MOGUĆNOST REMEDIJACIJE ISTORIJSKE DEPONIJE OTPADNE ŠLJAKE U FIRMI MG SERBIAN BALJEVAC

POSSIBILITY OF REMEDIATION THE HISTORICAL TAILING DUMP OF THE MG-SERBIAN BALJEVAC PLANT

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U cilju smanjenja uticaja na životnu sredinu deponije jalovine koja se nalazi u firmi Mg Serbian Baljevac, istraživana je mogućnost sanacije 700 000-800 000t istorijskog otpada. Otpad je nastao u periodu između 1979. i 2001. godine kao rezultat primarne proizvodnje magnezijuma u fabrici Mg Serbian Baljevac. Kako bi se eliminisao negativni uticaj koji ova deponija ima na životnu sredinu i smanjilo zagađenje vazduha i tla, izvršena je karakterizacija uzoraka sa različitih lokacija na deponiji. Različite biljne kulture su zasejane na stvarnim uzorcima, u laboratorijskim uslovima, i praćena je efikasnost sanacije.

Ključne reči: *remedijacija; deponija jalovine*

In order to reduce the environmental impact of the tailings dump located in the company Mg Serbian Baljevac, the possibility of remediation of 700,000-800,000 tons of historical waste was investigated. The waste was generated between 1979 and 2001 as a result of primary production of magnesium in the Mg Serbian Baljevac factory. In order to eliminate the negative impact that this landfill has on the environment and reduce air and soil pollution, the characterization of samples from different locations on the landfill was performed. Different plant cultures were sown on actual samples, in laboratory conditions, and the efficiency of remediation was monitored.

Key words: *monitoring remediation; tailings dump*

1 Introduction

Mining activities result in various environmental problems such as the air, soil and water pollution [1]. Tailing dump created by the deposit of waste, due to a high content of harmful components represent a wide range of problems to the environment. They do not have biological potential, so their remediation should be done in order to minimize their environmental impact [2,3]. The abandoned mines and tailing dumps have different physical, chemical and environmental conditions [4,5].

Tailing dumps usually are differing in their physical composition, content of the basic plant nutrients, especially nitrogen (N), phosphorus (P) and potassium (K). Some tailings may have high levels of heavy metals or other toxic materials. Taking plants with potentially toxic chemicals or heavy metals and incorporating them into the food chain are real problems [6,7].

Selection of plant species for remediation of the tailing dumps is based on several criteria: (1) chemical and physical properties of tailings, (2) geographic location and climatic characteristics, (3) elevation, (4) season of seeding, (5) compatibility with other vegetation, (6) topographic exposure, and (7) land use objectives. If the selected plant species are not compatible with one or more of the above criteria, then the remediation is likely to fail.

Biological measures include the application of agricultural and forest land remediation, which contribute to the stability and maintenance of the remediated areas, but are much more significant from the aspect of space revitalization and establishment the natural biocenoses. Horticultural species play a significant role in biological measures. The aim of the study was to plant easily accessible

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crops on samples from three sites. The rapeseed and native clover are planted under the laboratory conditions [8].

2 Experimental part

Investigation the possibility of remediation the tailing dump with historical waste was performed through the following phases:

- Sampling of waste slag, in accordance with a previously prepared sampling plan
- Formation the representative slag samples from individually sampled increments
- Storage and packaging of composite specimens and their transportation for the purpose of further chemical analysis and testing of possible cultures for landfill remediation
- Record existing plant species growing in landfill
- Determining the extent and rate of auto-remediation.
- Determination the chemical composition on composite samples.
- Planting the crops on samples from three locations.
- Monitoring of crop growth

Sampling of waste slag was performed by monitoring the conditions on the field and nature of sample in accordance with the purpose of test and in accordance with the standard for waste sampling SRPS CEN / TR 15310-2, 6.2 (sampling individual increments and forming a total of 3 composite samples from the existing three sites with historical) - probabilistic sampling. Sampling was carried out to a depth of about 4 m and, according to the sampling plan, the entire surface was covered by a stratified random sampling system. Table 1 shows the exact sampling locations.

Table 1. Sampling locations

GPS coordinates	*Location 1*	*Location 2*	*Location 3*
N	43°23'06.879"	43°23'06.904"	43°23'06.357"
E	20°37'01.174"	20°37'01.282"	20°37'00.062"

Formation of representative samples of slag from individually sampled increments was done in accordance with standard SRPS CEN / TR 15310-3, 7.1 blending of granular material using a heap method was applied to samples without high moisture content (sample taken from site 3).

3 Results and discussion

The locations of sampling and taking the individual increments is illustrated in Figure 1 (a-c).

a) Location 1 *b) Location 2* *c) Location 3*

Fig. 1. Locations of sampling and taking the individual increments

In order to determine the level and timing of auto-remediation, during the terrain inspection, the species of plants growing on the landfill was determined.

- At the location 1 (Figure 2a) no plant crops, but this site was excavated in the near-term period at the behest of official bodies. This location cannot be claimed as to whether there is, and if so, how much the capacity for auto-remediation is the same. It is necessary to carry out an additional research in laboratory and real conditions.

- At location 2, the plant representation is medium (about 20% of self-remediation has been achieved), but a more diverse plant culture is present than woody plants, shrubs and grasses, which in many ways means further remediation (Figure 2b).

- At location 3, the representation of plants is highest (about 25% to 35% of self-remediation is achieved). Low vegetation, reeds and grasses are present (Fig. 2c).

The chemical composition of samples was performed using the ICP-MS technique (coupled plasma induced mass spectrometry). Determination of moisture content was done by the gravimetric method. Conductivity and pH values were determined using the electrochemical method (conductometry and pH metric). The test results obtained are shown in Table 2.

Table 2. Results of chemical analysis of waste slag from locations 1, 2 and 3

Parameter	*Location 1*	*Location 2*	*Location 3*	*Method*
Moisture content(%)	19.18	48.66	41.10	SRPS EN 12879
pH value	11.47	9.54	10.33	EPA 9045D
Conductivity [μS/cm]	>9000	>9000	>9000	EPA 121.1
Be %)	0,0002	0,014	0,0100	VMK J.t.1
As (%)	<0.0010	<0.0010	<0.0010	
Ni (%)	0.0042	0.0020	0.0022	
Cd (%)	<0.0001	<0.0001	<0.0001	
Pb (%)	0.0019	0.0025	0.0013	
Ba (%	0.0038	0.0096	0.010	
V (%)	0.0002	0.0002	0.0002	
Cr tot. (%)	0.016	0.0039	0.0033	
Zn	0.0082	0.057	0.086	
Sb	<0.0010	<0.0010	<0.0010	
Cu	0.023	0.0065	0.0050	

It can be concluded from Table 2 that the physico-chemical composition samples from location 1 is different than samples from the other two locations. A clear indicator is the low value of moisture content, which is only 19.18%, compared to the moisture at site 2 (48.66%) and site 3 (41.10%). According to the measured pH value, it is clear that this is a high alkaline substrate for growth plant, which must be taken into consideration in selection the crops for further remediation, as well as salinity of the substrate (which is high at all tested sites > 9000). The content of heavy metals is low. This information is very important from the point of view of the period after the remediation and from the point of view of what to do with the crops growing at the investigated site.

It was determined that there is a certain degree of self-recultivation and that it is not the same for all three locations (Figure 2 a-c). There are no crops at location 1 (Figure 2 a). The assumption is that the reason for that is the recent excavation of this location by order of the official bodies. For location 1 it cannot be claimed whether and if so, what is its ability to self-recultivate.

a) Location 1

b) Location 2

Fig. 2. Self-recultivation

At location 2 (Figure 2 b), the representation of plants is medium (about 20% of self-recultivation was achieved). The presence of various plant cultures was noticed, such as some woody and shrubby plants, as well as grass. This is very important for further recultivation of this site, because the risk of spreading waste slag in the form of erosion and drought during the dry period has already been reduced, and it only needs to be improved.

At location 3 (Figure 2 c) autorecultivation reached the highest level (25-30%) compared to the previous two locations. Low vegetation, reeds and grass are present.

Under laboratory conditions, the native clover and rapeseed were planted on samples from three locations. Over a period of three months, their growth was monitored. The results of the study showed that the recultivation is possible (Figure 3a-domestic clover, Figure 3b-rapeseed).

a) Native clover

b) Rapeseed

Fig. 3. Recultivation in laboratory

4 Conclusion

Based on the physical and chemical characterization of t samples from the Mg Serbian Baljevac historical waste site and laboratory testing on the use of native clover and rapeseed, it can be concluded that these two crop cultures can be successfully used for remediation of landfill.

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