MINING AND METALLURGY INSTITUTE BOR
and
TEHNICAL FACULTY BOR, UNIVERSITY OF BELGRADE

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# 53rd International October Conference on Mining and Metallurgy

# PROCEEDINGS

Editors:
Ana Kostov
Milenko Ljubojev

3 – 5 October 2022. Hotel "Albo" Bor, Serbia

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# RECULTIVATION OF DEGRADED AREAS FORMED BY DEPOSITION OF TAILINGS AT THE FLOTATION TAILING DUMP "STUBIČKI POTOK'', LEPOSAVIĆ

**Miomir Mikić[1], Emina Požega[1], Radmilo Rajković[1], Milenko Jovanović[1], Daniel Kržanović[1]**

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## Abstract

*Degraded areas were formed by deposition of flotation tailings at the location of "Stubićki potok" near Leposavić. The final couture of the flotation tailing dump was designed, and it is at the elevation K + 570 m above sea level. In order to protect the environment, the protection measures are taken at the flotation tailing dump by reclamation of all degraded areas. For this purpose, an analysis will be performed to determine the optimal method of reclamation. In order to prevent the air pollution and erosion of tailings material through torrents and its transport to the surrounding land, a special attention is paid to the possibility of afforestation and greening of degraded areas by the deciduous and coniferous species. In this way, the seedlings of ash tree and hornbeam are planned applying the biological reclamation. The alternating combination of these plant species enables the binding of substrate and gives a beautiful aesthetic appearance to the environment.*

***Keywords:*** *flotation tailings, environment, reclamation*

## 1 INTRODUCTION

The newly formed flotation tailing dump "Stubički Potok" is located in the immediate vicinity of Leposavić. It belongs to the Trepča mine. The location of the flotation tailing dump was chosen to be near the flotation plant located to the east, next to the main road M-22.3 Raška - Leposavić.

The flotation tailings dump itself is located in the west of the existing one, i.e. active flotation tailings pond consisting of three fields, which will be united according to the existing project (Figure 1).

The location of the new flotation tailing dump was chosen due to the advantages of the existing terrain, namely it is located in a basin, between two peaks of southern Rogozna. The basin has a west-east direction. The river Ibar with its bed is situated between the two flotation tailing dumps. In the foreground, the terrain is quite flat, after that the southern slopes of the Rogozna mountain begin to spread. They are characterized by a steep slope and vegetation.

The approach to the location in question is from the main road M-22.3 Raška - Leposavić, which continues to the rural road leading to the foot of the future dam of the newly designed flotation tailing dump.

The pulp pipeline from the flotation to the flotation tailings pit is placed under the main road, and then extends parallel to it and part of the railway line. The pulp pipeline was installed to the existing flotation tailing dump, and to the newly designed one; it will be routed under it and transferred by a bridge over the river Ibar to the newly designed flotation tailing dump.

**Figure 1** *Spatial location of the "Stubički Potok" flotation tailing dump and surrounding facilities*

## 2 CHOICE OF RECULTIVATION METHOD

From the point of view of technology, the flotation tailings represent a necessary mining facility, and from the point of view of the environment, a real danger to the ecological elements of the environment, whether they are in operation or disposal process has been completed.

The impact of flotation tailings on the environment is reflected in the impact on the basic life factors: water, air and soil. In this case, the flotation tailing dump "Stubički Potok", due to its characteristic position and size, can be viewed as a potentially large polluter. Due to this reason, it is necessary to take all the measures that will enable a reduction of the potentially negative impact of flotation tailings to reasonable limits, preferably to a minimum. This will be done applying the adequate measures. One of the basic measures is remediation of the flotation tailing dump. Applying the optimal recultivation will greatly reduce the dust emissions from the flotation tailing dump, prevent washing of material from dams and slopes of the flotation tailing dump, and indirect pollution of surface and underground water, occurrence of faults, initiation of the bio-pedological processes in degraded land, as well as the establishment of vegetation on the beaches of the flotation tailing dump [1].

The basic object of recultivation the physically, chemically and biologically damaged lands is to establish the function of managing the land space, as a resource that has been damaged by the anthropogenic activities.

The added humus layer of the soil serves to activate the work of soil microflora and initiate pedological processes in a direction of creation the organic matter and later humus, as well as the accessible elements for plant nutrition.

Due to the condition of surfaces after disposal of flotation tailings and specific pedological, microclimatic and climatic conditions for recultivation the "Stubički Potok" flotation tailing dump, an optimal recultivation with grassing is foreseen.

The recultivation will take place in two phases: technical and biological phase, and dynamics of works are expected to last for two years.

## 3 DEGRADED SURFACES

During the formation of the "Stubički Potok" flotation tailing dump, the natural surfaces will be degraded. The total area that has been degraded is 279800 $m^2$. The flotation tailing dump will be formed by damming the Stubički stream with a 70 m high dam, elevation K+575. Within the reservoir, the flotation tailings will be deposited up to elevation K+570.

## 4 TECHNICAL PHASE OF RECULTIVATION

Technical reclamation includes the degraded areas of the flotation tailing dump, i.e., the dam and dry beaches. The technical phase of reclamation at the "Stubički Potok" flotation tailings pond represents the stage of preparatory works, which enable the implementation of biological reclamation. As part of technical recultivation, in order to ensure the execution of works, several operations will be carried out, namely: excavation, loading, transport, unloading of soil humus material on degraded surfaces. At the same time, the final layer of soil material will be formed on the dry beaches of the flotation tailing dump. After formation the final layer, the agrotechnical works are carried out to prepare the substrate for grassing these areas. Within the framework of technical recultivation, the works on excavation pits for seedlings are also included. Excavation of pits will be carried out by machine, and on surfaces where mechanized access is impossible, such as dam slopes, excavation will be done manually.

## 5 BIOLOGICAL PHASE OF RECULTIVATION

The biological phase of optimal recultivation is the application of phytomelioration measures on the previously prepared soil substrate (degraded surface) in order to establish and survive vegetation for later formation the stable ecosystem. The greening of the degraded surface has primarily the role of environmental protection and, at the same time, contributes to a better appearance of the environment and better microclimate of the area.

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

- Sowing a mixture of grasses 35 g/m$^2$ in the mixture (350 kg/ha):
  - Red fenugreek (50%)
  - English rye (35%)
  - Yellow star (10%)
  - White clover (5%)
- Shrub vegetation: *Carpinus orientalis*. It is used for afforestation of bare areas and prevention of erosion, so it is a good choice for afforestation of the subject area.
- Woody plants: Black ash - *Fraxinus ornus L*. It was chosen for its characteristics to bind the soil well on steep terrains.

In this case, the biological phase of reclamation involves a combination of afforestation and grassing of degraded areas.

Grass will cover the degraded areas of the flotation tailing dump, namely beaches and dams. If the conditions are right, grassing is preferably done in autumn.

The planting of deciduous shrub crops implies a square scheme, on flat surfaces, with a mutual arrangement of 3 m, and about 1100 seedlings can be planted on one hectare. The planting of deciduous shrub crops on the slopes of the landfill will be carried out according to a triangular scheme with a spacing of 3 m, with about 1100 seedlings per hectare. The distance between rows on the slopes of dam is 3 m.

Figure 2 shows the transverse profile of the flotation tailing dam with the arrangement of crops for afforestation. 1100 seedlings per hectare were adopted for the planting of hornbeam and black ash. The picture shows that the combined method of grassing and afforestation of the areas was carried out.

A mosaic of culture was planted on the beach of the flotation tailing dump (Figure 3). Roads for mechanization were designed along the beach, which were covered with grass.

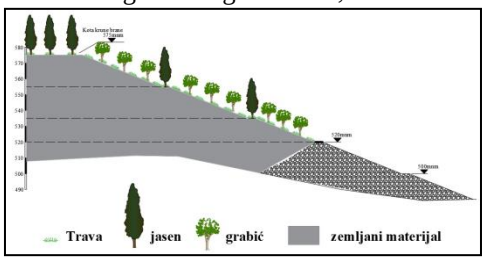


**Figure 2** *Sketch of the cross-section of the dam of the flotation tailing dump showing the arrangement of cultures*

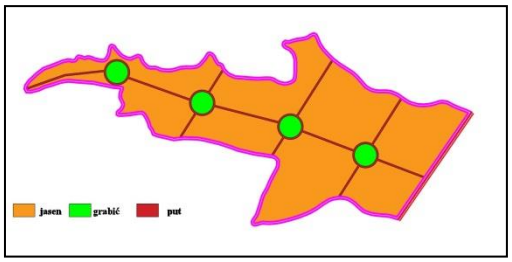


**Figure 3** *Sketch of the cross-sectional profile of the beach of the flotation tailing dump showing the distribution of cultures*

## 6 CONCLUSION

The restoration and revitalization of the space represents the last, very important phase (after the end of exploitation) and requires appropriate planning activities for its realization.

In this case, the effects of recultivation of degraded areas are reflected in the fact that:

Forest plantings enable better binding of the soil, stimulate the development of ground flora, activate pedological processes in the substrate with the root system, prevent insolation and drying of the soil, blowing of strong winds and raising of dust.

The application of grass cover on the final levels aims to prevent the erosion of humus (soil) applied in a layer of 50 cm height and enable the creation of grass surfaces.

Afforestation of degraded areas contributes to the environmental protection, improvement of the microclimate and aesthetic appearance of the environment.

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## REFERENCES

[1] M. Mikić, D. Urošević, R. Rajković, M. Jovanović, Recultivation of Degraded Areas Formed by Depositing Tailings at the Flotation Tailing Dump "Valja Fundata", Majdanpek, Mining and Energy 2021, 12th Symposium with International Participation, Sustainable Development in Mining and Energy, May 21, 2021, pp. 202-210.