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RECULTIVATION PROCEDURE OF FLOTATION TAILINGS AT THE LOCATION OF RTH IN BOR

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ABSTRACT – The RTH flotation tailings in Bor represents a critical environmental issue due to prolonged exploitation and inadequate closure of mineral processing facilities. This paper presents an integrated approach for the technical and biological reclamation of the RTH tailings, relying on field experience, comparative regional cases, and practical planning measures. A phased plan is proposed which includes surface profiling, application of cover soil, and long-term revegetation using native and tolerant plant species. The goal is to reduce environmental risks, stabilize the terrain, and create a functional green landscape.

Keywords: Flotation Tailings, RTH, Reclamation, Ecological Restoration, Bor, Soil Rehabilitation, Recultivation, Degraded areas, Phases, Species.

INTRODUCTION

Mining activity has considerably increased due to notable population growth and worldwide demand for mineral resources [1]. This increase coincides with a new awareness in which environmental concerns have become a growing challenge for all of the agents within the sector [2-3]. The social demand has increased for the sustainable development of all of the activities related to mining, particularly the adequate management of waste products during each phase of the mining process, including prospection and exploration, development, extraction, transport and treatment of product obtained, etc. [4]. The mining process generates a large quantity of residues that must be strategically treated and managed to combine economic efficiency with demands for environmental sustainability. Energy requirements, environmental and human health risks, demands on water resources, and the required technology must all be taken into account [5].

One of the greatest environmental problems caused by the mining and refinement of strategic elements, is the problem of waste management. This becomes a problem when mines and refineries that do not adhere to regulations regarding proper waste disposal.

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This can result in soil and water contamination by substances such as heavy metals and radioactive materials. This affects the ecosystem around the waste disposal site; and, if the contaminants get into the water table, it can affect areas beyond the site.

Improper waste disposal is often the largest of mine and refinery pollution Waste is generally categorized into two different types: tailings and waste rock stockpiles. Tailings have the most damage potential because they tend to be composed of smaller, finely milled particles, whereas waste rock stockpiles are made up of coarser particles, which are not absorbed into the water and the ground as easily. In addition to the small particles, tailings contain waste water and flotation chemicals. Tailings are typically placed in impoundment areas exposed to precipitation and water runoff, which can allow toxic substances to be washed out. Groundwater can be contaminated if the impoundment area is not leak-proof. Impoundment areas also run the risk of overflowing during periods of heavy rain, if the areas are not made large enough to contain great amounts of rain and runoff. The most serious risk, however, is that of a collapsed dam, which would allow the toxic tailings to flood the area. Although the exact composition of tailings is site-specific, they generally contain heavy metals, acids, fluorides, sulphides, and radioactive material.

This paper is analyzing location of RTH flotation tailing. In order to prevent impact on environmental there has been performed analysis to determine the optimal method of recultivation. This recultivation procedure has many goals such as: prevent air pollution and erosion of tailings material through torrents and its transport to the surrounding land. Special attention has paid to the possibility of afforestation and greening of degraded areas by deciduous and coniferous species. In this way, i.e. by applying biological reclamation, seedlings of birch, and juniper, are planned. The alternating combination of these plant species enables the binding of the substrate and gives a beautiful aesthetic appearance to the environment.

Two phases are adopted: technical and biological. Each of them has specific works that are presented in this paper.

LOCATION OF INTEREST

Flotation tailings facilities in the Bor region, especially the RTH, are legacy environmental burdens. Decades of flotation processes have left behind surfaces with limited ecological value and high erosion potential. This study proposes a solution based on tested practices and local environmental data.

The RTH tailings pond covers around 27 hectares and includes fine-grained waste with high acidity and metal content. Problems include dust pollution, acid mine drainage, slope instability, and lack of vegetation. Environmental monitoring confirms elevated levels of heavy metals such as Cu, Pb, and Zn.

The RTH flotation tailing (Figure 1) was built southeast of the boron flotation pit in the RTH open pit mining area. After mining was completed, the RTH open pit area was filled. Due to the need for additional storage space, the original Bor Valley flotation landfill was expanded to the northwest and southeast. The river valley leading to the metallurgical slag heap and the abandoned boron open pit in the northwest was blocked by Dam No. 1 (Figure 1). Downstream, the Bor River valley was blocked by Dam No. 2

(Figure 1). The east side of the flotation ore retention pit borders the eastern landfill of the boron open pit, and a cofferdam was built on the west side of the flotation tailings.

Figure 1 Spacial representation of the location of the flotation tailing RTH [6]

Based on the analysis of the flotation tailings, several conclusions were reached [7]:

1. In the side dams of Dam No. 1 (I) and Dam No. 2 (II) and the RTH flotation residues, a homogeneous technogenic material predominates. Morphologically, this material consists of fine sand. This matrix leads to poor water vapor conditions and is unfavorable for plant growth.
2. In some locations in the dam where sulfur-sulfide oxidation has not yet taken place, the pH value of the flotation residues is about 6. This flotation material reacts neutrally with high concentrations of active phosphorus and a complete lack of potassium.
3. Where sulfide sulfur oxidation occurs, the pH value of the matrix is about 3
4. The lack of clay particles containing organic matter in the flotation residue impairs self-renewal and plant growth. Clay and humus particles in the flotation residue activate the soil microflora, initiate soil-related humus formation processes and the formation of available plant nutrients. Therefore, humus-rich soil materials are added to the substrate.
5. The addition of organic matter to the substrate in the form of humus accelerates microbial processes and provides a constant influx of plant assimilates to promote the development of grass and shrub plant species, as envisioned by biorecultivation.

DEGRADED AREAS FOR RECULTIVATION

The new project addresses the elevation of the dam from elevation K+378 to elevation K+390. Based on the projected state of the flotation tailings, with an elevation

up to K+390, the surface area of the flotation tailings RTH, which will be treated by recultivation, represents internal and external slopes, dam crest and tailing beach (K+385). Total degraded area projected for recultivation is 551.200 m^2.

TYPES OF RECULTIVATION AND CHOICE OF RECULTIVATION METHODS

Reclamation is a complex of mining-technical, engineering, reclamation, forestry and agricultural works, which are carried out in a certain time, aimed at bringing degraded terrain to a state suitable for reuse, in the previous or in a new way, compared to the state before the degradation. [8]

Reclamation measures must ensure the most necessary abiotic and biotic conditions of the habitat, its biotization, the creation and support of the formation of initial life communities on the meliorated habitat and corresponding communities at a higher level of cenotic structure and complexity. [8]

The aim of recultivation is to, through a series of activities foreseen by the recultivation project, in some form, "return" what was previously borrowed from nature through exploitation.

In the world and in Serbia, for the recultivation of degraded areas, the following is applied:

- autorecultivation,
- semi-recultivation,
- optimal recultivation.

Optimum results in terms of recultivation are achieved by applying complete recultivation - eurecultivation. Complete recultivation means the procedure when all the foreseen phases of recultivation are carried out: technical, agrotechnical and biological recultivation.

Due to the condition of the surfaces after the disposal of the flotation tailings and the specific pedological, microclimatic and climatic conditions, for the recultivation of the RTH flotation tailings, optimal recultivation with grassing is foreseen.

Reclamation works are consist of two phases:

1. Technical phase of reclamation,
2. Biological phase of recultivation.

TECHNICAL AND BIOLOGICAL RECULTIVATION

The technical phase include engineering interventions consist of reprofiling slopes, sealing the surface with clay layers, and installing drainage systems. Application of cover soil is planned using material from surrounding plots. Protective berms, erosion mats, and water redirection structures will be integrated.

The second – biological phase includes planting metal-tolerant grasses (Festuca rubra, Agrostis capillaris) and nitrogen-fixing trees (Robinia pseudoacacia). The objective is to create initial ground cover and enable soil development for future succession. Later afforestation will include birch, pine, and other native forest species. Monitoring of growth and coverage will be performed annually.

A biological method of recultivation will be applied for the greening of degraded areas at the site in question, namely:

1. Sowing a mixture of grasses 49 kg/ha: Red fennel (50%), English rye (35%), Yellow star (10%), White clover (5%),
2. Woody plants: Betula alba L. (birch) – a total of 47,974 seedlings, Acer campestre L. (juniper) – a total of 4787 seedlings.

On the outer slope of the flotation tailings pond, only grass is planned. It will be done using hydroseeding. The other areas will be grassed using agricultural machinery. After weeding, the next phase is afforestation.

The planting of trees, chub, on the internal slopes of the dam will be done according to a triangular scheme at a distance of 3 m between the seedlings. This means that about 1100 seedlings can be planted on one hectare. The planting of trees on the crown of the dam will be done in two rows, with a space of 4 m wide for the road, 6 m between these rows. Birch seedlings are planted at a distance of 3 m. The total number of seedlings per hectare is about 1100.

For the beach of the flotation tailings, afforestation was designed according to a mosaic layout. At the same time, birch and chub are planted according to a square pattern at a distance of 3 m between the seedlings. In this way, about 96% of the area will be forested, while the rest will be the space reserved for the road (4%) for the passage of machinery.

Works on the formation, i.e. the raising of green areas on the beach consists of the formation of individual mosaics that will consist of shrubby and woody plants. Woody plants (birch) will be used within one mosaic. Planting will be done two meters from the edge at a distance of 3 m between seedlings (square scheme). In this way, about 1100 seedlings will be planted per hectare. Seedlings aged 2+1 will be used for planting.

Bushy vegetation (clump) will be used for roundabouts. Planting will be done two meters from the edge at a distance of 3 m between seedlings (square scheme). In this way, about 1100 seedlings will be planted per hectare. Seedlings aged 2+1 will be used for planting.

CONCLUSION

The recultivation of RTH tailings is not only a technical task but an ecological necessity. By integrating engineering and ecological techniques, the proposed plan addresses environmental hazards and promotes gradual transformation into a stable and green space.

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