Justification of environmental technologies and means for dust control of tailing dumps surfaces of hydrometallurgical production and concentrating plants

V. I. Lyashenko

Cand Sci. (Tehn.)
SE «Ukrainian scientific–research and design–prospecting Institute of industrial technology», Zheltye Vody, Ukraine
E-mail: vi_lyashenko@mail.ru

A. A. Gurin

Doctor Sci.(Tehn.)
GVUS «Kryvyi Rih National University», Krivoy Rog, Ukraine
E-mail: raop35@gmail.com

F. F. Topolniy

Doctor Sci.(Biolog.)
GVUS«Central Ukrainian National Technical University» Kropivnizkij, Ukraine,
E-mail: topolniy@gmail.com

N. A. Taran

Academy of Mining Sciences,
Krivoy Rog, Ukraine
E-mail: taran230452@mail.ru

Abstract
Objective of paper consists in research and development of environmental technologies and means of dust control of tailing dumps surfaces of hydrometallurgical production and concentration plants by binding tailings with lime and securing dusting surfaces with chemical substances, biological hydraulic fluids and biological reclamation.An analysis of previous studies and test observations, mathematic and physical simulation on wind tunnel model, analysis and statistical processing of the results, the establishment of dependencies, performing the calculations and studies, ex-experimental investigations in gutterways with tailings, field measurements on the surface of the tailing dumps and their zone of influence according to standard procedures are carried out.
The most effective way for fixing the biological dusty surfaces of MMP tailings with soil mixtures consisting of water, fertilizer, grass seed, hydrolyzed polyacrylonitrile and mulching additives (clay, ashes from combined heat and power plants, rasping) is recommended. Biological reclamation of waste tailing dumps of Krivbass MPP by sowing seeds of mock cypress on the black soil will prevent tailings dust blowing after 4 -5 months and subsequently ensure active growth of weeds, which seeds are in sufficient amount in black soil.
Scientific novelty. On the basis of the results of laboratory and industrial experiments for securing tailings, the environmental technologies and means of dust suppression of dry beaches by binding the tailings to the total weight with lime, as well as securing the dusty surfaces of existing tailing dump with chemicals; soil mixtures in the form of pellets; with specially prepared composition containing the solution with the addition of ingredients such as clay, black soil, dust, lignosulfonates, water, fertilizers, seeds, and biological reclamation of waste tailing dumps of Krivbass MPP by sowing seeds are described.
The developed technologies, tools and methods for controlling dusting on operating and dormant tailing dumps will reduce the levels of air pollution of the working area with dust, improve the working conditions of staff and the environment in the areas of waste storage of hydrometallurgical processing of ores.
Key words: TAILINGS, DUST SUPPRESSION, LIME, CHEMICALS, BIOLOGICAL SLURRY, BIOLOGICAL RECLAMATION

Relevance of the problem

According to the method of tailing laying, three types of tailing dumps are reconsidered by the current regulatory documents: aggradational, pouring and combined. In case of aggradational tailing dumps, the main part of the enclosing dam is washed from recycled ore material. When pouring ones, the dam is built from imported or inert local materials, and the pulp is poured into the formed pond. An analysis of the world practice of existing trends in handling with wastes from ore processing shows that a promising way of creating tailings is a combined one, in which processing wastes are placed in a specially equipped natural hole with a fencing dam, part of which is built of inert soils, and the other part is poured from the processed ore material in a mixture with the binder. Technologies of dust control at existing tailing dumps are implemented by introducing bounding elements into the flow of pulp and binding tailings throughout the mass. The results of laboratory studies and industrial experiments on fixing tailings with water-soluble structure-forming polymers based on polyacrylamide and polyacrylnitrite has shown that their use is limited by high cost and scarcity [1, 2]. The fight against deflation of dust from the surface of the tailing dumps is insufficiently effective due to the lack of technologies and means of dust suppression. Therefore, the research and development of environmental technologies and dust suppression means of the tailing dumps surfaces of hydrometallurgical production and concentrating mills due to binding of tailings with lime, and also fixing of dusting surfaces with chemical substances, biological hydromixtures and biological reclamation are the important scientific and practical tasks that require an immediate solution [3, 4].

Research Methods

Research methods include analysis of previously performed studies and control observations, mathematic and physical simulation in the aerodynamic model, analysis and statistical processing of results, determination of dependencies, performance of calculations and justifications, experimental studies in gutterways with tailings, actual measurements on surface of tailing dumps and in zone of their influence according to standard methods.

Discussion of research results

General characteristics of MMP tailing dumps. The alternately multi-storey lavage of tailings, from dams along the perimeter of the entire tailings pond are used there. The release of the pulp can be both underwater and above water. At such storage, the most part of the washed tailings is under water. However, both in the process of reclamation, and after the end of storage, dehydrated areas are formed in the tailing dumps (ash pond beach), which are in this state for several months a year. Ash pond beach (slightly inclined plane towards the tailing pond) is formed along the entire perimeter of the tailing dump. The width of this plane depends on the method used for storing tailings and ranges from 100 to 500 m. There is an experience of pond-based tailings washing, in which the tailing dump is divided into sections (ponds) separated from the main by separating dams. The pulp release is performed in one of the sections of the pond and is piled in layers, after which the outlet nozzles in this section are overlapped, and the next section is included in the work. When the height of the layer of design marks is reached, the aggradation stops, the pond stops for "sedimentation", the duration of which depends on the size, the number of ponds on the tailing dump and the intensity of the storage process and it is 1.5-2 years. Thus, there are dehydrated areas on the existing tailing dumps (above-water ash pond beaches, ponds areas, the external sidings of dams and dikes which are in sedimentation) are an intense source of dust formation. They are in this state for several months a year. In the summer period, the surface is heated to 80 °C and the dry layer reaches 30-50 cm. Dry tails are a loosely sandy material, between the particles of which there are no stable bonds. The content of dust particles $C \leq 0.07$mm is more than 65%, and particles of the fraction $\geq$ mm - up to 25%.

Thus, since the beginning of operation of Zheltorechenskiy iron (1895) and uranium (1951) deposits (Ukraine), two new open-cuts such as "Gabaevsky" and "Veseloivanovsky", four tailing dumps, depleted pit of limonite (DPL); "Shcherbakovskaya" (Figure 1); "Razberi" and "Ternovskaya" cloughs as well as the pitcrater of the funnel as a result of underground mining of iron ore deposit systems with forced ore and host rocks caving have been formed. The ore mining in mines and open-cuts has led to the formation of dumps of gangue and off-balance, in terms of content of useful components, ores and disturbance of fertile lands, which are now partially reclaimed (Fig. 2).

Figure 1. General view of tailing dump for storage of products of hydrometallurgical ore processing (picture)

Figure 2. Mining and technical reclamation at the tailings dump of the DPL, Zheltye Vody (picture)

Investigation of MMP tailings secured with lime

To determine the wind erosion resistance, tailing samples fixed with lime were blown in a wind tunnel at an air flow rate of up to 15-16 m/s with air sampling for dust content. It is established that the protection factor, i.e. the ratio of the compressive strength of fixed and loose samples should be in the range of 4.0-5.0. In addition to wind erosion resistance, shear indicators were determined; they characterize the stability of dams and dikes in the water-saturated state aggradated from the tailings, as well as the water resistance of the samples and the acidity of the pulp. The tailings selected for the tailing dump were mixed with water in the ratio of solid (S) to liquid (L) S:L= =1:3 [5, 6]. Lime was introduced into the pulp in an amount of 2 to 10% (by weight) with respect to the solid. The pulp was stirred for 20-30 min, after deposition of the tailings water was poured. Dehydrated tailings were laid in detachable forms of cubes with the size of the sides of 7 cm for testing them for uniaxial compression and water resistance; in pallets with 40×30×5 cm dimensions – for investigation of wind erosion resistance; samples for a shear test were cut with the help of cutting cylinders. Shear characteristics of the samples in the water-saturated state were determined with GGP-30 device by standard methods. Water resistance was evaluated by the time of destruction of the sample placed in water. Ionomer EV-74 was used to determine the pH of the pulp. To study under laboratory conditions, calcium quicklime was used [7, 8]. The time of lime slacking was 14 minutes (Table 1).

Table 1. Results of laboratory studies of MMP tailings fasten with lime

Lime content in the tailings	Indicators					
	Compressive strength, 10^5 Pa	Protection factor, unit	Coefficient of internal friction, unit	Adhesion, 10^5 Pa	Water resistance, fractions of units	pH of mixture, unit
0,0 (control)	0.25	1.00	0.505	0.014	0.01	7.8
2.0	0.68	2.75	0.510	0.016	0.60	11.1
4.0	1.25	5.00	0.520	0.016	1.43	12.2
6.0	3.84	15.36	0.530	0.017	2,40	12.3
8.0	3.96	15.84	0.550	0.018	For 24 hours, no damage occurred	12.6
10.0	4.05	16.20	0.55	0.018	Same	12.8

The strength of the samples intensively rises with increasing the lime content in the tailings to 6.0 %, and the protection coefficient increases from 5.0 to 15.3 with the content of lime 4 and 6%, respectively. Lime additives improve the performance indicators, but they reduce the useful volume of tailings. Therefore, considering the necessity of obtaining the strength of stored tailings ensuring their stability of wind erosion (not maximum), the optimum lime additive can be taken in the amount of 4.0-5.0% of the solid mass in the pulp. However, with this lime content, recycled water obtained under laboratory conditions has an alkaline reaction. At the existing tailing dumps, where large volumes of water are accumulated in sedimentation ponds and are diluted with rain, flood and technical waters, the pulp aggrade with lime is not supposed to carried out continuously, but only to the upper layer up to 10 cm, then the water acidity in the sedimentation pond will be close to neutral. Shear tests have shown that lime additives do not deteriorate the strength properties of the tailings massif in the wet state, but rather improve these indicators [9].

In the experiments with lime from the equipment of the experimental testing site, a pulp discharge section was used on the ash pond beach. Entering lime in the pulp was carried out directly at the plant.

The lime was injected into the pulp directly at the factory. It was not possible to control the amount of lime injected into the pulp, therefore, control over the amount of lime in the pulp was carried out by maintaining the concentration of hydrogen ions with pH was equal to 12 or more, because this corresponds to a consumption of 50 kg of lime per 1000 kg of tailings, i.e. 5% to the content of lime. Control over the pH content of the pulp was carried out both at the plant and at its discharge to the ash pond beach. The range of pulp transportation from the plant to its discharge on the beach was about 13 km [10]. In the initial pulp, it was not possible to maintain the design alkalinity, and consequently, the percentage content of lime in the pulp (Table 2).

Table 2. pH value of pulp with lime additive (in units)

Name of indicators	Sampling time, h									
	8-00	9-00	10-00	10-30	11-00	11-30	12-00	12-30	13-00	13-30
pH at the plant	8.2	21.6	11.8	11.7	12.0	11.8	12.0	11.7	7.9	7.8
pH at release	-	-	8.18	8.62	9.36	10.09	9.88	9.16	10.92	10.89

Preliminary, the beach of the pilot site was divided into squares with a side of 30 m, in the center of which the measuring bars were hammered, with the help of which the height of the aggraded layer was determined. The beach aggradation of the experimental site lasted three hours. At the same time, 60 tons of lime were expended and about 1,400 tons of tailings were laid [11]. To determine the efficiency of fixing agents introduced into the flow of pulp, an experimental test site was constructed at the existing tailings dump, which consisted of:

- the point of preparation of aqueous solutions of fixing agents including a tank with a capacity of 20 m^3 to which water is supplied and a stirrer;
- the point of introduction of water solutions of fixing agent in the flow of pulp equipped with a pump and a liquid meter;
- the pulp discharge area to the ash pond beach, which includes 10 outlet nozzles with a diameter of 100 mm on both sides equipped with valves.

To determine the compressive strength and shear tests, the pulp was collected (averaged sample), and sampling was carried out after stabilization of the surface (Table 3).

Table 3. Test results for tailing samples with lime

Test sample	Compressive strength, 10^5 Pa	Coefficient of internal friction, units.	Adhesion, 105 Pa
Tailings without lime at the time of discharge	0.27	0.52	0.13
Tailings with lime at the time of discharge	3.83	0.53	0.17
Tailing samples selected on the ash pond beach	1.76	0.53	0.17

Inspection of surface of ash beach in the experimental section showed that the thickness of the coating tailings layer with lime was non-uniform and ranged from 0 to 5 cm. Analysis of aqueous extracts of tailing samples selected in the area of experimental plot after the surface stabilization showed that the pH varied from 8 to 10. The strength of the samples with lime made from the pulp collected at the time of dumping is 2 times higher than the samples taken at the ash pond beach after stabilization of the surface (2 weeks after the aggradation). Less strength and alkalinity of the samples sampled at the ash pond beach is due to the fact that part of the lime, together with the water has moved to the tailings pond due to the steep slopes of the beach. Observations of the experimental site at the existing tailing dump during the autumn-winter period has shown that, at positive temperatures, tails with 5% lime additive to the pulp do not dust, and at negative temperatures, the freezing of moisture breaks the structural bonds leading to wind erosion [12].

Study of the most effective fixing agents

For this purpose, experiments were conducted to determine the specific dust blowing treated with various fixing compounds in gutterways placed inside the wind tunnel. The blowing time is experimentally chosen equal to 30 minutes. For the same reason, the airflow velocity in the pipe is chosen equal to 15 m/s, because at a lower velocity, the dust blowing after fixing with the test compounds was insignificant. To collect dust, analytical filters AFA-VP-20-1 with a working surface area equal to 20 cm^2 were used. They were installed in the allonge IRA-20. Considering allowable load on filter by air equal to 7 l/min-cm^2, blowers performance of 120 l/min was accepted for each filter. The dose of dust by weight on the filter was defined as the difference between the weight of the filter before and after blowing in the wind tunnel. At the same time, a correction was made taking into account the weight of dust introduced from the surrounding atmosphere, which corresponded to the dose of dust by weight on the filter installed in the control allonge in front of the cuvette.

The filters were weighed on the equiprobable laboratory balance of the second class of the VLR-200g-M model (factory No. A-95, having the verification certificate No. 44/02), with samplings taken with an accuracy of 0.05 mg with the help of indexing apparatus. In this case, the largest weighing error in absolute magnitude did not exceed 0.1 mg. Before each weighing, the filters were kept for 24 hours in a desiccator with dried silica gel to remove moisture from them. Bischofite, polyacrylamide, and hydrolyzed polyacrylonitrile possessing bounding, gluing and water-retaining properties, lignosulphonates (hereinafter LST) were used to study the fixing capacity of chemical substances. This is a by-product of the production of sulphate cellulose, which is used as fertilizers, soil formers, anti-erosion agents, dust-removing materials for the treatment of dusty road surfaces. LTS with a solids content of 43-52% is a homogeneous, bounding viscous liquid of a dark brown color. The density is 1.17-1.24 g /cm^3; pH – 20; the mass fraction of transported substances is 0.3-1.0%. LST is a high-molecular substance of natural origin with a wide range of molecular masses (2000-10000). The average elementary composition (%): C - 53-56; H-5-6; Na = 0-8; Ca-0-6 (the content of nitrogen, sodium, calcium depends on the acid base used). The bounding properties of LST were verified visually. On the surface of the crushed rock (5 mm fraction), a 5% solution of LST was applied by spraying. After drying, when the surface slope of 45-60º, flowability of the tailings was not observed. The structural capacity of the LST was determined by the water resistance of units artificially formed from the crushed rock. The share of LST application was 0.05; 0.1; 0.5; 1.0 % to the mass of the tailings. Experiments have shown that the use of LST is effective at a dose of more than 0.5% of the soil mass. The experiments were carried out to determine the effect of LST on the germination of seeds used for the biological fixation of dusting surfaces. The action of the LST was tested on lawn grass and esparcet in the presence of fertilizers such as florax and nitroammophos. 100 g of seeds were placed in a special bowl and they were wetted with a solution of LST concentrations of 0.5 and 1.0 % (Table 4).

Table 4. Effect of LST on seed germination

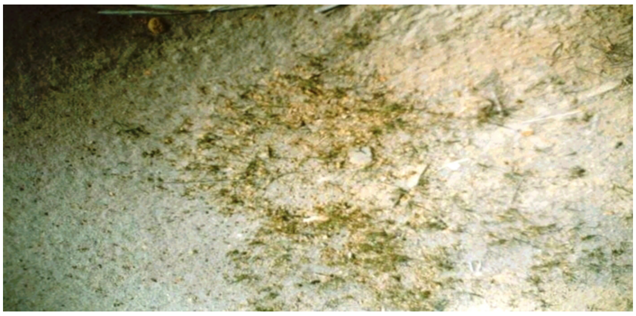
LST concentration, %	Germination, %	
	lawn grass	esparcet
0.0	82	48
0.5	80	32
1.0	76	34

For biological bounding, vegetation experiments were carried out in special tanks with an area of 0.12 m^2, where the tailings of the MMP were placed from the tailing dump. Similar experiments were conducted with LST, hydrolyzed polyacrylonitrile and bishophyte. Hydrolyzed polyacrylonitrile is a pasty viscous mass of liquid glass color obtained by saponification of dry and wet waste of nitro-new fiber with a solution of technical sodium hydroxide. The ratio of weight of hydrolyzed polyacrylonitrile and water was selected under laboratory conditions and was 1:20. According to its physical and chemical properties, the aqueous solution of natural bischofite (hereinafter bischofite) must comply with the norms of TU.U.22.52511.003-97. There is a toxic-hygienic passport for bischofite solution (TU.U.22529511.008-2001). The action of hydrolyzed polyacrylonitrile on the germination of plant seeds used for the biological fixation of dusting surfaces is similar to the LST. After carrying out laboratory studies and selecting the most effective ways of chemical fixation of the dusting surfaces, research should be carried out using special cuvettes located under the open sky.

The industrial experiment was carried out directly on the southern part of the existing tailing dump. At the polygon, which includes 10 sections with size of 2.0 x 1.0 m, three methods of fastening were tested: chemical; with soil mixes in the form of pellets; soil mixtures in the form of a specially prepared solution (Fig. 3).

Studies have shown that for short-term fixation of tailings surface in dry weather binders based on hydrolyzed polyacrylonitrile, lignosulfanate, polyacrylamide can be used. The biological method for fixing the dusting surfaces of the existing and mothball tailings of the MMP is to lay the fixing material in the form of a clay solution with additives of ingredients such as clay, chernozem, sawdust, lignosulfonates or hydrolyzed polyacrylonitrile, water, fertilizers, plant seeds. Consumption is 12-15 liters per 1 m^2. Thus, reducing the level of air contamination of the working area with dust allows improving the working conditions of personnel during the operation of tailing dumps.

a)



b)

Figure 3. Polygon for dusty surfaces securing (photo: general view): a - polygon; b - site on the tailing dump secured by a biological method (soil mixes)

Pollution around tailing dumps requires the implementation of environment protection measures. Thus, it is advisable to plant the territory of the sanitary protection zone (hereinafter SPZ) by planting trees and bushes that are resistant to increased gas and dust contamination, which are natural sorbents (horse chestnut, maple ash, poplar pyramids, large-leaved larch, oak, birch warty and bushes - common lilac, scumia, spirea Bumalda, honeysuckle plain and ornamental plants - rose, spruce and others) [5]. It is also planned to create protective forest belts along the transport routes (road and rail). And in areas where the level of pollution exceeds the permissible values, it is necessary to transform them into industrial crops, to forbid fishing, bathing and other activities in water bodies with a possible excess of the MRL of pollutants and conducting more detailed study of the availability of pollution in environmental facilities in adjacent areas to tailing dumps and the degree of impact on the environment and human beings.

Direction of further research

The biological recultivation by various species of herbaceous plants is most acceptable for dry mothball tailing dumps of MCP in Kryvbas. So, employees of the Krivoy Rog Botanical Gardens (Ukraine) recommend the following perennial plants for fastening dry and dusty sections of the tailing dumps: the Black Sea grub, the lumpy bushy, the elongated wheat grass. A prerequisite for the creation of a grass cover from these gramen is the introducing of large doses of mineral fertilizers (ammonium nitrate, superphosphate, potassium salt, etc.) into the tailings, both during sowing and periodically 2-3 years later, which requires constant care for plants and significantly increases the cost of reclamation [13]. Studies conducted by the Krivoy Rog National University have shown that the density of overgrowing and the biomass of wild plants is 3-6 times less than that of the mock cypress. However, they can be successfully applied for biological reclamation of dusting surfaces (Fig. 4).

Figure 4. General view of the experimental section after 4 months of sowing of plants (photo): 1 - a section of black soil seeded with mock cypress; 2-self-growth of black soil by wild plants; 3-section of clay sowed with mock cypress; 4-tailings

Germination of sowing clover and sowing alfalfa sown on black soil for a four-month observation period was detected in small quantities. Seedlings of sown seeds were not observed in the sections of the tailings dump covered with clay. Clay is considered a conventionally fertile substrate due to the lack of humus. Under these conditions, the process of self-growth occurs with some species of weeds in cracks or meadows for 5-10 years. On the uncovered by substrate section of the tailing dumps, overgrowth by sown and wild plants did not occur during the observation period [15].

Mock cypress is an annual dicotyledonous herbaceous plant 15-150 cm high, green, blushing under autumn, strongly branchy. The inflorescence is fuzzy, but spicate. Flowers 1-2 in the bosom of the bracts are inconspicuous. It blooms in July-August period. It grows on salt marshes, sands, as a weed in gardens, vegetable gardens, along roads and garbage areas, at an altitude of 1000 m above sea level, alone or in groups. Mock cypress is a forage and environmentally friendly plant. It is characterized by the shortest period of vegetation, a high yield of seeds, a deep bedding of the root system, which is required for accelerated fixation of the dusty surface of the tailing dumps. Mock cypress provides the growth over the black soil after 3-4 months. To create a vegetation cover, it is advisable to use other weed plants that are found in black soil or are provided on experimental areas by natural means - animals, water and wind. The proposed technology of reclamation of dusting surfaces will allow us to return land of tailing dumps for economic use within 2-3 years.

Continuing observations of the experimental areas in 2015-2016, the authors found that there was a disappearance of the mock cypress on the black soil, and its place was taken by the plants of the deervetch (babies'-slippers, bean seeds) (Fig. 5). Perennial from 30 to 60 cm in height blooms in May and September in meadows and grassy slopes throughout Ukraine usually in the south it is a little bit rarer. The time of the babies'-slippers and the vegetation blooming begins in May providing complete state support in the vegetation cover of the black soil of the site. Coverage is 70-80%. Plants that had time to occupy the site for the experiment did not allow the germination of the mock cypress at the end of July or beginning of August. The plant repeatedly bearing during the vegetative period provided itself with a vast territory and further spread.

Studies have shown that the density of overgrowing and the biomass of the wild plants of deervetch are in no way inferior in density to the standing of the mock cypress plants, the degree of sheltering is 0.9 (Fig. 5a). As we can see, there was a succession phenomenon, when one kind of plant replaced another. It is necessary to pay attention to the appearance of the sinuses of gum plants, which in recent years has captured space in the experimental plot. This is an experimental species that occupies the steppe regions of the central part of Ukraine. Among the thickets of the deervetch, there are small patches of bilberry (Asteraceae seeds), Sophia feather geranium (cruciferous seeds), pig weed (goosefoot family seeds) and single mullein plants scepeter-like (Noricum seeds), Acanthoid tubercle (Asteraceae seeds) (Fig. 5, b). The listed species are potential participants of the successions on the experimental site (see Fig. 5, c). The narrow-leaved hawk and shrubs began to take root spontaneously (see Fig. 5, d) in addition to herbaceous plants in the area covered with black soil.

a) b)

c) d)

Figure 5. Biological recultivation by various species of herbaceous plants for dry mothballed tailing dumps (photo of the general view of the experimental site): a - density of overgrowing and biomass of wild plants of deervetch; b,c - in the spots of absinth sage, Sophia feather geranium, pig weed, single plants of mullein scepeter-like and Acanthoid tubercle; d - plot covered with black soil with narrow-leaved hawk and shrubs

At the tailings sites covered with clay, the development of vegetation is much poorer. The rare shrubs of Austrian wormwood (Asteraceae seeds), Tataria's spurge (Asteraceae seeds), cotton thistle (Asteraceae seeds) begin to secure against the backdrop of the open clay sites, rare and absinth sage (Asteraceae seeds), bed of rushes is coming out of clay (gramineous seeds). The huge thickets (dry wood) of white sweet clover reaching 1.5-1.8 cm (beans seeds) and mosaic spots of dry plants of wild oat grass (an annual one) (seeds of mints) appeared. Shoots of oat grass in early spring will provide coverage of experimental sites for the whole summer. Occasionally, there are spreadings of pink sockeye and branching larkspur [14]. On a site of tailing dump, which was uncovered by the substrate, the grooving over of wild plants during the observation period did not occur except for the single urban reeds that come from under the stones and its roots go deep into the aquifers of rock formations. Thus, the introduction of the developed technologies, means and methods of dust control on existing and mothballed tailing dumps will allow us to reduce the air pollution levels of the working area with dust, improve the working conditions of personnel, the environmental situation in the waste storage areas of hydrometallurgical processing of ores, iron ore mining and processing enterprises of Krivbass [15- 17].

Conclusions

1. The chemical fixation of the dusting surface consisted in processing the surface of the site on the tailings dump with chemicals. Water-soluble polymers exhibit stabilizing properties when kept in soils $10^{-2}\ldots10^{-1}$ weight %. The ratio of solid to liquid in the initial pulp varied from 1 to 5. The content of binders (polymers) with respect to water was 0.5% of polyacrimide and 2% of hydrolyzed polyacrylonitrile and lignosulphonates. The solution consumption was 5-6 liters per 1 m^2 of the surface, it was adjusted taking into account small fixed areas. The sites fixed by hydrolyzed polyacrylonitrile, polyacrylamide and lignosulphonates have not confirmed the effectiveness and cannot be recommended as fixing agents.

2. The fixation of dusting surfaces with soil-mixes in the form of pellets consisted in laying the fixing material in the form of spherical pellets along a dusty surface, these pellets were made of clay, straw (reed), wood sawdust, fastening additives (hydrolyzed polyacrylonitrile, lignosulphonates) and water at the following ratio of ingredients, weights, %: clay - 68-75; crushed straw, reeds or sawdust - 3-8; lignosulphonates or hydrolyzed polyacrylonitrile - 0,3-1; seeds of plants, water - the rest. Consumption is 8-10 kg pellets per 1 m^2. Straw or reeds were cut to pieces up to 2 cm long, sawdust sieved through 1 cm sieve. Consumption was up to 10 kg per 1 m^2 of surface.

3. Securing of dusty surfaces with a specially prepared compound consists of the laying of the securing material in the form of a clay solution with additives of ingredients. Clay, black earth, sawdust, lignosulphonates or hydrolyzed polyacrylonitrile, water, fertilizers, plant seeds were used as ingredients. Consumption was 12-15 liters per 1 m^2 of surface.

4.The most effective biological method for fixing the dusting surfaces of the MMP tailing dump with soil-mixes consisting of water, fertilizer, grass seeds, hydrolyzed polyacrylonitrile and mulching additives (clay and sawdust); water, fertilizer, seeds of grasses, hydrolyzed polyacrylonitrile and mulching additives (clay, TPP ash and sawdust) was recommended.

5. It is established that the phenomenon of succession occurs in the place covered with black soil. This gives grounds to believe that the process of restoring the natural habitat, inherent in the steppe conditions is gaining strength and proves that the natural environment helps the reconstruction of biotones. The development of the artificial ecotone took place in the fourth year of the experiment, although at other tailing dumps the succession process was observed after 10 to 30 years without pouring the black soil. It has a large number of weeds seeding and is a powerful source of plant groupings including woody shrubs.

6. It is shown that the biological reclamation of the tailing dumps of iron ore mines of Kryvbas must be started by sowing the seeds of the mock cypress to the black soil in April-May for the conditions of the central part of Ukraine, which due to its intensive growth will prevent the tailings dust from blowing after 4-5 months and subsequently ensure the active growth of sorbents, the seeds of which are in sufficient quantity in the black soil. After 3-4 years, the reclaimed land can be returned for economic use.

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