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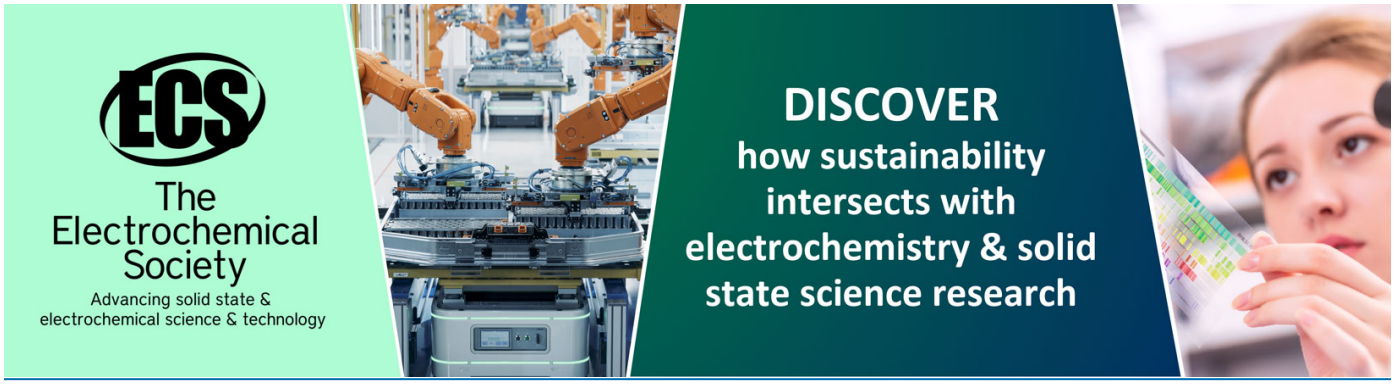

The use of non-toxic technogenic and natural materials to ensure the stability of disturbed ecosystems

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Abstract. Experimental field tests of the developed technology of the disturbed lands restoration with use of preliminary neutralization of the soil polluted with slurry alkaline waters are carried out. Various technological solutions for the use of substrates made of non-toxic technogenic and natural materials were studied. It was found that the use of combined soil treatment with a neutralizer, followed by the introduction of overburden quarry sand and silt from the treatment facilities of 5-year storage as the main component of the soil substrate led to a decrease in pH to the normalized value and the restoration of agrochemical properties of the soil. The ecological and toxicological assessment of the soil taken from the recultivated experimental area confirmed the absence of toxicity of the investigated substrates and their application ensured the stability of the ecosystem in the area of the operating industrial enterprise.

1. Introduction

Pollution causes irreversible destruction of ecological systems, affects the global physical and chemical parameters of the environment, as a result of this pollution there is a loss of fertile lands and the productivity of ecological systems and the biosphere as a whole decrease [1]. During the operation of the sludge storage of alumina production, emergency situations were noted, which led to breakthroughs of dams and filling of sludge waters to the surrounding areas, which adversely affected the state of the soil, while there may be "necrosis" and "salinization" of the soil. In this regard, to reduce the anthropogenic impact on natural complexes and agroecological systems in the conditions of technogenesis, it is necessary to develop a set of technical measures for the restoration of disturbed lands [2,3].One of the options for the restoration of disturbed lands is the implementation of technical measures of ecological engineering using sources of natural and technogenic origin for the preparation of substrates, which will help not only to increase soil fertility, but also to return at least partially removed elements in the biological cycle of substances [4,5].

The development of technology for production of the substrate required for the preparation of potentially fertile soil for the remediation of polluted sites in the area of sludge storage.

2. Obtained result

As objects of research, soil samples were taken from individual experimental sites of the disturbed lands adjacent to the sludge storage of JSC RUSAL Achinsk. The territory of the district near the

sludge storage is occupied by floodplain meadows, bushes, forest plantations and partly swamped. The areas of the territory located on the higher part are covered with deciduous trees on a small area. Soils in areas in the lowlands around the silo are saline and latched in places as a result of technogenicimpact of sub-sludge waters (figure.1).

Figure 1. The formation of "alkaline" cover in the control area (May, 2018).

Taking into account the formation of potassium-sodium alkaline crust after the spill of submerged water, during the experimental field tests, preliminary neutralization of soil contaminated with alkaline water by various reagents: dilute sulfuric acid, ammonium sulfate, gypsum was made [2, 6, 7]. Measurements data of water extraction of soil samples pH are given in table 1.

Table 1. Change in pH of water extraction of soil samples after neutralization with chemical reagents.

No	The name of the soil and land	pH of aqueous extract of soil samples at the sampling date					
		2017 year			2018 year		
		05.08	10.09	12.02	18.04	25.06	01.10
1.	Control area with contaminated soil	10,1	9,82	10,41	10,47	10,24	10,07
2.	Experimental area № 1 after neutralization with gypsum	9,25	9,56	9,98	9,73	8,64	8,35
3.	Experimental area № 2 after neutralization with sulfuric acid	9,2	9,08	9,02	8,86	8,82	8,79
4.	Experimental area № 3 after neutralization with ammonium sulphate	8,85	8,38	8,26	8,23	8,31	8,12

Monitoring studies of pH of aqueous extract from soil samples with potentially fertile soil layer after neutralization with chemical reagents (table.1) showed that the most effective neutralizer is ammonium sulfate.After neutralizing the soil with ammonium sulfate in the amount of 200g /m^2 (sample №3), the index decreased from 9.82 (10.07.2017) to 8.31 units (25.06.2018). The observed tendency to decrease the pH of the soil layer after ammonium sulfate neutralization remained in the following periods of soil pH control.So, on October 1, 2018, the pH of the aqueous extract of soil samples from the experimental plot №3 is already 8,12 units. Dynamics of change in pH of soil samples after neutralization with ammonium sulphate showed that this technique is quite effective and easy to implement.

After the neutralization of the soil for the development and testing of technology for the restoration of disturbed lands, substrates were prepared using overburden quarry sand in the floodplain of the Chulym River. Overburden rock was a soil-plant black soil layer with underlying yellow-brown loam, which performed very important functions to preserve the environment of plant life.Increasing the area of this layer in the restoration process of disturbed land part of the natural environment can be returned to its natural state. Floodplain soils are widespread in the floodplain of the Chulym River.Soil and plant soil, located in the quarries area sand extraction, has the properties of a fertile layer. The approximate volume of the placed fertile layer of overburden rock in the quarry of sand extraction in the floodplain of the Chulym River according to JSC "Dolomit" is 300 thousand m^3.

In order to avoid the formation of an alkaline crust in the second stage of industrial tests, the technology of applying substrates to the contaminated soil was changed and the soil surface of the experimental area was initially harrowed, followed by the components application of the fertile substrate to it.The analysis showed the prospects of this technique for its application in the technology of recultivation of contaminated areas in the area of sludge storage of alumina production. Based on the laboratory studies of the vegetation the most effective mixture of perennial grasses have been pre-determined, which was used at the experimental-industrial tests: - kentucky bluegrass - 40%, timothy-grass - 40%, white clover - 20%.

After neutralization with ammonium sulphate contaminated soil in the control area and the subsequent changes overburdenrock to it, extraction of sand layer not less than 20cm in 10-15 days there are sustainable seedlings sown perennial grasses on its surface (figure.2).

Figure 2. Germination of grass covers on experimental areas after neutralization with ammonium sulfate and introduction of overburden sand mining (July 2018).

The data of agrochemical and chemical-toxicological analysis of the substrates prepared according to the proposed formulation for the experimental areas indicate the suitability for use in the sanitation of the sludge storage area of the proposed mixtures. In the chemical-toxicological analysis of the proposed mixtures, excess of the maximum permissible concentrations of cadmium, lead, magnesium, copper, manganese and fluorine was not found.The concentration in the studied samples is much lower than the standards. As the analysis showed in the proposed mixtures the content of exchange aluminum is insignificant: less than 0.05 mmol/100 g of soil.

The productivity of plants in the experimental areas was relatively low (1.2 kg/m^2), which may be due to the late sowing period, but at the same time in these areas there was almost no weed vegetation.

3. Conclusion

Thus, the recultivation technology of disturbed lands in the areas located in the area adjacent to the sludge storage of JSC "RUSAL Achinsk" should consist of the following stages:

- drainage and drainage of water from the areas, lowering the level of groundwater and pumping water into the channel to intercept drainage water;
- ammonium sulfate neutralization of contaminated soil in recultivated areas;
- harrowing of neutralized soil;
- delivery and uniform distribution of overburden sand extraction layer of at least 20 cm and harrowing substrate;
- sowing a mixture of perennial grasses.

To increase the content of humus in the fertile layer at the stage of the biological stage of recultivation, it is recommended to introduce additional silt into the soil from the treatment facilities (5-year aging) – a layer of at least 15 cm with subsequent harrowing.Agrochemical and ecological-toxicological assessment of soil taken from the recultivated experimental area confirmed thetoxicity absence of the studied substrates and the effectiveness of the proposed restoration technology of disturbed lands to ensure the stability of the ecosystem in the area of the existing industrial enterprise.

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