5.17.),

Q_{aCO}=12675 kC/m^3 or Q_{aCO}=3018 kkal/m^3 (2.5.17.)

And the mass of the formed carbon monoxide can be determined as follows:

This reporting technique can only be used if the exact results of the gas analysis are known (formula 2.5.18.).

$$G_{CO} = V_{CO} \cdot \rho \quad (2.5.18.)$$

here; ρ - the density of carbon dioxide, the value ρ = 1.25 kg/m^3.

3. The following formula can be used to calculate the approximate amount of steam generated as a result of the combustion process during the normal operation of furnaces and boilers (formula 2.5.19.):

$$G_{CO} = 0{,}233 \cdot c \cdot q_k \quad (2.5.19.)$$

here, c – the amount of carbon atoms in the fuel by percentage of mass (%),

q_k – coefficient of incomplete chemical oxidation of fuel.

For firewood, peat and brown coal q_k = 3 %, for fuel oil and natural gas q_k = 2 %.

In general, during the normal operation of the ovens, from the burning of 1 kg of diesel fuel, 40-50 grams of carbon monoxide is absorbed.

2.6. Calculation of the amount of nitrogen oxides released into the atmosphere together with flue gases

The concentration of nitrogen oxides increases rapidly with increasing temperature and reaches significant values at temperatures above 750 ^{0}C. At the same time, the lowest NO oxide has the highest concentration, while the content of higher NO_2 and N_2O_4 oxides is insignificant. Nitrogen oxidation can be represented as follows:

$$N_2 + ½ O_2 = NO + N$$
$$N + O_2 = NO + 1/2\ O_2$$

The NO formed in the core of the combustion chamber can practically not be oxidized by the flue gas oxygen in the short time, measured in seconds, during which the gases move within the steam generator of the external flues and the chimney. Thus, mainly NO oxide is released into the atmosphere, which can gradually be oxidized to NO_2 when moving in the atmospheric air.

Methods for calculating the content of nitrogen oxides in flue gases are given below.

1. The amount of nitrogen oxides (in terms of NO_2) emitted per unit of time (t/year, g/s) is calculated using the formula (2.6.1.):

$$M_{NO_2} = 0{,}001 B Q_H^P k_{NO_2} (1 - \beta) \qquad (2.6.1.)$$

here: B – fuel consumption for the period under review, t / year, thousand m^3/year, m^3/s, g/s;

$Q_н^p$ - heat of combustion of fuel, MJ/kg, MJ/m^3;

K_{NO_2} - is a parameter describing the amount of nitrogen oxides produced per 1 gJ of heat, kg/gJ;

β - a coefficient that takes into account the degree of reduction of nitrogen oxide emissions as a result of implementing technical solutions.

The value is determined according to the schedule for different types of fuel, depending on the rated load of boilers. When the load of the boiler differs from the nominal, it should be multiplied by $(Q_F/Q_n)^{0.25}$ or $(D_F/D_N.)^{0.25}$, where Q_F, Q_n- respectively the actual and nominal heat capacity, kW; D_F, D_N- respectively the actual and nominal steam capacity, t/h.

2. If there is data on the content of nitrogen oxides in flue gases (%), the emission is calculated using the formulas (2.6.2.-2.6.3.), kg / year:

$$G_{NO_x} = 20.4 G_{NO_x} VB(1 - q_4 / 100) \qquad (2.6.2.)$$

here: G_{NO_x} – known content of nitrogen oxides in flue gases, %;

V – volume of fuel combustion products at α_{xy}, m^3/kg;

$$V = V_{\Gamma}^{0} \alpha_{yx} \qquad (2.6.3.)$$

The NOx concentration in flue gases and the parameter describing the amount of nitrogen oxides per 1 gJ of heat can be calculated in g/m^3 and kg/gJ, respectively, using the formulas (2.6.4.-2.6.6.):

$$G_{NO_2} = 20{,}4 NO'x \qquad (2.6.4.)$$

$$K_{NO_2} = 20{,}4 NO'x \frac{V}{Q_i^p} \qquad (2.6.5.)$$

$$NO'x \frac{V}{Q^p{}_i} \qquad (2.6.6.)$$

here: V — is the volume of combustion products of a unit of fuel under existing conditions $\alpha_г$, m^3/kg.

For boilers with a capacity of more than 30 t/h, the amount of nitrogen oxides in terms of NO_2 emitted with flue gases can be determined by the following formulas (2.6.7. – 2.6.8.), kg/h:

for $Q_н^p$, expressed in kJ/kg or kJ/m^3:

$$G = 3.4 \cdot 10^{-5} kBQ_н^p (1 - q_4/100)\beta_1(1- \beta_2 r)\,\beta_3 \qquad (2.6.7.)$$

for $Q_н^p$ expressed in kcal/kg or kcal /m^3:

$$G = 0.143 \cdot 10^{-3} kBQ_н^р(1 - q_4/100)\beta_1(1- \beta_2 г)\ \beta_3 \qquad (2.6.8.)$$

here: k – is the coefficient characterizing the output of the dioxides of nitrogen, kg per 1 t of conditional fuel;

B – is a solid, liquid or gaseous fuel consumption, t/h or 1000 m^3/h;

q_4 – is the heat loss from mechanical incompleteness of combustion, %;

β_1 – is a correction factor that takes into account the influence of the quality of the burned fuel (N_2 nitrogen content and slag removal methods) on the yield of nitrogen oxides;

г - is the degree of flue gas recirculation, %;

β_3 – is the coefficient that takes into account the design of the burners (for vortex burners β_3=1, for direct-flow burners β_3=0.85).

β_2 – is the coefficient that characterizes the efficiency of the effect of recirculating gases on the output of nitrogen oxides, depending on the conditions of their supply to the furnace.

The values of the β_2 coefficient are shown in table 2.6.1.

The coefficient for boilers with a steam capacity of more than 70 t/h when burning gas and fuel oil in the entire load range, as well as for high-temperature combustion of solid fuel with loads higher than 75% of the nominal is determined by the formula (2.6.9.)

$$к = 12D_ф/(200+D_н) \qquad (2.6.9.)$$

here: $D_ф$ и $D_н$ actual and nominal capacity of the boiler, t/h.

For boilers with steam capacity less than 70 t/h (formula 2.6.10.):

$$к = D_ф/20 \qquad (2.6.10.)$$

For hot water boilers K is defined by the formula (2.6.11.):

$$k = \frac{2{,}9 \cdot 10^3 Q_{ф}}{(20 + 1160 Q_{н})} \qquad (2.6.11.)$$

if $Q_{ф}$ Q ф and $Q_{н}$ Q н expressed in kW,

$Q_{ф}$ Q ф and $Q_{н}$ Q ф – actual and nominal heat output of the boiler (formula 2.6.12.):

$$k = \frac{25 Q_{ф}}{(20 + Q_{н})} \qquad (2.6.12.)$$

when $Q_{ф}$ Q ф and $Q_{н}$ expressed in g cal.

For high-temperature combustion of solid fuel with boiler loads below 75% of the nominal value in the formula for determining k instead of $D_{ф}$ and $Q_{ф}$ substituted values of 0.75D and 0.75Q. For low-temperature solid fuel combustion, the formulas for determining k are always substituted with the values of D_{H} and Q_{H}. When burning liquid and gaseous fuels in power boilers the coefficient values are taken as follows

Natural gas ……………………………0.085

Fuel oil at the coefficient of excess air in the combustion chamber:

$\alpha_{г} \geq 1.05$……………………………………..0.8

$\alpha_{г} < 1.05$……………………………………..0.7

Table 2.6.1.

Coefficient that characterizes the efficiency of the effect of recirculating gases on the output of nitrogen oxides

Fuel supply conditions in the furnace	β_2
When burning gas and fuel oil and entering the recirculation gas into the heating space (when placing the burners on vertical screens)	0.002
When entering through the slots under the burners	0.015
When entering through the slots on the external channel of the burners	0.020
When entering through slots in the air blast	0.025
When entering through the slots in the dissection of two air flows	0.030
With high-quality solid fuel combustion and recirculation gas input	
in the primary air mix	0.010
in the secondary air	0.005

If two types of fuel are used simultaneously in power boilers with the consumption of one of them less than 10% of the heat received, the value of the coefficient β1 should be taken for the prevailing type of fuel. In other cases, the coefficient β1 is determined by the formula (2.6.13.):

$$\beta_1 = \frac{\beta_1^{'} B_1 + \beta_1^{''} B_2}{B_1 + B_2} \qquad (2.6.13.)$$

here: $\beta_1^{'}, \beta_1^{''}$ β'_1, β''_1 - coefficients corresponding to each type of fuel

B_1, B_2 - expenses of each type of fuel.

Example Determine the amount of nitrogen dioxides entering the atmosphere with flue gases of a boiler unit when natural gas is burned in it.

Source data. Fuel consumption 3000 m^3/h; $Q_н^p$ = 35.910 kJ (8550 kcal/m^3). The vortex burner. There is no flue gas recirculation in the boiler unit. Steam capacity of the boiler is 46 t/h.

Decision. Coefficient that characterizes the yield of nitrogen oxides, kg per 1t of conventional fuel:

$$k = D_ф/20 = 23/20 = 1.15$$

Heat loss (%) from mechanical incompleteness of combustion (according to the standard method of thermal calculation of boiler units) q_4=0. Coefficient β_1 for gaseous fuel β_1=0.85. Coefficient for vortex burners β_3=1. The amount of nitrogen oxides under normal conditions in terms of NO_2:

for $Q_н^p$ expressed in kJ/m^3

$$G = 3{,}4 \cdot 10^{-5} \cdot Q \cdot B \cdot Q_н^p (1 - \frac{q_4}{100}) \beta_1 (1 - \beta_2 r) \beta_3 =$$

$$= 3{,}4 \cdot 10^{-5} \cdot 1{,}15 \cdot 3{,}0 \cdot 35910 \cdot 0{,}85 \cdot 1 = 3{,}6 кг/час \text{ or } 1 г/с$$

when $Q_н^p$, expressed in kcal/m^3

$$G = 0{,}143 \cdot 10^{-3} \cdot Q \cdot B \cdot Q_н^p (1 - \frac{q_4}{100}) \beta_1 (1 - \beta_2 r) \beta_3 =$$

$$= 0{,}143 \cdot 10^{-3} \cdot 1{,}15 \cdot 3{,}0 \cdot 8550 \cdot 0{,}85 \cdot 1 = 3{,}6 кг/час \text{ or } 1 г/с$$

To determine the amount of oxides entering the atmosphere during a day or year, enter the cost values for the day or year in the formula.

2.7. Calculation of the amount of metal oxides emitted into the atmosphere together with flue gases

Flue gas is the gas exiting to the atmosphere via a flue, which is a pipe or channel for conveying exhaust gases from a fireplace, oven, furnace, boiler or steam generator. Quite often, the flue gas refers to the combustion exhaust gas produced at power plants. Its composition depends on what is being burned, but it will usually consist of mostly nitrogen (typically more than two-thirds) derived from the combustion of air, carbon dioxide (CO_2), and water vapor as well as excess oxygen (also derived from the combustion air). It further contains a small percentage of a number of pollutants, such as particulate matter (like soot), carbon monoxide, nitrogen oxides, and sulfur oxides.

Most fossil fuels are combusted with ambient air (as differentiated from combustion with pure oxygen). Since ambient air contains about 79 volume percent gaseous nitrogen (N_2), which is essentially non-combustible, the largest part of the flue gas from most fossil-fuel combustion is un-combusted nitrogen. Carbon dioxide (CO_2), the next largest part of flue gas, can be as much as 10–25 volume percent or more of the flue gas. This is closely followed in volume by water vapor (H_2O) created by the combustion of the hydrogen in the fuel with atmospheric oxygen. Much of the 'smoke' seen pouring from flue gas stacks is this water vapor forming a cloud as it contacts cool air.

A typical flue gas from the combustion of fossil fuels contains very small amounts of nitrogen oxides (NO_x), sulfur dioxide (SO_2) and particulate matter. The nitrogen oxides are derived from the nitrogen in the ambient air as well as from any nitrogen-containing compounds in the fossil fuel. The sulfur dioxide is derived from any sulfur-containing compounds in the fuels. The particulate matter is composed of very small particles of solid materials and very small liquid droplets which give flue gases their smoky appearance.

The steam generators in large power plants and the process furnaces in large refineries, petrochemical and chemical plants, and incinerators burn considerable amounts of fossil fuels and therefore emit large amounts of flue gas to the ambient atmosphere. The table 1 presents the total amounts of flue gas typically generated by the burning of fossil fuels such as natural gas, fuel oil and coal. The data were obtained by stoichiometric calculations.

The total amount of wet flue gas generated by coal combustion is only 10 percent higher than the flue gas generated by natural-gas combustion (the ratio for dry flue gas is higher).

The amount of vanadium oxides released into the atmosphere by flue gases in the furnace per unit of time (in relation to 5-vanadium oxide) is determined as follows (formula 2.7.1.):

$$G_{V_2O_5} = 10^{-6} \cdot q_{V_2O_5} \cdot B(1-\eta_2)(1-\eta_t) \qquad (2.7.1.)$$

here $q_{V_2O_5}$ - the composition of liquid fuel is the amount of vanadium oxide determined by the analysis,

η_q – it is a coefficient that takes into account the deposition of vanadium oxides on the inner surface of the furnace (for steam-heated ovens, which can be cleaned surface when suspended $\eta_q = 0.07$;

for ovens without a steam heater, the surface of which can be cleaned when suspended $\eta_q = 0.05$; and in all the rest cases $\eta_q = 0$).

η_t – considering the degree of purification of smoke gases from solid particles by means of special precipitators and grippers, the coefficient is determined by the approximate characteristics of precipitators and grippers.

If, according to the results of the fuel analysis, the amount of vanadium oxides contained in it is not known, then the amount of vanadium oxides contained in the fuel is calculated as follows (formula 2.7.2.):

$$q_{V_2O_5} = 95{,}4 \cdot S^p - 31{,}6 \qquad (2.7.2.)$$

here, S^p – the amount of sulfur in the composition of diesel fuel by percentage.

When performing welding work, the atmospheric air is polluted with welding aerosol, which, depending on the type of welding, grades of electrodes and flux, contains metal oxides harmful to health (iron, manganese, chromium, vanadium, tungsten, aluminum, titanium, zinc, copper, nickel, etc.), as well as gaseous compounds (fluoride, carbon and nitrogen oxides, ozone, etc.).

The amount of pollutants released during welding or submerged welding is usually characterized by gross emissions attributed to 1 kg of consumable welding materials. In metal cutting processes, specific indicators are expressed in grams per linear meter of cut length and have different values depending on the thickness of the metal being cut.

The flue gases of installations and engines contain tens of thousands of chemicals, compounds and elements, more than two hundred of which are highly toxic and poisonous.

The greatest environmental damage to the atmosphere and the environment as a whole is caused by substances such as nitrogen and carbon oxides, aldehydes, formaldehydes, benz (a) pyrene and other aromatic compounds that belong to toxic substances.

In addition, during the operation of any installation and engine, about 1.0-2.0 percent of the consumed fuel is emitted, which settles on surfaces (earth, water, trees, etc.) in the form of unburned hydrocarbons, soot, dust and ash.

Flue gases have an unpleasant odor and have a harmful and sometimes fatal effect on the human body, flora and fauna. Gas and thermal pollution of the air basin contributes to the formation of acid rain, atmospheric smoke, changes the nature of clouds, which leads to an increase in the greenhouse effect.

Gases from power plants pollute the air and the territory (water area) in the areas of their location. Significant emissions of harmful components into the atmosphere occur when starting, warming up and changing the operating modes of installations and engines.

The most intensive sources of environmental pollution with cadmium are metallurgy and electroplating, as well as the burning of solid and liquid fuels. In the unpolluted air above the ocean, the average concentration of cadmium is 0.005 micrograms/m^3, in rural areas – up to 0.025 micrograms/m^3, and in the areas of the enterprises whose emissions contain it (non-ferrous metallurgy, thermal power plants running on coal and oil, plastics production, etc.), and in industrial cities – up to 0.5 micrograms/m3 (usually 0.02–0.05 micrograms/m^3). About 52% of cadmium enters the environment during the combustion and processing of materials containing it, especially plastic products, where it is added for strength, and cadmium dyes. The burning of fuel oil and diesel fuel is an additional source of cadmium pollution.

Near metallurgical enterprises, due to the deposition of cadmium from the atmosphere, its content on the soil surface is 20-50 times higher than at control sites; in the air of large industrial cities, the concentration of cadmium reaches 15 efficiency coefficient. Soil contamination with cadmium persists for a long time even after this metal ceases to flow again. Up to 70% of cadmium entering the soil binds to soil chemical complexes available for assimilation by plants. In areas of high cadmium content in the soil, a 20-30-fold increase in its concentration in the terrestrial parts of plants is established in comparison with plants of uncontaminated territories.

Cadmium does not undergo decomposition, and once it enters the environment, it continues to circulate in it. New cadmium emissions are added to the cadmium already contained in the environment. Cadmium and cadmium compounds have relative water solubility, so they are more mobile, for example, in soil, as a rule, they are more bioavailable and tend to biological accumulation.

Cadmium is widely distributed in the environment. Its consumption increases and this causes an increase in contamination of soil, water and air with cadmium compounds. 77% of cadmium in the world is used in nickel-cadmium batteries, 11% - in pigments, 8% - in paints, and the remaining 4% - in various fields.

Over the past 70 years, one of the main sources of lead accumulation in the environment with subsequent intoxication of living organisms, including and the human body, in areas with heavy traffic is motor transport, since internal combustion engines use fuel with an additive of tetraethyl lead as an anti-detonator. It is estimated that up to 260 thousand tons of lead enter the atmosphere annually as part of the exhaust gases of vehicles, and one car annually emits an average of 1 kg of lead into the atmosphere in the form of an aerosol. In the USA, more than 90% of anthropogenic lead pollution is caused by road transport. 7

Tetraethyl lead also enters natural waters, due to its use as an anti-detonator in the motor fuel of water vehicles, as well as with surface runoff from urban areas. This substance is characterized by high toxicity and has cumulative properties. The burning of coal supplies 27.5 - 35 thousand tons of lead to the environment, and as a result of the burning of oil and gasoline, almost 50% of anthropogenic emissions account for lead.

As a result of the work of metallurgical enterprises, about 90 thousand tons of lead enter the Earth's surface.

The source of lead entering the environment is also metallurgical and chemical industry enterprises, which emit lead oxides into the atmosphere along with other pollutants.

In the global economy, mercury is used: in batteries, in the production of chlorine /alkali, in small-scale gold and silver mining, dental amalgam, control and measuring devices, electrical control devices and switches, lighting devices and in other areas.

Mercury is widely used in the electrical industry and instrument making, in chlorine production, as an alloying additive, coolant, catalyst in the synthesis of plastics, in laboratory and medical practice, agriculture. The main sources of mercury pollution are: pyro-metallurgical processes of metal production, burning of organic fuels, waste water, production of non-ferrous metals, paints, fungicides, etc.

Significant amounts enter water bodies with wastewater from enterprises producing dyes, pesticides, pharmaceuticals, and some explosives.

Thermal power plants running on coal emit significant amounts of mercury compounds into the atmosphere, which as a result of wet and dry precipitation fall into water bodies.

3. DETERMINATION OF THE DEGREE OF POLLUTION OF WATER BASINS

3.1. Determination of the degree of purification of waste water

Production water released from reservoirs must be cleared of harmful impurities. To control the degree of purification of industrial water, the following indicators are used: water temperature, color, smell, salt content, pH, amount of mechanical impurities, decomposable hardness of harmful substances, the amount of oxygen spent on complete neutralization, etc.

The rate of waste water treatment for water basins with runoff must meet the following conditions (formula 3.1.1.):

$$\mathrm{g}\, C_{z.m,} + C_S \cdot a \cdot Q \leq (aQ + g) C_{B.B.Q} \qquad (3.1.1.)$$

here, $C_{z.m.}$ – the composition of the production water is a layer of harmful substances remaining after cleaning,

C_S – concentration of this substance in the water basin,

$C_{B.B.Q.}$ - it is a layer of that substance that can be released in water,

a - coefficient that expresses the degree of mixing of pool water with production water,

Q – it is the total amount of water in the basin.

To clean industrial waste water from harmful substances, the following methods can be used:

1. mechanical cleaning method
2. chemical cleaning method

3. physical chemical cleaning method
4. biological cleaning method

Mechanical cleaning

Mechanical cleaning of industrial wastewater is applied for the removal of suspended and dispersed colloidal particles. Mechanical cleaning includes filtration, sedimentation, filtration methods from porous material. By these methods, various dispersions in industrial wastewater (sand, clay and ets.) insoluble mechanical impurities are removed up to 90%, and from domestic waste water up to 60%. For this purpose, sand catchers (horizontal and vertical), precipitators (horizontal, vertical and radial with continuous and continuous working mode), filters loaded with transparencies, oil dispensers and porous materials are applied.

Chemical cleaning

Chemical methods include neutralization and oxidation. Special reagents (limestone, NaOH, KOH, Na_2C0_3, NH_4OH, $CaCO_3$, $MgCO_2$) for neutralizing turbines and alkalis, and various oxidizers (chlorine, chloride, chlorinated lime, potassium permanganate, air oxygen, ozone, etc.) for oxidation is added. With the help of these substances, wastewater is purified from toxic and other harmful components.

Physical-chemical cleaning:

Coagulation

The following methods are used in physical and chemical wastewater treatment: coagulation - the formation of a precipitate in the form of flakes with the addition of coagulants (ammonium, iron, copper salts) in the wastewater, which is then easily removed. Coagulation in wastewater treatment is used to accelerate the deposition of fine dispersed mixtures. The resulting flakes have the ability to capture colloidal particles and turn them into aggregates. This phenomenon is due to the fact that colloidal particles have a weak negative load, and coagulant flakes have a weak positive load, so there is a mutual attraction between them.

Flocculation

Flocculation is the process of aggregation of particles obtained by adding high-molecular compounds to wastewater. These compounds are called flocculants. They use the flocculation process to intensify the formation of flakes of aluminum and iron hydroxides and to increase their deposition rate. The use of flocculants reduces the dose of coagulants, the duration of the coagulation process and increases the deposition rate of the formed blades. Natural and synthetic flocculants are used for wastewater treatment. Natural flocculants include starch, dextrin, esters and etc. Synthetic flocculants currently belong to the widespread polyacrylamide.

Sorption

Sorption process-the process of obtaining certain substances (bentonite clay, activated carbon, zeolites, silica gel, peat, etc.) means the ability to absorb pollutants. They use an adsorption method to remove dissolved organic substances in wastewater. The advantage of this method is that a high efficiency of wastewater treatment is achieved, several pollutants can be removed simultaneously and these substances can be recovered. Adsorption treatment is obtained and disposed of as regenerative, i.e., absorbed from the adsorbent substance, and destructive, i.e., substances removed from waste water, together with the adsorbent are destroyed. The most versatile adsorbent is activated carbon, and they must have certain properties - weakly interact with water molecules, while organic compounds must interact well.

Flotation

The essence of the flotation method is that when air bubbles are released from wastewater, as they rise up the volume of water, they create a layer of foam, taking with them surfactants, gasoline, oil and other pollutants to the water surface, which makes it very easy to remove them from the water surface. The positive aspect of the flotation method is that the process is continuous, can be applied in a wide range, with less capital and operating costs, ease of equipment, etc.

Ion exchange

The essence of ion exchange cleaning is that when the solution interacts with the solid phase, ions are exchanged. The solid phase is called the ion exchanger. They practically do not dissolve in water. Ionites that have the ability to exchange positive ions from an electrolyte solution are called cationites, and those that exchange negative ions are called anionites. The first have an acidic, and the second an alkaline nature. If the ion exchangers are exchanged as cations and anions, they are called amphoteric ion exchangers. Ion exchangers are characterized by a value, called the volume of exchange, and are divided into three types: total, static and dynamic volumes for the exchange. Ionites are of inorganic (mineral) and organic origin. In addition, it can be both natural and artificial ion-exchange resins. Inorganic natural ionites include zeolites, clay minerals, feldspar, etc., and organic synthetic ionites include silica gel, permubite - artificial aluminosilicate used for water purification and softening, metal oxides and hydroxides of complex solutions. Natural organic ion exchangers is a humic acid soil and coal .

Biological treatment

A large-scale method of biological treatment is used for the treatment of municipal waste water from pulp and paper, oil refining, and food enterprises. This method is based on the use of organic and inorganic substances in wastewater as food for the development of microorganisms. Organic substances are a source of carbon for micro-organisms. When they come into contact with microorganisms with organic substances, they partially destroy them and turn them into ions of water, carbon dioxide, nitrite and sulfate. The other part of the substance is spent on the formation of biomass. Decomposition of organic substances is called biochemical oxidation. Some organic substances are oxidized very quickly, others are either not oxidized at all, or they are oxidized very slowly.

Note:

In recent years, new effective methods of wastewater treatment have been developed. These are the following:

- electrochemical methods - based on anodic oxidation and cathodic reduction, electrocoagulation, electro-flotation;
- membrane cleaning processes; magnetic processing (allows to improve the flotation of the obtained particles);
- radiation treatment of water (causes pollutants to quickly oxidize, coagulate and decompose);
- ozonation, while the waste water does not form substances that negatively affect natural biochemical processes;
- application of new selective sorbents for separation of useful components from wastewater.

3.2. Water supply systems used in industry

Calculation of the degree of purification of waste water for non-flowing water basins

The following indicators are used in production to control the speed of industrial water treatment: water temperature in the basin, color, smell, salt content, PH indicator, quantity of mechanical mixtures, permissible concentration of harmful substances, the amount of oxygen consumed for complete neutralization.

For non-flowing water basins the degree of wastewater treatment should be as follows (formula 3.2.1.):

$$C_{z.t,} \leq C_S + n(C_{B.B.Q} - C_s) \qquad (3.2.1.)$$

here, n – it is the degree of dissolution.

$$C_{z.t,} + C_S \cdot \frac{aQ}{g} \leq \frac{(aQ+g)}{g} C_{B.B.Q}$$

$$n = (aQ + g)/g; \quad a = (ng - g)/Q$$

If these values are taken into account above (formula 3.2.2.),

$$C_{z.t,} + (n-1) \cdot C_S \leq nC_{B.B.Q} \qquad (3.2.2.)$$

The analysis of the last expression shows that if there is no harmful substance considered in the basin of non-flowing water, then in this case (formula 3.2.3.)

$$C_{z.t,} \leq nC_{B.B.Q} \qquad (3.2.3.)$$

If the water does not flow into the basin and the concentration of the harmful substance constantly increases, then in this case

$C_{z.t,} \leq C_S$, that is, the production of water $C_{B.B.Q.}$ – must be cleared to a lower value

The degree of purification of industrial water from mechanical impurities is determined as follows (formula 3.2.4.)

$$D = \frac{C - C_{B.B.Q.}}{C} \cdot 100 \qquad (3.2.4.)$$

here, C –the amount of mechanical impurities contained in the production water before cleaning, $C_{B.B.Q.}$ – it is a layer that can be released in the production waters of mechanical mixtures.

According to the full biochemical demand for oxygen, the required degree of purification of production water is as follows (formula 3.2.5.):

$$K = \frac{B_f - B_n}{B_f} \cdot 100 \qquad (3.2.5.)$$

here, B_f – actual cost of production water in full biochemical demand for oxygen, B_n - this is the norm of total biochemical oxygen demand for production waters.

If $B_f > B_n$, then the water must be purified before it is released into the reservoir.

The necessary degree of purification for oxygen dissolved in the water of the reservoir is usually established experimentally.

When releasing acidic and alkaline wastewater, it is necessary to take into account the neutralizing capacity of the reservoir (the pH value in it), which in some cases allows you to do without special structures for neutralizing wastewater. Water reservoirs often contain calcium bicarbonates $Ca(HCO_3)_2$ and magnesium $Mg(HCO_3)_2$, causing its carbonate hardness, as well as dissolved carbon dioxide CO_2. These mineral salts and carbon dioxide react with acids and alkalis dissolved in wastewater, such as sulfuric acid

$$Ca(HCO_3)_2 + H_2SO_4 = CaSO_4 + 2H_2O + 2CO_2$$

or with sodium hydroxide

$$2NaOH + CO_2 = Na_2CO_3 + H_2O$$

According to the sanitary rules, in reservoirs of all types of water use, the pH change should not exceed 6.5-8.5 for the calculated discharge of effluents.

1. *Scheme of direct water supply systems*

Industrial water supply. The availability of water resources and the possibility of their use play a decisive role in the development and placement of industry.

The volume of water consumption depends on the structure of industrial enterprises, the level of technology, and the measures taken to save water. The most water-intensive industries are thermal power engineering, ferrous and non-ferrous metallurgy, mechanical engineering, petrochemical and woodworking industries. The share of the most water-intensive industry - the electric power industry - accounts for about 68% of the total consumption of fresh and 51% of recycled water.

Industrial enterprises are the main source of surface water pollution, annually dumping a large amount of waste water (in 1996 - 35.5 km'). About 70% of industrial enterprises discharge sewage into the municipal sewer system, which, in particular, contains heavy metal salts and toxic substances. The sediment formed during the treatment of such wastewater cannot be used in agriculture, which creates problems with its disposal.

Wastewater from the chemical, petrochemical, oil refining, pulp and paper and coal industries is particularly diverse in its properties and chemical composition. Despite the sufficient capacity of the treatment facilities, only 83-85% of the wastewater discharged meets the regulatory requirements.

Waste water generated during the production process is a potential hazard for water pollution. Therefore, one of the important issues in the design is the organization of environmentally safe water supply systems. Water supply systems for industrial areas are divided into three groups:

1) direct water supply systems
2) sequential water supply systems
3) closed-loop water supply systems

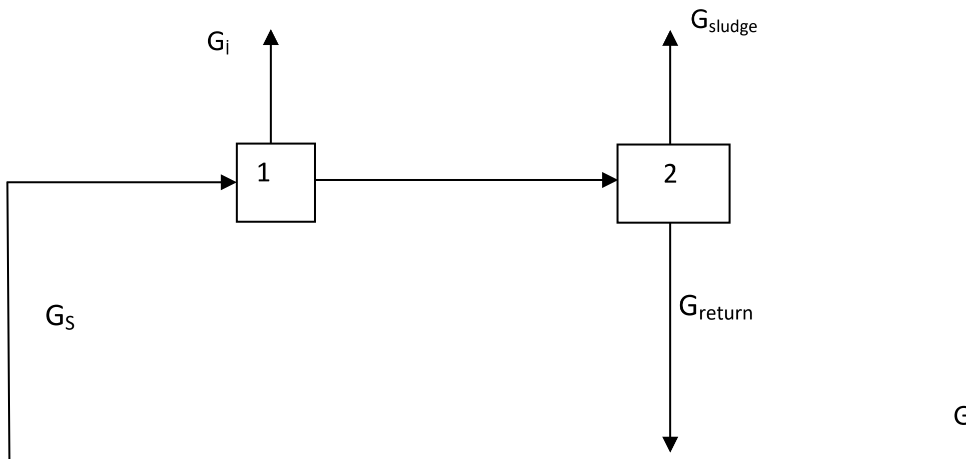
The conventional scheme of the direct water supply system is shown in Fig.3.2.1.

G_S the amount of water taken from the pool used for technical and technological purposes at the production facility. At this time, there is a loss of the vehicle in the amount of water. In the treated treatment facilities after cleaning from harmful substances, it is returned to the reservoirs again. If a sludge (silt-like residue) is formed during the cleaning process, it also contains an appropriate amount water.

The amount of water used for direct water supply systems is determined as follows (formula 3.2.6.):

$$G_{return} = G_s - G_i - G_{sludge} \qquad (3.2.6.)$$

The danger of contamination of reservoirs with harmful substances can not be completely eliminated either directly or in the system of sequential water supply. Therefore, at present, closed-loop water supply systems are used in modern industrial premises.



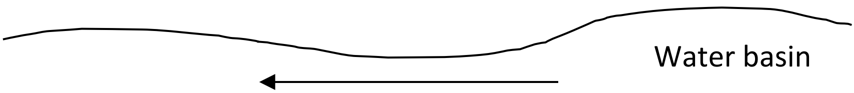


Fig. 3.2.1. Scheme of a direct water supply system

The main indicator of good production performance is the multiplicity of water use. This indicator is defined as the ratio of the total volume of water consumed by the enterprise to the volume of fresh water for the same time.

The multiplicity of water use in the industry of our country is still very small. In light industry, the multiplicity is about one, in the heat power industry-a little more than three. In the chemical and oil refining industry, which occupies a leading position in water turnover, the multiplicity of its use is from 5 to 7, depending on the sub-sector. for individual chemical enterprises, as a result of the organization of recycled water supply and secondary use of waste water, water intake from open reservoirs is reduced by 15-20 times compared to water intake for direct-flow water supply. At the same time, the discharge of polluted waste water into reservoirs is significantly reduced, and when there is no waste water, there is no waste water at all.

2. Scheme of sequential water supply systems

Waste water generated during the production process is a potential hazard for water pollution. Therefore, one of the important issues in the design is the organization of environmentally safe water supply systems.

Water supply systems for industrial areas are divided into three groups:

1) direct water supply systems

2) sequential water supply systems

3) closed-loop water supply systems

After being used at two or more production facilities that operate sequentially in water supply systems, the water obtained from the pool is treated in the treatment facility and returned back to the reservoirs. A conditional diagram of a sequential water supply system is shown in Fig. 3.2.2.

The amount of water used for sequential water supply systems is calculated as follows (formula 3.2.7.):

$$G_{return} = G_s - G_i' - G_i'' - G_{sludge} \qquad (3.2.7.)$$

The danger of contamination of reservoirs with harmful substances can not be completely eliminated either directly or in the system of sequential water supply. Therefore, at present, closed-loop water supply systems are used in modern industrial premises.

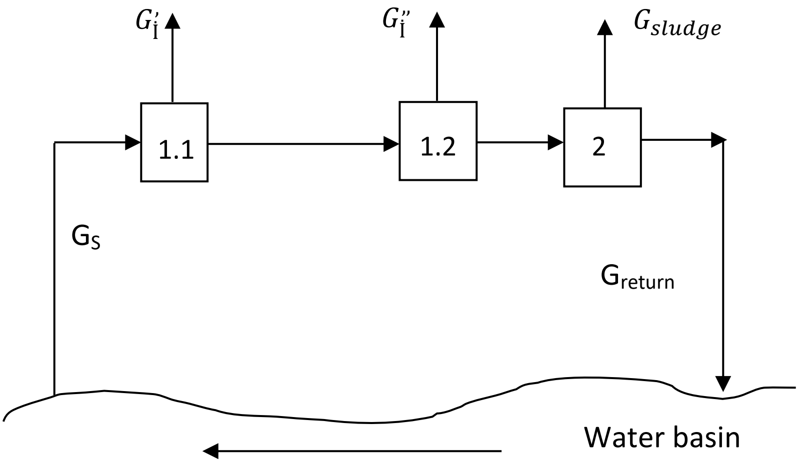


Fig. 3.2.2. Sequential water supply system

Treatment of recycled waste water should include measures to combat biological fouling, corrosion and deviations in recycling systems. In systems of repeated and especially recycled water supply, the intensity of biofouling, corrosion and deposits increases significantly. Existing methods of dealing with these phenomena are expensive, but enterprises are forced to use them, since stopping production and replacing or repairing technological equipment are even more expensive**.**

Biofouling of pipelines and process equipment operating on natural or treated wastewater depends to a greater extent on the physical and chemical properties of the latter (temperature, presence of dissolved oxygen, chemical composition of water), the speed of liquid movement, etc. Biofouling of the internal surfaces of pipelines and devices leads to a decrease in their throughput, a decrease in heat transfer, an increase in electricity consumption to overcome resistances when water moves, etc.

3. Scheme of closed-loop water supply systems

Waste water generated during the production process is a potential hazard for water pollution. Therefore, one of the important issues in the design is the organization of environmentally safe water supply systems.

Water supply systems for industrial areas are divided into three groups:

1) direct water supply systems
2) sequential water supply systems
3) closed water supply systems

The essence of closed-loop water supply systems is that the treated wastewater is not discharged into the reservoir, its temperature and salt content are lost after treatment, they are periodically filled and returned to the production facility (formula 3.2.8.). The diagram of a closed-loop water supply system is shown in Fig. 3.2.3.

$$G_s = G_d + G_i' + G_i'' + G_{sludge} + G_b \quad (3.2.8.)$$

G_d – amount of circulating water,

G_b – water loss occurs in the temperature control system. The scheme shown is a salt treatment system, is a water circulating pump, and 1 and 2 ⧖ are valves installed on communication lines with a water source.

The danger of contamination of reservoirs with harmful substances can not be completely eliminated either directly or in the system of sequential water supply. Therefore, at present, closed-loop water supply systems are used in modern industrial premises.

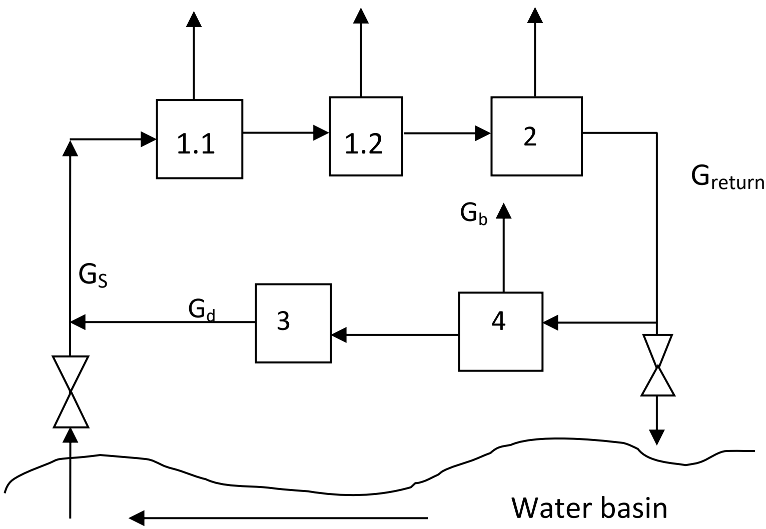


Fig. 3.2.3. Closed-loop water supply system

The composition of deposits in recycling water supply systems depends on the composition of the water that feeds the recycling water supply system. The main reason for the appearance of deposits is the saturation of water with calcium carbonate, less often with calcium sulfate. To prevent carbonate deposits, recycled water is acidified with, for example, sulfuric acid. Combined additives are widely used of crystallization, which simultaneously prevent the processes of biofouling and corrosion.

It is possible to formulate General principles for the establishment of circulating water systems chemical plants:

1) to improve the efficiency of cleaning of water circulation systems, they must be transparent: wastewater with polluting substances with similar properties, should be in a separate closed loop;

2) local treatment systems in the circulating water systems should provide demineralization of wastewater, the release of impurities, lack of biogarantie;

3) in order to combat biofouling in recycling water supply systems and corrosion of equipment that comes into contact with the water of these systems, the introduction of appropriate inhibitors into the water should be provided.

Industrial water supply is equipped with circulating water supply systems, which play a major role. This happens so that the preheated recycled water in the heat exchangers enters the splash pools, cooling towers for cooling, and then is fed back into the cycle by special circulation pumps. At the same time, it is successively subjected to physico-chemical treatments many times. Under chemical and physical influence, water aerates, changes temperature, becomes polluted and evaporates. As a result, recycled water is partially lost due to drip entrainment into the atmosphere, which, accordingly, leads to its increased mineralization, moreover, it becomes corrosive with a large number of undesirable impurities. That is why, in the industrial water supply system, it is provided to constantly replenish recycled water with fresh water in order to restore its quality characteristics.

In accordance with the needs of production and the intended purpose, the quality of the water used may vary significantly. If the liquid is used for cooling purposes, the hardness and turbidity index should be minimal. Also, the absence of corrosive properties is required from the liquid. Distilled water is often used for this purpose. To pour water into steam boilers, it should not contain any salts. When used in the food industry, water should also not contain salts that can change the taste properties of products. The operating mode of any industrial facility initially determines the production needs for the use of water.

3.3. Determination of the efficiency of water use in industry

Calculation of the relative amount of water circulating in closed-loop water supply systems

The following indicators are used to evaluate the efficiency of industrial water supply systems:

1) relative amount of circulating water

2) water utilization rate

3) loss of circulating water

The relative amount of circulating water indicates how progressive the water supply system used in the relevant production area is. The relative amount of circulating water is calculated as a percentage as follows (formula 3.3.1.):

$$G_{de.s.} = \frac{G_d}{G_s + G_d + G^{"}} \cdot 100\% \qquad (3.3.1.)$$

G_d – a closed-loop is the amount of water that circulates in a water supply system

G_s – this is the amount of water taken from the reservoir to make up for the resulting water losses.

G^* - this is the amount of water that contains raw materials and additional reagents and flows from here to the closed water supply system.

To evaluate the effectiveness of water supply systems, the so-called number of water periods is used. The frequency of water is defined as the ratio of the amount of water circulating in the reservoir to the amount of water taken from the reservoir (formula 3.3.2.):

$$N = G_L / G_s \qquad (3.3.2.)$$

For refineries and petrochemical companies, this water supply system is considered effective if the number of waters in the period between 5-7.

There is a special demand for the quality of water circulating in the closed water supply system. First of all, the circulating water must be completely safe both in chemical composition and from a bacteriological point of view for employees working there. Studies have shown that the composition of water circulating in closed-cycle water supply systems usually contains soluble substances in the amount of 150-500 mg/l. This means that these waters do not meet sanitary standards for the amount of dissolved substances and are subject to mandatory cleaning.

Closed-loop water supply systems used in modern large-scale chemical plants are usually multi-faceted, that is, the overall water supply system is formed from the combination of individual water supply systems. In individual cycle water supply systems, the composition of which is similar, is treated by the selected effective treatment method, and the total cycle of treated water is connected to the water supply system.

One of the main problems that arise in closed water supply systems is the contamination of water treatment plants, including other objects that are part of the water supply system. To prevent this, special chemical reagents are used, and in many cases, chlorine (Cl).

Measures for the protection and rational use of water resources include reducing water consumption, increasing the use of water in recycling and reuse systems, reducing unproductive costs and water losses, reducing and stopping the discharge of contaminated wastewater, wastewater treatment, extraction of valuable substances from them, etc. The reduction of water consumption at oil refineries is ensured by the improvement of technological processes, the creation of closed technological systems, the transfer of equipment from water to air cooling

Proper use of the country's water resources requires systematic accounting of water consumption and water use.

4. ENVIRONMENTAL AND ECONOMIC ASSESSMENT OF PROJECTS

4.1. Purpose and principles of environmental and economic assessment

One of the main issues facing the design work in the conditions of modern scientific development is to determine the economic efficiency of the facilities intended for construction or reconstruction by preventing pollution of the environment and violation of ecological balance. It is for this reason that the project manager carries out an eco-economic assessment of the concrete project assigned to him by the organization and together with the project documents are submitted to the environmental expert. One of the important conditions for the ecologic-economic evaluation of the designer of the object to be built is its implementation with a similar or similar project.

At this time, the following should be considered:

1) degree of use of natural resources

2) selecting the source of raw materials and the method of supplying the object with raw materials for the projected object

3) supply of fuel and electricity to the facility

4) the volume of production, its role in the economy, range and quality

5) the volume of capital investments

6) the effectiveness of the new technology

7) ensuring normal social and hygienic conditions for the population of nearby localities.

When conducting an environmental and economic assessment, it is necessary to take into account the interaction of the environment with the object in the future. When determining whether a project is environmentally satisfactory, it is important to take into account the volume of production per year and the anthropogenic impact on various environmental systems. As a result of the environmental and economic assessment, the following potential losses can be calculated:

1) the cost of finished products that cannot be produced as a result of contamination of raw materials and semi-finished products
2) additional costs resulting from the integrated use of raw materials
3) expenditures on public health protection and social insurance due to inefficient use of natural resources.

Environmental and economic assessment depends on many conditions. First of all, the project being implemented must fully comply with the state standards, regulations and regulations in force during this period. As an example of such documents, we can cite:

1) sanitary standards for the design of industrial enterprises
2) instructions for calculating the distribution in the atmosphere of harmful substances contained in industrial waste
3) rules for protecting surface water bodies from pollution by sewage
4) instructions on the preparation, agreement and approval of design and estimate documentation required by the company for the construction of buildings and structures, etc.

The main condition that is taken into account when conducting an environmental and economic assessment is the correct choice of the object of the basic (reference) comparison.

For comparison, you need to select the company (installations) that operates throughout the country and has the highest indicators. This work is carried out by an expert Commission consisting of leading specialists from ministries and main departments of the relevant sphere.

They use the following indicators to assess the environmental impact of the project:

1) the total number of harmful compounds released into the environment

2) the amount of harmful waste that falls into a single volume of the finished product

3) the ratio of the actual hardness of a particular harmful substance in the air or reservoir to its maximum permissible hardness before and after commissioning, etc.

Another main condition for environmental and economic assessment is the use of natural indicators that characterize the progressiveness of the technological process. To do this, they use an economic system for evaluating natural resources based on land and water use laws.

For accurate environmental and economic assessment, the selected construction area must have the most accurate information about the natural state of the environment before and after commissioning. To get this information, use the following:

1) integrated territorial and field schemes for environmental protection and efficient use of natural resources

2) systems for monitoring the General state of the environment and controlling pollution of land resources, air and water basins

3) statistical data.

The concept of sustainable development emerged as a result of combining three main points of view: economic, social and environmental.

The economic component.

The economic approach to the concept of sustainable development implies the optimal use of limited resources and the use of environmentally friendly - natural, energy, and material-saving technologies, including the extraction and processing of raw materials, the creation of environmentally acceptable products, minimization, recycling and destruction of waste.

The social component.

The social component of sustainable development is human-oriented and is aimed at preserving the stability of social and cultural systems, including reducing the number of destructive conflicts between people. An important aspect of this approach is the fair sharing of benefits. It is also desirable to preserve cultural capital and diversity on a global scale. The concept implies that a person should participate in the processes that form the sphere of his life, facilitate the adoption and implementation of decisions, monitor their execution.

Environmental component.

From an ecological point of view, sustainable development should ensure the integrity of biological and physical natural systems. Of particular importance is the viability of ecosystems, on which the global stability of the entire biosphere depends. Moreover, the concept of "natural" systems and areas can be understood broadly, including in them a man-made environment, such as, for example, cities. (Fig. 4.1.1.)

Fig. 4.1.1. The concept of sustainable development

The concept of sustainable development includes not only an economic component, but also covers other spheres of society, which only together can ensure the prosperity of mankind and its proper development. Sustainable development is the basis for the stable functioning and improvement of the activities of any economic entity. Currently, the problem of ensuring sustainable development is becoming very urgent, and this is not only due to the situation that has developed under the influence of the global economic crisis. Even in conditions of economic stability, the issues of sustainability and development of the enterprise are the most important, the decision on them is directly related to the planning of the company's activities and the justification of the chosen strategy.

The problem of ensuring the sustainable development of enterprises in economic practice is only beginning to be realized. At the stage of transition to a market economy, enterprises faced the task of survival. Later, it was replaced by the task of ensuring sustainable functioning. At the same time, the problems of managing sustainable the development of the enterprise in the economic science is not sufficiently developed.

The creation of an effective enterprise management system based on the formation of a mechanism for its sustainable development is caused by vital necessity.

In order to manage the sustainable development of the enterprise, it is necessary to proceed from the fact that in order to achieve the overall goals of the enterprise, it is necessary to consider it as a single system in which all subsystems interact in order to achieve the efficiency of production activities

4.2. I stage of environmental and economic assessment

Environmental and economic assessment of industrial projects is carried out in four stages. These are the following:

1) Determining the environmental feasibility of building a new enterprise or reconstructing an existing one

2) economic justification of the project

3) minimizing the impact of the projected object on the environment

4) calculation of the relative environmental and economic effect of the construction of a new enterprise or reconstruction of an existing enterprise at the expense of investment costs.

The implementation of the first stage ensures compliance with the norms on the harmful effects of waste on the environment. Here, it is determined that the total volume of waste of the project object will not exceed the limit of the solid (MPC – maximum permissible concentration) that can be released in atmosphere air and water basins together with the harmful substances contained in the waste of the objects that are active in the period under consideration and intended to be built in the future The ratio of the actual layer of harmful substances to MPC must pay the following conditionally (formula 4.2.1.):

$$C_i / MPC_i \leq 1 \qquad (4.2.1.)$$

here, C_i is the actual layer of harmful matter in the atmosphere or in water,

MPC is a MPC of that substance in the atmosphere or in water, respectively.

If there are several harmful substances that simultaneously affect the joint in atmospheric air or water (formula 4.2.2.), then

$$\sum_{i=1}^{r} \frac{C_i}{MPC} \leq 1 \qquad (4.2.2.)$$

should be.

Here C_1, C_2.....C_n – it is the actual layer of harmful substances that simultaneously affect it.

Provided that the projected production facility can be built, the provision of the norm on the amount of waste that can be released (AAW - Amount Allowable Waste) is taken (formula 4.2.3.).

$$\sum_{k=1}^{n} V_{ik}^{/} \Big/ \sum_{S=1}^{m} AAW_{is} \leq 1 \qquad (4.2.3.)$$

here, V_{ik} is the volume of i harmful substances released from all waste sources to the environment of the projected production.

AAW_{is} is the norm for the *AAW* defined for the I hazardous substance released in the S – waste source of the object for the project,

m is the total number of waste sources of the projected object,

n is the nomenclature of the produced product.

To determine the volume of waste, the following formula(4.2.4.) is used :

$$V_{ik}^{/} = V_{ik}^{//} \cdot A_k \qquad (4.2.4.)$$

here $V_{ik}^{//}$ - this is a special norm of harmful substances in the production of a specific product range,

A_K - the annual volume of production of a specific product range.

4.3. II stage of environmental and economic assessment

In the second stage of the eco-economic assessment, the volume of annual capital investments and operating costs is compared with the base (benchmark) enterprise for economic justification of comparable variants of the project. At this stage, this project is selected (formula 4.3.1.):

$$Z_i \leq Z_b \qquad (4.3.1.)$$

here, Z_i - *i* project costs

Z_b - it is the costs incurred on the base enterprise.

In the implementation of short-term measures (including capital investment and the annual volume of operating costs for the remaining long-term measures), they determine the volume of costs as follows (formula 4.3.2.):

$$Z = C_i + E_n K_i \qquad (4.3.2.)$$

here, K_i - private capital investment for the construction or reconstruction of the object,

C_i - current costs incurred for one manat product,

E_n - the normative coefficient of the effectiveness of capital investment costs

If the ongoing activities are long-term and unstable during the year, the total amount of expenses incurred is calculated as follows (formula 4.3.3.):

$$Z = \sum_{i=1}^{T} \frac{K_p + K_{Dt} + C_{it}}{(1+E_{np})} \qquad (4.3.3.)$$

here, K_p - annual capital investment costs,

K_{Dt} - additional capital investment costs required to ensure the normal operation of the facility in the year of operation,

C_{it} - the cost of maintenance and maintenance of the main production funds in the year of operation,

E_{np} - the coefficient of bringing to an equal size cost is 0.08 for ordinary costs and 0.1 for new equipment.

Following the developed methodology, at the second stage, using the same values of indicators, a three-dimensional diagram of a comprehensive assessment is constructed, according to which it is possible to determine in which of the areas (unfavorable, average favorability, favorable) the complex indicator of the territory under consideration is located. As a result of the analysis of the graph and diagram, a list of recommended measures aimed at correcting the values of indicators in need of improvement is selected. After applying the recommendations, the values of environmental, economic and social indicators are recalculated and a graph and diagram of a comprehensive assessment are constructed showing the effect achieved as a result of the application of the methodology.

Sustainable development of enterprises is a development in which the use of enterprise resources and scientific and technological development are coordinated with each other and strengthen the present and future potential for functioning. With this understanding, economic development is always associated with environmental protection and social responsibility.

Sustainable development of enterprises makes it possible to influence the improvement of the efficiency of enterprises in the long term. Integration of the Sustainable Development Goals in the strategic business development will bring short-term benefits such as the opportunity to increase the effectiveness of risk management, reduce operating costs, and develop innovation and investment activities.

In general, the concept of sustainable enterprise development has high practical value and universality for wide use in management activities at the level of individual enterprises and their divisions.

4.4. III stage of environmental and economic assessment

The importance of the third stage of environmental and economic assessment is related to the fact that in some economic areas and districts the concentration of harmful substances in the air and water bodies exceeds the *maximum permissible concentration* (MPC). Minimizing the harmful impact of the projected object on the environment allows you to create favorable conditions for the assimilation of the existing volume of harmful waste.

As a criterion for environmental optimization of the project, they use the minimum price of the indicator of the impact of an industrial object on the environment (formula 4.4.1.):

$$P_{EIA} = K_k + K_z \rightarrow \min \qquad (4.4.1.)$$

here, $P_{EİA}$ is an indicator of the impact of the projected production facility on the environment,

K_K - production capacity of natural materials,

K_z - environmental pollution indicator.

The natural resources capacity of the project is defined as follows (formula 4.4.2.-4.4.3.):

$$K_k = \left(\frac{\sum_{i=1}^{e} Q_i B_i}{A}\right) \qquad (4.4.2.)$$

here Q_i is the amount of natural resource consumed,

B_i - the cost of those i natural resources,

A - annual output of the facility,

e - this is the amount of natural resources used.

$$K_z = \frac{\sum_{i=1}^{z}(B_j \sum_{i=1}^{k} V_{ij})}{A} \qquad (4.4.3.)$$

here V_{ij}- the conditional volume i of the harmful substance emitted in the direction of pollution j (air, water, soil),

B_J – j cost per unit of conventional waste in the direction of pollution,

K - number of pollution ingredients,

z is the number of types of polluted natural resources.

Conditional volume of harmful substance (formula 4.4.4.):

$$V_{ij} = V_{ij}^{/} \cdot E_i \qquad (4.4.4.)$$

$V_{ij}^{/}$ is the volume i of the harmful substance released in the direction of contamination j (formula 4.4.5.).

$$E_i = \frac{MPC_n}{MPC_i} \qquad (4.4.5.)$$

here, the MPC_n - is the *MPC* of the harmful substance, which is conditionally accepted as a benchmark, the *MPC* of the harmful substance is the MPC_i.

As a reference, it is selected from the possible production waste of the production in question, so that its level is the highest.

4.5. IV stage of environmental and economic assessment

At the fourth stage of the environmental and economic assessment, the annual environmental and economic effect obtained from the cost of capital investment in construction and reconstruction work is determined. To calculate the annual relative economic efficiency, they compare the costs of the planned production with the basic (reference) production and indicators of their environmental and economic damage. If the MPC standards for all waste are established and met in the base production, the annual relative environmental and economic effect is calculated as follows (formula 4.5.1.):

$$E_{ns} = \left[(C_{ub} - C_{ue}) + (K_{ub} - K_{ue})E_n\right]A_e + (y_1^{/} - y_b^{/})A_1 \qquad (4.5.1.)$$

here, C_{ub} and C_{ue} – accordingly, the current costs per one manat of the base and projected enterprises,

K_{ub} and K_{ue} – the cost of private capital investment in the baseline and project production,

E_n - normative efficiency ratio of capital investment costs,

A_e – annual volume of the product to be produced at the projected facility,

$y_1^{/}$ and $y_b^{/}$ - accordingly, the volume of annual ecological and economic losses incurred in the projects and base enterprises per one manat of product

If sometimes the reduction of waste at a production facility is carried out in stages over a certain period and temporary waste standards are established, then the actual environmental damage must be taken into account when calculating the relative environmental and economic effect (formula 4.5.2.):

$$E_{ns} = \left[(C_{ub} - C_{ue}) + (K_{ub} - K_{ue})E_n\right]A_e + (y_0 - y_1)A_e \qquad (4.5.2.)$$

here, y_0 and y_1 – accordingly, it is the amount of annual environmental and economic damage associated with pollution of the environment for the base and projected production.

The amount of environmental and economic damage associated with environmental pollution can be expressed as the sum of damages on individual elements (formula 4.5.3.):

$$y = y_a + y_s + y_t \qquad (4.5.3.)$$

here, y_a, y_s and y_t – accordingly, the harm associated with pollution of the atmosphere, water and soil.

The average height of the waste disposal of the projected production facility into the atmosphere is calculated as follows (formulas 4.5.4.-4.5.5.):

$$H = \sum_{i=1}^{m} H_i \frac{V_{Ai}}{\sum_{i=1}^{m} V_{Ai}} \qquad (4.5.4.)$$

here, H_i – height of the waste source,

V_{Ai} – annual volume of waste from the source of waste to the atmosphere, m – it is the number of waste sources in the production facility.

$$y_a = K_1 K_2 \sum_{i=1}^{b} U_{Ai} V_{Ai} \qquad (4.5.5.)$$

here , K_1 – coefficients taking into account the position of the source of waste

K_2 – coefficient that takes into account the height of waste distribution,

A_i – he amount of damage caused by a ton of waste,

V_{Ai} – annual amount of waste released into the atmosphere

b – the number of waste types

Environmental and economic damage associated with water pollution is calculated as follows (formula 4.5.6.):

$$y_s = K_3 \sum_{i=1}^{\alpha} U_{si} V_{si} \qquad (4.5.6.)$$

here, K_3 – coefficients taking into account the position of the source of waste,

V_{si} – annual volume of waste from source,

U_{si} - amount of damage related to waste 1 ton i

α- number of waste sources.

The environmental and economic damage associated with soil pollution is calculated as follows (formula 4.5.7.):

$$y_t = K_u \sum_{i=1}^{n} U_{ti} V_{ti} \qquad (4.5.7.)$$

K_u – coefficient taking into account the value of land resources,

V_{ti} – annual emissions of waste to the soil,

U_{ti} - damage caused by 1 ton i waste,

n - this is the number of wastes

4.6. The evaluation system of environmental-economic assessment

Environmental and economic assessment of projects also uses natural indicators that reflect how progressive the project's environmental protection measures are. To do this, we recommend using an economic system for evaluating natural resources. The economic system for assessing natural resources is based on the law on land and water adopted in each country, including on the protection of the atmosphere.

For example, the economic system for estimating water reserves is as follows:

1) for economic regions of the first category, where there is absolutely no water shortage – 5 points
2) for second-level economic areas that have sufficient water resources to fully meet their needs and use only 75% of their water resources, - 10 points
3) for economic areas of the third category, where the demand for water resources is almost exhausted and the construction of new hydraulic structures is not required, – 15 points
4) for economic areas of the fourth category, where the volume of water demand is provided from large reservoirs or large channels with an area of at least 4 km^3 – 20 points
5) for economic areas where there are only small rivers near the territory, and the demand for water is provided by these rivers – 30 points
6) for economic areas where underground water sources are used and there are no surface water sources – 40 points

For environmental economic assessment, you can also use a system of economic points made up of 1 ton of conditional waste. This economic assessment system for a reservoir looks like this:

1) for first reservoirs – class water bodies that are not subject to artificial pollution and fully meet sanitary norms-2 points

2) for secondary reservoirs with little exposure to artificial pollution– 6 points

3) water pollution rate for third–degree water basins not more than 2.5 – 3 times the limit of the release layer of harmful substance-10 points

4) for fourth – grade water bodies with a pollution degree exceeding 3 times the limit of the release of harmful substance-16 points

5) for cases of leakage of harmful water into underground water sources – 22 points

The system of economic assessment, made up of 1 ton of conditional waste released into the atmosphere, looks like this:

1) for territories that are not suitable for agricultural work and are not protected as a nature reserve – 5 points.
2) for objects located on land plots suitable for agriculture – 7 points.
3) for territories located at the foot of the Caucasus mountains and having the value of a recreation area – 10 points.
4) for the forest territory - 12 points.
5) for objects located on the territory of a rural settlement – 16 points.
6) for cities with a population under 50,000 – 0 points.
7) for cities with a population of more than 1,000,000 – 50 points.
8) for objects located on state – protected territories, on territories of mass recreation of the population - 60 points.
9)

The economic system, made up of 1 ton of conventional waste dumped into the soil, looks like this:

1) for irrigated agricultural land – 3 points.
2) Chernozem-for steppe territories-2 points.
3) for forest territories – 1.5 points.
4) for clay-salty areas-1 point.

The results of an environmental assessment based on the economic points system should be compiled in the form of appropriate tables.

Ecological and economic assessment of the technogenic impact of the well construction process and environmental measures to reduce it is a system of multivariate studies and calculations that allow at each stage of pre-design, design and technical activities to calculate the environmental and economic values of each option in order to select the one that can provide the desired combination of environmental standards of the state of the environment with economic indicators.

The point evaluation is carried out on the basis of conventional units-points or bonus classes. This is mainly a qualitative assessment of resources and their territorial combinations.

The main tasks solved by the ecological and economic assessment of natural resources include the following:

- substantiation of standards for the consumption of natural resources, including their alienation for development, road construction and other needs of the national economy;
- substantiation of standards for resource density and rent, and in the conditions of privatization – prices for natural resources;
- development of cadastres of natural resources and organization of ecological and economic monitoring as

elements of the system of nature protection and environmental management;
- forecasting the costs of reproduction of natural resources, taking into account environmental measures, etc.

5. DOCUMENTATION OF THE RESULTS OF THE ENVIRONMENTAL ASSESSMENT

5.1. Structure of the final environmental assessment document

The results obtained after completion of the project or the environmental expertise within the project are summarized and the final conclusion of the environmental assessment is accepted.

This document has legal force. It must be carried out by the designer and the client of the project, including the management of the active enterprise.

The final conclusion of the environmental assessment indicates how environmentally friendly the relevant object is, as well as provides appropriate recommendations to fully ensure environmental safety. These recommendations indicate the measures that need to be taken to reduce or eliminate the environmental impact.

Currently, based on international experience, all developed countries have adopted a common structure for the final review of environmental pricing. In general, the final conclusion of the environmental assessment should consist of the following sections:

1) Information about current legal and regulatory documents in the relevant field.

This information refutes the legal basis on which prices are based on an environmental experiment.

2) General information about this project and its alternatives.

This section should indicate the purpose of the project and the advantages of the selected option from alternative options. It uses natural resources, waste generation, the volume of waste, the characteristics of the technology used, etc. should be given.

3) characteristics of primary natural conditions and individual components of the environment.

This section should specify the natural conditions that exist in the territory where the project is planned to be implemented, as well as the sources and objects of impact that will occur after the project is implemented. In addition, changes in nature that may affect the environment, changes in human health, and other negative situations must be reflected.

4) characteristics of impact sources and forecast of the environmental situation after the project.

This project should consider the circumstances of the accident and how to resolve them. When preparing this section of the document, it is also important to take public opinion into account and reflect it in the document.

5) ways to reduce or eliminate the impact on the environment.

This section should explain in detail the nature protection measures envisaged by the project, evaluate their effectiveness, and note possible residual effects. This section should also specify environmental safety measures.

In addition, depending on the specific features of the project, in many cases the results of agreements concluded with the relevant ministries and main departments, as well as the opinions and proposals of public organizations that are interested in the project, should be included in the final conclusion in a separate section.

When drawing up the final conclusion of the environmental assessment, the authorized state bodies that carry out environmental expertise must observe legality and objectivity as the main principle. In this regard, the prepared conclusion is sent to another competent organization for quality verification. Current environmental and legal regulations are used to check the quality of the final report. In some cases, the document is consistent with the final conclusion of the environmental assessment of the analogical project.

5.2. Taking into account internal opinions in environmental assessment

Consideration of public opinion in environmental assessment

When conducting an environmental assessment of materials obtained at all stages of design, expert work, along with highly qualified specialists in the relevant field, involves individual public organizations that are interested in this project, representatives of the population living on the territory where the project will be implemented, and scientists who are interested in this project.

The goal is to implement controversial issues that may arise in connection with the project that will be implemented in the future even during the design period. In General, this can be called public participation in the environmental assessment of the project.

The study of public opinion creates conditions for determining people's environmental requirements, informing them about the project, and taking into account the opinions and suggestions of individual citizens.

A high-level public opinion poll identifies the following:

1) identification of individuals and public organizations interested in the project.

2) timely communication of information about the project to the public.

3) organization of a mutual dialogue between the organization implementing the project and representatives of the public.

4) taking into account the results of the mutual dialogue in the final document of the environmental assessment.

5) informing the public about the decisions taken on the project.

Usually, public refers to one or more individuals and legal entities. The environmental assessment of a project does not imply a public interest, but a public interest in the project. This includes representatives of the population living on the project's territory, various public organizations that are interested in the project, individual scientists and specialists.

When carrying out an environmental assessment of a project, the final document must necessarily reflect the opinion of the public. This helps prevent individual disputes from arising in the post-project period.

The public should participate in all stages of environmental assessment. For example, at the stage of justification of the environmental assessment, it should be determined how much the public is concerned about the project and whether they want to participate in the environmental assessment of the project. After that, it is necessary to determine which problems are causing public discontent. Members of the public must be informed of the environmental situation after the project. It is more appropriate to develop a special program to study public opinion in connection with the project.

When drawing up the program, you must consider the following:

1) issues that the public pays special attention to

2) identification of ways to solve problems of concern to the population

3) study of public opinion about the project

4) familiarizing the public with alternative versions of the project

5) elimination of dissatisfaction and reaching general agreement

To carry out all this, public hearings, informal meetings, etc. it must be done. Summarizing the results of the conducted opinion polls, the main issues that have a serious impact on society and cause dissatisfaction with the project should be identified, ways of solution should be sought, reflected in the project and the public should be informed about the work done. It should be noted that there are also relevant international documents on public opinion during the design and environmental assessment of the project. Compliance with them is very important in terms of international law.

5.3. Making a final decision based on the results of an environmental assessment

The purpose of ecological assessment is to record ecological factors in making decisions on the relevant project. Decisions on the project can be made at all stages of the project. The reasons for making ecological decisions on the project are diverse. An example of this is the position of interested parties in the project, forecasts on the impact on the environment, comparison of alternative options of the project, the rules laid down by various government agencies, etc. can be shown. The effectiveness of ecological assessment depends on the extent of its use in decision-making.

As for the methods of decision-making, they can be different.

Some formal methods of decision making are as follows:

1. Verification of compliance of the project with environmental standards.

The application of this method is very simple. If the farm activity envisaged in the project meets the legislative norms, then this project can be implemented. However, this method does not allow to take into account many aspects of ecological assessment. For example, taking into account unique local natural conditions, studying the opinions of interested parties in the project, taking into account cumulative effects and unregulated effects, etc. This method is characteristic for decisions made by" ecological " ministries.

2. Multilateral analysis. To this method of decision-making "the matrix of achieving the goal", "the balance sheet of planning", etc. related.

This method is also very simple and is widely used in making informal decisions.

3. Feasibility study.

The essence of this method is that the environmental and other results of
the project are expressed in monetary terms and calculated on the total profit.

The main problem with this method is that many effects cannot be expressed in monetary terms.

4. Methods of expert assessment.

This method is one of the most widely used methods. Because this method does not require any additional information. In many environmental assessment systems, the results are made available to the public. This creates transparency in decision-making.

5.4. Strategic environmental assessment

Strategic environmental assessment is the process of systematically identifying possible environmental changes in environmental factors for a project or other activity under consideration. Using strategic environmental assessment, you can achieve:

1. Elimination of limitations and shortcomings in the ecological evaluation of projects.
2. Detection of effects that are difficult or impossible to take into account when designing.
3. Ensuring a stable development process.

The main principles of strategic environmental assessment are:

1. Strategic environmental assessment is carried out by the designer on the initiative of the customer.
2. Strategic environmental assessment is carried out during the main design period.

3. The purpose and main issues of strategic environmental assessment are clearly defined.

4. Strategic environmental assessment takes into account the scale of impacts on the environment.

5. Alternative options are implemented and environmental impacts are determined on each option.

6. Socio-economic and other factors must be taken into account during the strategic environmental assessment.

7. The value of the project and the possibility of its implementation are assessed in terms of the country's environmental policy.

8. Public opinion is studied and the social significance of the project is determined.

9. Strategic environmental assessment is carried out in a gradual manner.

10. Strategic environmental assessment is ensured to be independent.

A step-by-step version of a strategic environmental assessment may consist of the following levels:

1. National level. For example, the solution of issues related to waste treatment.
2. Regional (local) level. For example, the solution of issues related to the placement of the project object.
3. Project level. For example, reduction or complete elimination of environmental impacts.

Environmental impact assessment (EIA) and strategic environmental assessment (SEA) as part of a decision-making process (Fig.5.4.1.).

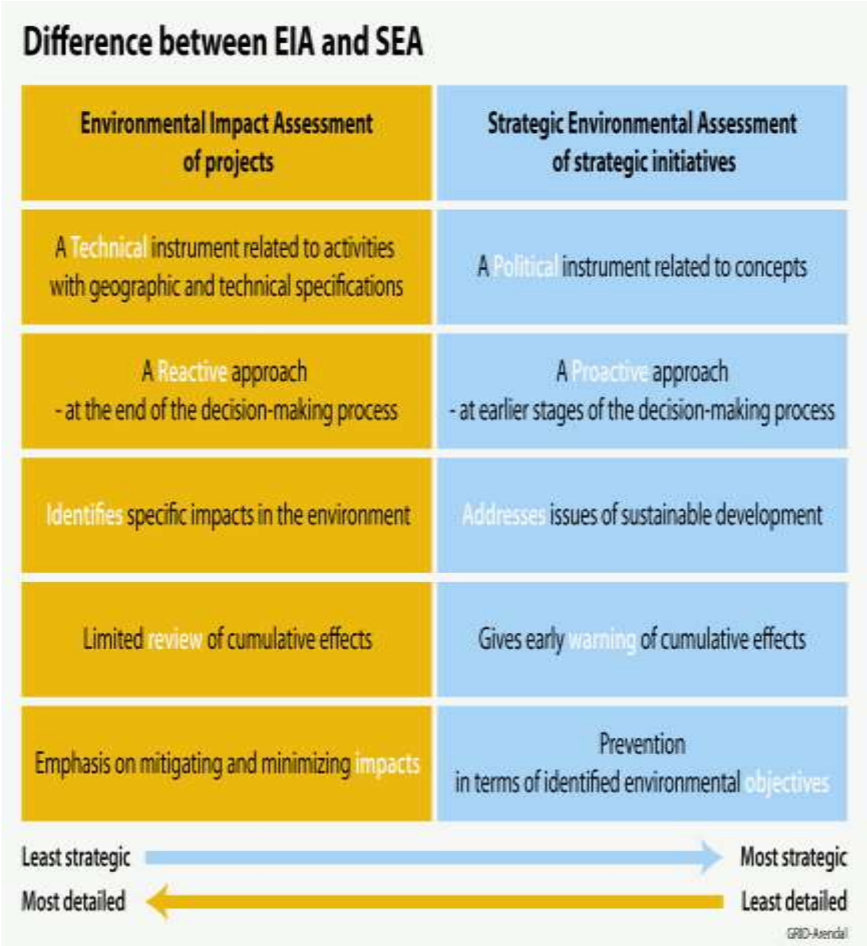


Fig. 5.4.1. Difference between EIA and SEA

LİTERATURE

1. N.Ə. Səlimova, B.Ş. Şahpələngova, Ə.İ. Babayev. "Mühəndis ekologiyası", Dərslik, Bakı, 2012
2. N.Ə. Səlimova, Ə.İ. Babayev, S.Ə. Rzayeva "Ətraf mühitiun mühafizəsi", Metodik vəsait, Bakı, 2003
3. Т.А. Хоружая Оценка экологической опасности: обеспечение безопасности, методы оценки рисков, мониторинг. Изд-во «Ноосфера», 2001, 284 с.
4. А.П. Платонов, В.А. Платонов Основы общей и инженерной экологии. Изд-во «Феникс», серия «Учебники и учебные пособия», 2002, 352 с.
5. О.Н. Трикаш, В.И. Андрейцев, В.С. Горбунов и др. Справочник по экологической экспертизе проектов /Под ред. М.А. Пустовой - Киев, «Урожай», 1986, 192 с.
6. П.С.Белов, И.А.Голубева, С.А Низова. Экология производств химических продуктов из углеводородов нефти и газа. Учебник для вузов. – М., Химия, 1991, 256 с.
7. Н.Ф Тищенко. Охрана атмосферного воздуха. Расчет содержания вредных веществ и их распределение в воздухе. Справ.изд. – М., Химия, 1991, 368 с.
8. А.В. Путилов, А.А. Копреев, Н.В. Петрухин Охрана окружающей среды – М., Химия, 1991, 223 с.
9. Anji Reddy Environmental Impact Assessment. Theory and Practice, Marredy (Auth.), 2017, p. 632
10. Judith Petts Handbook of Environmental Impact Assessment, Vol. 2: Environmental Impact Assessment in Pracice: Impact and Limitations, 1999, Publisher: Willey-Blackwell, p. 464

11. John Glasson, Riki Therivel, Andrew Chadwick Introduction to EIA, 1994, 394 p.
12. Peter Wathern Environmental Impact Assessment: Theory and Practice, 1998, 352 p.
13. Suheyla Suzan Gökalp Alıca, Çevresel Etki Değerlendirmesi, 2019, 1.Baskı, 368 s.
14. Çevresel Etki Değerlendirme (ÇED), Yiğit, N., Çolak, E., Ankara, 2002 2.Çevresel Etki Değerlendirmesi, M. Yücel, Baki Kitabevi, 2001.
15. Orhan Uslu, Çevresel Etki Değerlendirmesi, Türkiye Çevre Vakfı Yayını, 1996, 276 s.
16. Çevresel Etki Değerlendirmesi (ÇED) El Kitabı, projelerin çevresel değerlendirmesi, 2009, 126 s.
17. Çağatay Güler, Zakir Çobanoğlu, Çevresel etki değerlendirmesi. Ankara, 1994, 45 s.
18. Alica, Süheyla Suzan, "Setörel plan ve Programların stratejik Çevresel Değerlendirmesi", kentsel Politikalar, Palme Yayınçılık, Ankara 2018,sh.613-631.
19. Aydın, Mustafa ve Çerçi, Ezgi, "ÇED_SÇD Direktiflerinin İlişkisi ve Mevzuatımızın Bu Bağlamda Değerlendirilmesi", Bildiri Kitabı, 2013, sh. 235-242.
20. Cengiz, Canan /Cengiz, Bülent / Yıldız, Şule, "Çevresel Etki Değerlendirmesi (ÇED) ve Peyzay Onarım Süreci, Uluslararası Çevresel Etki Değerlendirmesi Kongresi Bildiri Kitabı, 8-10 Kasım 2013, İstanbul, sh. 207-212