CLIMATE CHANGE & SUSTAINABLE DEVELOPMENT: NEW CHALLENGES OF THE CENTURY

MONOGRAPH

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Petro Mohyla Black Sea National University, Ukraine
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Olena Mitryasova
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RECULTIVATION OF DISTURBED LANDS DURING THE LIQUIDATION OF SLUDGE STORAGE LIMITED LIABILITY COMPANY "OCEAN SHIPBUILDING PLANT"

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ABSTRACT

The article highlights the requirements of the legislative and regulatory framework for land recultivation. A brief description of galvanic production and projected sludge storage activities is presented. The purpose of the sludge storage is determined: temporary storage of liquid industrial waste of galvanic, electrode and acetylene production. The further inexpediency of operation of sludge storage in connection with reorganization of technological processes is substantiated. Attention is focused on the scientific and organizational principles of development of the project of recultivation of disturbed lands. The volume of waste in the sludge storage was estimated; chemical composition and hazard class of waste stored in the sludge storage. The hazard class of waste according to the content of exchange forms of heavy metals is determined. The choice of recultivation methods is substantiated. The organizational component of the work is determined. Work planning has been adjusted. The stages of sludge recultivation measures are analyzed.

Keywords: rational use of lands, recultivation of disturbed lands, land management, galvanic production, sludge storage

INTRODUCTION

The industrialization of society, the intensification of the agricultural sector of the economy, the development of new technologies, the creation of new materials leads to increasing human intervention in the life of nature. This is manifested in the consumption of natural resources, on

the one hand, and on the other - in the generation of waste that enters the natural environment. Galvanic production is no exception to this pattern.

In general, galvanic production is developing in accordance with technical progress, is used in many traditional and new industries, one of which is shipbuilding.

The advantages of electrochemical technologies for processing metallic and non-metallic materials are the ability to fine-tune the structure and thickness of the resulting surface films, electrodeposition of such alloys and composite coatings, which can not be obtained by other methods, uniform surface treatment on protrusions, holes and depressions.

At the same time, an important aspect of the application of galvanic production is its environmental hazard. The use of various chemicals, including heavy metals, raises the issue of waste disinfection, reducing their amount or their complete exclusion, which should be addressed in the development and implementation of technological processes.

Recultivation of disturbed lands at machine-building enterprises is part of the problem of rational use of natural resources and environmental protection. There is a constant increase in the area of disturbed land plots within the industrial sites of enterprises. Therefore, the issue of restoration of disturbed lands in Ukraine is quite relevant and requires state regulation.

The choice of the method of recultivation and implementation of its stages requires a comprehensive comparison taking into account economic, environmental, social and technological factors.

Recultivation is considered as a set of two successive stages: technical and biological. At the end of the XX century, the concept of the technical stage of recultivation was formulated as a preliminary stage in the preparation of areas after the development of minerals, the end of the life of sludge storage for various types of further development of the territory.

Experts say that the scientific basis of recultivation should be a complex of such geographical sciences as landscape science, biogeocenology, geobotany, plant ecology, soil science, agrochemistry, forestry, phytomelioration and more. Scientists reduce the problem of recultivation of disturbed lands to the solution of two interrelated main tasks - the technical solution to the problem of reclamation of disturbed lands and the formation of a new natural landscape.

Technical recultivation is defined as a cycle of works on forming the surface of landscapes and covering their surface with a fertile layer, forming terraces, stable slopes of quarries, sludge storages, their terracing, strengthening the surface of dumps from water and wind erosion, etc.

The purpose of biological recultivation is to restore the fertility and biological productivity of disturbed lands. This can be achieved in several ways: continuous application of the soil layer on the disturbed lands; cultivation of soils by planting and fertilizing; stimulation - cultivation of soils by introducing bioactive reagents and structuring polymers; cultivation of soils by applying a small amount of soil and planting perennials; cultivation of soils by introducing bioactive reagents and microorganisms.

METHODS AND EXPERIMENTAL PROCEDURES

The purpose of the article is to highlight the scientific and organizational aspects of recultivation of disturbed lands of sludge storage LLC "OCEAN SHIPBUILDING PLANT".

The following tasks were set during the study:

1. Analyze the scientific and organizational principles of recultivation of disturbed lands;

2. General characteristics of the sludge storage of LLC "OCEAN SHIPBUILDING PLANT" to give;

3. Analysis of project activities for the recultivation of sludge storage LLC "OCEAN SHIPBUILDING PLANT".

During the study, the following research methods were used: analysis and synthesis, which allows to determine the scientific and organizational aspects of recultivation of disturbed lands; statistical method used during the processing of statistical materials to assess the volume and dynamics of waste accumulation in the sludge storage; the graphic method was used for the purpose of formation of graphic material concerning project measures of recultivation of LLC "OCEAN SHIPBUILDING PLANT".

REQUIREMENTS OF THE LEGISLATIVE AND LEGAL FRAMEWORK FOR LAND RECULTIVATION

During the construction of the sludge storage, the management of LLC "OCEAN SHIPBUILDING PLANT" used the State Construction Standards B.2.4-2-2005 "Landfills for solid waste" [1]. It was planned that waste from galvanic production of hazard class IV should be stored on the territory of the sludge storage, which corresponds to the hazard class of solid household waste.

The operation of the sludge storage of LLC "OCEAN SHIPBUILDING PLANT" was implemented on the basis of the management of the following regulatory and legislative requirements: the Law of Ukraine "On regulation of urban planning activities" [2]; Law of Ukraine "On Strategic Environmental Assessment" [3]; State Construction Standards B.2.2-12: 2018 "Planning and development of territories" [4]; State Construction Standards-173 "State sanitary rules of planning and development of settlements" [5]; State Construction Standards B.2.3-5-2001 "Streets and roads of settlements" [6]; State Construction Standards B.1.1-14: 2012 "Composition and content of the detailed plan of the territory" [7], GOST 17.5.3.04-83. Conservation. Earth. General requirements for land recultivation [8].

Now, when the main activity of LLC "OCEAN SHIPBUILDING PLANT" has changed and the need for sludge storage has disappeared, there is a need to implement recultivation measures for disturbed lands of sludge storage.

Land legislation stipulates that lands are subject to recultivation, which have undergone changes in the structure of the terrain, the ecological condition of soils and parent rocks and in the hydrological regime due to mining, exploration, construction and other works. In this case, before the start of these works, the working project is developed and approved in the prescribed manner with the mandatory involvement of government agencies.

According to Article 166 of the Land Code of Ukraine [9]:

1. Recultivation of disturbed lands is a set of organizational, technical and biotechnological measures aimed at restoring soil cover, improving the condition and productivity of disturbed lands.

2. For recultivation of disturbed lands, restoration of degraded lands, soil is used by applying it to unproductive areas or areas without soil cover, which is removed during mining, exploration, construction and other works.

According to Article 52 of the Law of Ukraine "On Land Protection" [10]:

1. Lands that have undergone changes in the structure of the terrain, the ecological condition of soils and parent rocks and in the hydrological regime due to mining, exploration, construction and other works are subject to recultivation;

2. Recultivation of land plots is carried out by layer-by-layer application on low-yielding land plots or plots without soil cover of the removed soil mass, and if necessary - of the parent rock in the order that ensures the highest productivity of reclaimed lands;

3. Works on removal, storage, preservation and application of soil mass on the disturbed land plots shall be carried out at the expense of natural and legal persons, on whose initiative or fault the soil cover is disturbed. Works on application of the removed soil mass on unproductive lands are carried out at the request of owners or land users, including tenants, of these land plots at their expense.

At the enterprise level, the procedure for waste management is regulated by departmental regulations, including general guidance documents. But a significant breakthrough in the regulatory framework was approved by the state sanitary norms DSanPiN 2.2.7.029-99 "Hygienic requirements for the management of industrial waste and determining their class of danger to public health" from 01.07.1999 № 29 [11].

Also, the Ministry of Regional Development, Construction and Housing of Ukraine plans to revise state building codes for the design of industrial waste landfills. The new normative document plans to introduce a number of modern solutions and technologies for industrial waste management, which are used throughout the civilized world and are aimed at improving the environmental situation on the planet.

Therefore, the new normative document plans to prescribe the requirements for mandatory recultivation of landfills after the end of their service life or in the absence of the need for their further operation in order to create a safe and pleasant environment in places where landfills were previously located.

THE RESEARCH RESULTS AND DISCUSSIONS

Brief description of galvanic production and projected sludge storage activity.

Galvanic production is an electrochemical method of applying metal and chemical coatings on a material to give it certain properties: protective anti-corrosion, protective-decorative, decorative, special: antifriction, to give hardness, wear resistance.

The technological process is implemented in galvanic baths, where the process of coating metal products takes place (Figure 1).

Pollution from the technological process is divided into phases: liquid, solid and gaseous.

Liquid contaminants are wastewater that is formed as a result of washing parts and equipment, as well as processing and replacement of spent electrolytes.

Solid waste is generated mainly in the processes of wastewater treatment or concentrated electrolytes.

Gaseous gases are toxic gases, vapors, aerosols and air-gas mixtures released in technological processes both in galvanic shops and in sewage treatment plants.

Gaseous waste is generated during machining of parts, during operation of electrolytes, during wastewater treatment, processing of spent electrolytes. But gaseous emissions are not the cause of major environmental problems. However, they are quite dangerous and require disposal.

There are different types of harmful gaseous substances in galvanic waste. Thus, in the process of degreasing parts, vapors of organic solvents, aerosols, alkalis are formed; during digestion - aerosols of acids, various gases (nitrogen oxides). Ammonia, hydrogen cyanide, and aerosols of all electrolyte salts can also enter the atmosphere.

A particularly large amount of gaseous waste is generated in the following cases:

a) the use of highly light components (carbohydrate degreasing compounds, ammonia electrolytes);

b) operation of hot solutions;

c) implementation of chemical and electrochemical reactions with the release of gases; even if the gas itself is not harmful, it carries out droplets of electrolytes, forming toxic aerosols (eg, chromium plating).

Fig. 1. Galvanic bath for coating

When using chlorinated tin, titanium tetrachloride and silicon, keep in mind that they easily absorb water from the air, forming thick fogs. Toxic dust occurs in the processes of polishing, grinding, trimming, sandblasting, as well as stripping of anodes and rods. In the process of preparation of electrolytes, the emergence of dust of organic origin from glue, gelatin is also possible. Solid wastes are mainly insoluble metal compounds, such as sludges after liquid waste treatment, solution filtration products. It is as a result of cleaning that solid waste is formed, which is often buried in a special sludge storage. This also includes anode residues, metal dendrites, dust or powders, insoluble polymer compounds and the like.

Liquid waste. Electroplating uses 30-80% of metals, only 5-20% of acids and 2-3% of water. Everything else goes into wastewater, which becomes the main source of environmental pollution by toxic substances. In the case of insufficient wastewater treatment, the entire ecosystem is polluted: water bodies > soil > flora and fauna > man.

Sludge storage of LLC "OCEAN SHIPBUILDING PLANT" is intended for storage and temporary storage of liquid industrial waste of galvanic, electrode and acetylene production.

According to the project documentation (Figure 2), the site is located in the south-eastern part of the territory of LLC "OCEAN SHIPBUILDING PLANT", which is surrounded by a concrete fence, behind the open site of shop № 11, at a distance of 200 m west of the Bug estuary, 60 m south of concrete fence of the plant, 120 m to the east of the fire and rescue unit №7.

The site has a natural depth of 2 m from the surface of the terrain, which was used during the works. A layer of soil with vegetation was cut along the bottom of the site and the bottom and slopes were planned. The soil surface is rolled: the density of the base should provide a deformation modulus of 50 kg/cm. The planned and rolled surfaces were treated with an aqueous solution of the herbicide of continuous action. The bottom of the site is covered with 0.2 mm polyethylene film in 2 layers and covered with a layer of sand 500 mm thick. Slopes are covered at an angle of 40o, covered with polyethylene film in 2 layers, filled with moist soil at an angle of 60o and reinforced with concrete panels PG 60.12-2-L.

The site measures 210 × 51 m. It is surrounded by a barbed wire fence. There are 2 pits for storage and temporary storage of industrial waste measuring 36 × 42 m (S=1512 m^2) and 60 × 42 m (S=2520 m^2).

Trapezoidal embankment from the soil with bases of 3000 mm and 500 mm, height 1000 mm was made along the perimeter of the pits. The separation of industrial waste storage sites is based on the annual volumes of waste and their chemical composition: galvanic sludge (neutral medium), carbide sludge (alkaline medium), electrode production sludge (alkaline medium).

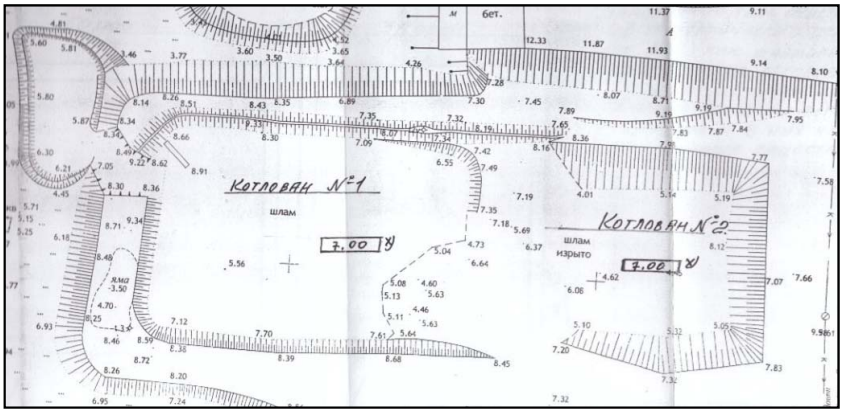


Fig. 2. Map-scheme of the sludge storage LLC "OCEAN SHIPBUILDING PLANT"

At the neutralization station of LLC "OCEAN SHIPBUILDING PLANT", galvanic sludge is formed, which has the following qualities: pasty, fireproof, explosion-proof, unstable, hazard class 4. Wastes of galvanic productions include neutral or alkaline solutions containing metal hydroxides, neutralized waste which are formed during degreasing of metal surfaces, waste containing liquid glass.

The mass fraction of chemical elements in terms of hydroxide from dry matter is:

- iron hydroxide - 22.6%;

- zinc hydroxide - 3.8%;

- calcium hydroxide - 52.9%.

The galvanic wash water enters the neutralization station, where it is mixed with lime milk in the reactor and thus neutralized. Next, the neutralized solutions enter the carbide-type clarifier, where the deposition of sludge is performed. Illuminated industrial effluents, free from harmful impurities of heavy metals (pH 7.5-8.5), enter the sewer network of the plant, and then enter the municipal sewer system.

The formed precipitate (neutral sludge) enters the sludge storage of the neutralization station with a water content of 96-98%. Then the sludge is taken to the sludge storage by sewage machines.

In the sludge storage water evaporates, galvanic sludge settles to the bottom and should be removed by truck as it accumulates.

Estimation of volume and dynamics of waste accumulation in sludge storage.

Sludge storage of LLC "OCEAN SHIPBUILDING PLANT" is two hollows designed and constructed in accordance with the design documentation (Figure 3).

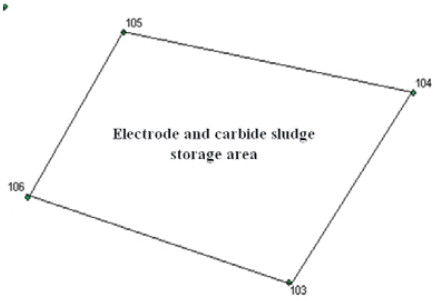
- *Site for storage of electrode sludge and carbide sludge*

The surface area of the filling area for storage of electrode sludge and carbide sludge is 870 m^2, the perimeter along the upper edge of the filling - 119 m. The absolute height varies within 1 m above sea level. The design filling volume of the Hollow № 1 is 3000 m^3.

Estimated fill volume is:

$$870\ m^2 \times 2{,}0\ m = 1740\ m^3 \quad (1)$$

According to the test data, the density of the filling material of the hollow for storage of electrode sludge and carbide sludge in the air-dry state is 350 kg/m^3. The volume of the dry residue of the pit filling is about 610 t. The hygroscopicity of the sludge is 38%, respectively the filling volume is about 850 t. The design volume of the pit filling № 2 is 5000 m^3.



Hollow №1

Hollow №2

Fig. 3. Natural and design sites of waste storage

- *Site for storage of galvanic sludge*

The area of the Hollow №2 for storage of galvanic sludge is 1524 m^2, perimeter 166 m. The absolute height of the basin varies within 1 m above sea level. The estimated amount of waste is stored at the site for storage of galvanic sludge:

$$1524\ m^2 \times 1{,}5\ m = 2286\ m^3 \quad (2)$$

The filling density of the air-dry sludge residue is 708.5 kg/m^3. The volume of dry residue filling the pit is about 1620 tons, hygroscopicity is 24.4%. Taking into account the hygroscopicity, the volume of filling is about 2025 tons.

The material composition of the sludge is determined by the place of formation at certain stages of production (table 1):

- electrode production sludge;

- sludge from phosphating baths (galvanic production);
- sediments of heavy metals (galvanic production);
- sludge from the degreasing process (galvanic production).

Table 1. The composition of the waste sludge

Name of waste	Phase composition	Code	Danger class	Substance composition		Number
				Substance	%	
Electrode production sludge	Liquid	1.48.00	3	Not specified		4500 tons
Sludge from phosphating baths (galvanic production)	Pasty	1.04.00	2	Fe Zn Mn Na P Cl^- NO_3^- pH	26,4 2,6 1,1 0,1 19 0,9 0,9 1,5-2	64.2 tons/year
Sediments of heavy metals (galvanic production)	Solid	1.04.00	2	$Fe(OH)_3$ $Ni(OH)_2$ $Zn(OH)_2$ $Ca(OH)_2$ $Cu(OH)_2$ H_3CrO_3 pH	17 0,2 4 35 0,6 0,5 12.7	108,4 tons/year
Sediments of the degreasing process (galvanic production)	Solid	1.04.00	2	Al Fe Cu Mn Zn Cr Ni PO_4^{3-} CO_3^{2-} pH	19,1 0,7 0,1 0,45 0,6 0,04 0,02 15,3 10,3 12,0	17,2 tons/year

According to the test data in the waste stored and stored in the sludge storage, the mass fraction of chemical elements in terms of dry matter is: iron hydroxide - 22.6%; zinc hydroxide - 3.8%; calcium hydroxide - 52.9% (table 2).

Table 2. Waste toxicity index

Chemical substance	Ingredient weight, t/t	Saturated vapor pressure, mm Hg	Solubility in water, g/100 g	MPC in soil, mg/kg on metal	Danger class	Toxicity index
$Fe(OH)_3$	0.226	0	$2{,}03 \cdot 10^{-8}$	Not regulated	III	605,3
$Zn(OH)_2$	0.038	0	Not regulated	23,0	II	
$Ca(OH)_2$	0.529	0	0,148	Not regulated		

According to calculations of laboratory of the Nikolaev Center "Regional State Fertility" the total toxicity index made 1606,3. Therefore, in accordance with DSanPiN 2.2.7. 029-99 waste is classified as hazard class 3. This conclusion was made on the basis of detection in the filling material of iron sludge (classified as hazard class 3 with organoleptic limited trait), for which

the maximum concentration limit in the soil is not regulated, at a concentration of 1501.6 mg/kg.

Project measures for recultivation of sludge storage of LLC "OCEAN SHIPBUILDING PLANT"
For the purpose of ecological safety and on the basis of sustainable development of territories, the project envisages recultivation of disturbed lands during liquidation of sludge storage.

When developing measures for the restoration of land are taken into account: the type of further use of recultivated land, the natural conditions of the area of work, location and area of the affected area, the actual condition of the disturbed land.

Before starting work, the engineer-technologist with the master must inspect the areas to be recultivated, to clarify their boundaries, places of arrival of equipment, to understand the location of communications.

Execution of the necessary permits for work, safety briefing, acquaintance of foremen and workers with the location of the areas of communications, delivery of personnel, equipment of the economic unit and delivery of equipment.

- *Technical recultivation*

The purpose of technical recultivation is to bring the land into a condition suitable for further biological stage of recultivation.

The technical stage is aimed at restoring natural conditions close to natural, localization and elimination of damage and unwanted processes, as well as includes preparatory work for biological recultivation.

The duration of the technical stage depends on the production of major works on the elimination of sludge on the basis of relevant design materials and schedules.

Technical recultivation of the sludge storage of LLC "OCEAN SHIPBUILDING PLANT" included the following measures:

- planning of territories;

- cleaning of garbage, materials, as well as all pollutants

- import and storage of soil and vegetation layer;

- planning of soil and vegetation layer.

The main stages of technical recultivation included the following works:

1. Formation of a technological (clay) screen 0.5-1 m thick at the bottom of the hollow, made of polymerized bentonite clay (Figure 4) (experimental batches are produced at the Institute of Environmental Geochemistry of the National Academy of Sciences and the Ministry of Emergencies of Ukraine).

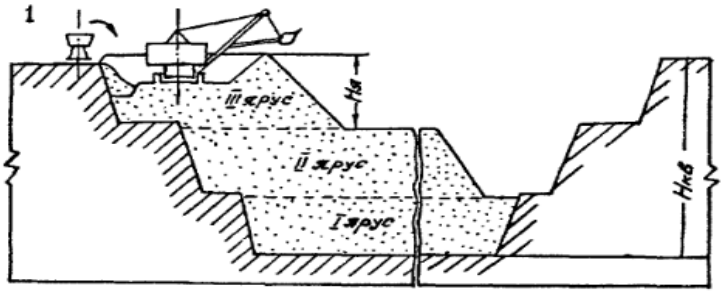


Fig. 4. Technological scheme of recultivation of hollow storage basins

The imported clay was leveled on the bottom of the hollow and compacted with a roller. The volume of clay for the screen was:

- for hollow № 1 V= L*B*h = 60*42*0,5=1260 m^3 (3)

- for hollow № 2 V= L*B*h = 36*42*0,5=756 m^3 (4)

2. Formation of a protective screen. The protective screen was arranged on top of the technological screen. It consists of the following layers (Figure 5):

- recultivation layer not less than 1 m thick, having a layer of fertile soil 30 ... 50 cm thick;

- drainage layer at least 30 cm thick;

- protective fine sand layer at least 20 cm thick;

- a layer of synthetic waterproofing with a thickness of at least 3 mm, resistant to chemical and biological aggression and rodent damage;

- mineral waterproofing layer consists of two layers of compacted clay, with a total thickness of about 1 m. The total filtration coefficient of waterproofing layers (synthetic and mineral) is about 9 m/s.

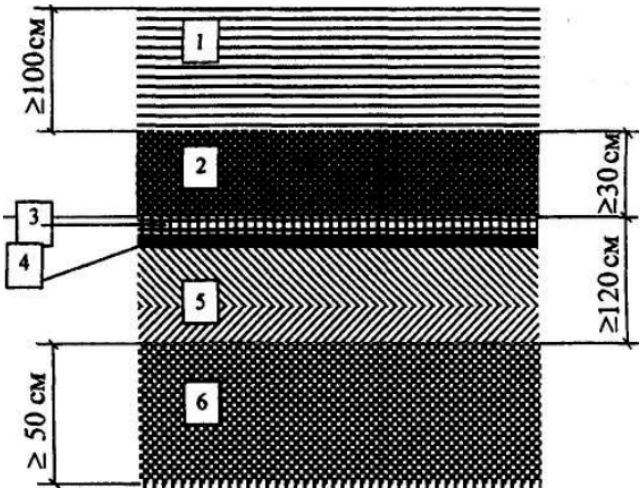


Fig. 5. Scheme of the layered structure of the technological stage of recultivation
Note: 1 - recultivation layer; 2 - drainage layer; 3 - protective layer; 4 - synthetic waterproofing; 5 - mineral waterproofing layer; 6 - leveling layer

The general protective screen was:

- for hollow № 1 V= L*B*h = 60*42*2 = 2630 m^3 (5)

- for hollow № 2 V= L*B*h = 36*42*2 = 1640 m^3 (6)

The hollows were filled in tiers from bottom to top. Tiers were poured sequentially taking into account the period of active shrinkage of rocks. Delivery of material for backfilling took place by road. Use roads on the territory of the enterprise to deliver clay and soil. The soil was leveled with a bulldozer. Layer-by-layer soil compaction was performed with rollers. Recultivation works were carried out in the warm season.

3. *Laying of slopes* during the technical stage of recultivation works was carried out on the principle of "top to bottom" (Figure 6).

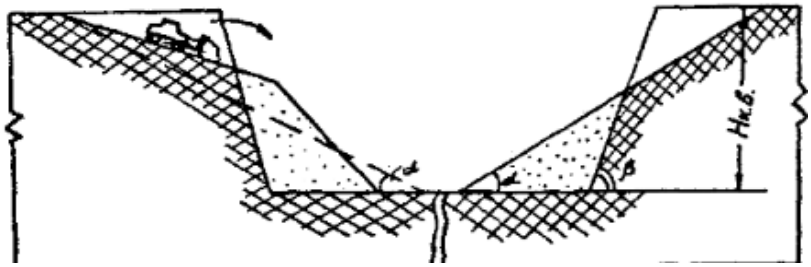


Fig. 6. Technological scheme of laying the slopes of the sludge basins

4. Wrapping the remains of the embankment and its compaction by a bulldozer required an additional volume of soil:

- for hollow № 1 volume amounted to: V= 700 m^3 (7)

- for hollow № 2 volume amounted to: V= 400 m^3 (8)

5. Formation of a leveling layer and gas drainage with a total thickness of about 0.5 m. Soil compaction works were carried out in layers.

Fertile lands were imported by road from places of temporary soil storage. Planning of a surface to a standard slope and its consolidation is carried out by the bulldozer.

Planning work was carried out with machines with low specific pressure on the ground to reduce the compaction of the surface of the recultivated layer. The formed relief has a calm plain character, without potholes and hollows. The surface of the sludge storage sites was leveled to the absolute mark of 7.0. Thus, the goal of technical reclamation has been achieved in full, the land has been brought to a condition suitable for the further biological stage of recultivation.

- Biological recultivation

The main purpose of biological recultivation is to create a secondary ecosystem. The biological stage of recultivation is soil preparation, fertilizer application, selection of grasses and grass mixtures, sowing of grasses, care of crops. The project provides for the creation of a full-fledged soil cover by applying mineral fertilizers and sowing a mixture of grasses after work on the territory. These works were carried out only in the warm season after the snow cover melted.

The biological stage of recultivation includes measures to restore the sludge storage area for further use and is at least 5 years.

At the biological stage of recultivation in order to prepare the soil surface, the project provided for the following measures:

1) small plowing to a depth of 20 cm with a tractor Belarus KO-705. Plowing reduces the number of weeds, loosens and makes the soil softer and more pliable, facilitates further sowing;

2) disking - the use of disk tools (including harrows and trowels) to loosen the top layer of soil.

The applied fertile layer is disposable, this operation is necessary for grinding and loosening the soil.

Disking was performed with a T-4A.01 tracked tractor with a BDT-3 disc harrow.

3) application of mineral fertilizers - was carried out in a previously created recultivation layer superficially, followed by sealing with a rake. The application of mineral fertilizers provided for the provision of recultivation grasses with mineral nutrients in the first period of plant life.

Doses, terms and methods of pre-sowing fertilization were determined taking into account soil and climatic conditions and biological characteristics of grasses.

Surface application technologies were used for pre-sowing fertilization. Fertilizers were evenly distributed on the soil surface and laid in the soil.

When making preference was given to convenient fertilizers in complex application, containing nitrogen, phosphorus, potassium in a form accessible for rapid assimilation by plants.

According to research, the soil imported to the sludge storage is a medium soil. The following fertilizer application rates were used to create grass stands: nitrogen - 30 kg/ha, phosphorus - 60 kg/ha, potassium - 60 kg/ha.

Mineral fertilizers were applied by a T-4A.01 tracked tractor equipped with an NRU-0.5 sprayer. Fertilizers applied to the soil were laid with disc harrows to a depth of 0.06 m. The uniform distribution of chemicals and the recommended application rate were maintained.

4) surface harrowing is loosening of the surface layer of soil with harrows and rotating hoes. Protects the soil from drying out, levels its surface, destroys the soil crust.

A T-4A.01 tracked tractor with a BZTS-1.0 harrow was used for harrowing. The working body of the harrow is rotating disks. The harrow is intended for work on all soils, with soil humidity no more than 35%. Harrow width 3.5 m, cultivation depth up to 12 cm, productivity 0.9 ha/h.

• sowing a mixture of grass seeds in a pre-formed reclamation layer of soil;

• rolling the soil after sowing.

5) selection of the range of perennial herbs (Table 4);

Sowing herbs is necessary for the following purposes:

• rapid consolidation of soils from water and wind erosion,

• restoration of their fertility,

• increasing biodiversity.

Table 4. Arrangement of the upper recultivation layer

Type of recultivation	Height of the reclamation layer	
	Underlying layer, cm	The height of the bulk layer fertile soil, cm
Sowing of perennial grasses	70	30

6) sowing and care of crops. All areas of the sludge storage should be covered with vegetation soil 0.3 m thick with leveling of the surface without compaction. The volume of vegetative soil for the whole area is V = 1760 m^3.

Herbal mixtures of grass species adapted to local conditions were used, which were created by combining species of different life forms: long-rhizome, loose- or dense-bush and plants with a universal root system. The grass mixture simulates the accumulation of plants in natural groups.

Accepted composition of the grass mixture: meadow forest tail (12-14 kg/ha) + meadow fire (6-8 kg/ha) + meadow thyme (4-6 kg/ha). It is to accelerate the processes of turf formation, to restore and form the root layer and its enrichment with organic matter, it was advisable to sow a selected mixture of herbs from several types of herbs.

To increase the germination of seeds before sowing was treated with peat-humic biological product "Flora-C" according to the manufacturer's instructions.

The sowing of the grass mixture on the total area of the hollows №1 and № 2 is S = 5865 m^3. Sowing of grass seeds was carried out in windless weather with a caterpillar tractor T-4A.01, equipped with a spreader NRU-0.5. The main condition is to ensure uniform scattering of seeds.

To preserve soil moisture, ensure friendly grass seedlings, reduce erosion processes after sowing, rolling was used as an effective agronomic technique that provided crushing of soil depths, lumps and crusts, leveling and compaction of the soil surface layer. To do this, used a mounted tool, as a field roller KTR 30.

Measures to care for crops were aimed at forming a stable grassland. That is why over the next five years, the sowing of grasses on bare areas and watering on drying soils is planned.

CONCLUSION

Scientific and organizational principles of recultivation of disturbed lands are aimed at shaping the landscape in accordance with the purpose of the land and socio-economic feasibility. Restoration of disturbed lands and their subsequent use in the economy is focused on the observance of ecological balance, ensuring harmlessness to the natural environment and preservation of local aesthetic values.

Sludge storage of LLC "OCEAN SHIPBUILDING PLANT" is designed for storage and temporary storage of industrial waste of galvanic, electrode and acetylene production. The waste disposal site is located in the south-eastern part of the territory of LLC "OCEAN SHIPBUILDING PLANT". The 210 × 51 m site is surrounded by a barbed wire fence. There are 2 hollows for storage and temporary storage of industrial waste measuring 36 × 42 m (1512 m^2) and 60 × 42 m (2520 m^2). A trapezoidal embankment made of soil with bases of 3000 mm and 500 mm and a height of 1000 mm was made along the perimeter of the pits. The separation of industrial waste storage pits is based on the annual volume of waste and its chemical composition.

The analysis of the factors of the impact of the waste disposal site on the natural environment is assessed as acceptable. The negative impact of local soil contamination was determined within the industrial site. To reduce the negative impact on the geological environment, flora and fauna, it is advisable to implement protective, protective, compensatory, restorative and other design solutions.

Project measures for recultivation of disturbed lands of sludge storage LLC "OCEAN SHIPBUILDING PLANT" are developed in accordance with the norms and rules of environmental protection and environmental safety requirements at all stages of its implementation. The mining stage involves planning the surface of the hollows with a volume of 1260 and 756 m^3, laying the slopes, wrapping the remnants of the embankment. The biological stage includes a set of agrotechnical and phytomeliorative measures aimed at improving agrophysical, agrochemical, biochemical and other soil properties for 5 years. Sow the surface of the cover with lawn grass.

The scientific novelty of the obtained results of the research is as follows: for the first time proposals have been put forward for the development of scientific and organizational measures for the recultivation of disturbed lands of the sludge storage of LLC "OCEAN SHIPBUILDING PLANT". The practical significance of the obtained results is the implementation of the use of recultivation lands of the sludge storage of LLC "OCEAN SHIPBUILDING PLANT".

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The book is written for scientists, lecturers, postgraduate students, engineers and students who specialize in the field of environmental researches.
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