ENGINEERING FOR WASTE WATER TREATMENT FROM TAILING DUMPS

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ABSTRACT. Apart from all measures to control and improve the quality (several days of purification by water settlement) of water that is discharged from tailing dumps in some periods, it is possible contaminated water to be discharge into the nearest watercourses. As a result of the discharge of contaminated water, deposition of harmful substances in the riverbeds can occur, which process causes contamination of the surrounding soil. To achieve a high level of environmental protection from waste water from tailing dumps, it is necessary to undergo special treatment for water purification. One of the methods for water treatment is an additional deposition of suspended materials in the auxiliary deposition beds and water discharge through horizontal and vertical drainage. Construction of additional beds beneath tailing dumps with geotubes filled with small drainage material is a cost effective method for water drainage and purification of tailing dumps. Another method is the biological treatment of water, which method is commonly used for the extraction of heavy metals from water. This treatment is mainly performed by aerobic bacteria. Most favorable option for the treatment of water from tailing dumps is by so called lagoons and treatment with reeds, or other plants that have potential for bio accumulation of heavy metals.

Keywords: heavy metals, environment, drainage, geotubes, lagoons

INTRODUCTION

Most serious environmental issue associated with deposition of tailing in tailing dumps is the discharge of contaminated waters in to surface and groundwater flows. This problem is more evident for groundwater flows. Increased concentration of heavy metals in the environment can cause destabilization of ecosystems, due to bioaccumulation of these metals in living organisms and toxic effects on the living organisms.

It is best if recirculation of water from tailing dumps is performed, that same water to be reused in the processing of mineral ores. But in some cases, significant amounts of water from flotation tailing dumps is discharged through the overflow collector, while a smaller amount (by filtration and drained water) is discharged in the form of drainage waters.

Flotation tailing dumps are a kind of water treatment plants, performing the role of purifying and treatment of water that is used in the process of mineral technology (processing) of metallic ores.

ENGINEERING FOR WATER TREATMENT WITH GEOTUBES

By the water treatment with geo tubes additional purification of water from tailing dumps is enabled.

The use of geosynthetic polypropylene material that is fabricated in a cylindrical tube called geotube has been widely implemented over the past few years. Several companies have developed experience, engineering, software for the size of geotubes, tests for their chemical use and areas of their installations.

Geotubes are textiles of synthetic fibers which perform the function of protecting the embankments from erosion, filtration of material with different particle size and so on. The aim of these geotubes is to retain suspended particles from tailing material from the processing of ore and to drain the water.

By the application of geotubes technical solution for construction of more auxiliary precipitation lakes with compartments based on Geotube technology can be applied (Figure 1). Geotubites constitute vertical drainage in combination with horizontal drainage pipes (Figure 2) and will retain small flotation particles.

Fig. 1 Dams from Geotube

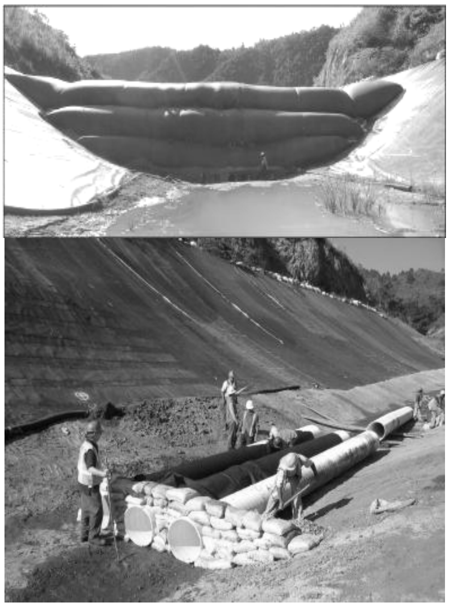

Fig. 2 Drainage system

Such a solution is applied to mine for lead, zinc and silver - El Mochito in Honduras, with the flotation tailing dump with large amounts of contaminated material, in which recirculation of water is performed, but during heavy rains dispersion of tailing material along valley was performed so the ecosystem in the vicinity was destabilized.

At the bottom of the terrain (and for tailing dump and auxiliary lakes) impermeable material - geomembrane is placed. Drainage tubes are placed at the bottom of the lowest compartments with drainage pipes wrap with geotextile and geotubes from which barriers (dams) are constructed are filled with sand and used as vertical drainage.

The height of the dam and the size of the auxiliary precipitation lakes, of course, depend on the size of tailing dumps and the flow of drained water. Installation of this system is simple and fast.

This water treatment system could performe a role in case of unwanted accidents, or compartments of geotubes prevent spills of tailing material from the first auxiliary lake that should be designed to store larger quantities of tailing material, ie the amount that would be expected under adverse disaster (dam breaking, slag/tailing penetration through the object, etc.). From the first auxiliary lake the water is drained through set compartment of geotubes filled with small filtration material.

In the case - tailing particles to pass through the first compartment, then the purpose of the second auxiliary lake is to slow down and deposit these particles and to perform slow water drainage.

If there is a third compartment, then in the third compartment horizontal drainage from pipes can be set, for fast water penetration, and compartment from geotubes to perform drainage only in enormous cases.

Water from the auxiliary precipitation lakes can be re-used in the processing of ores, with recirculation of water.

Due to this technology in the case of unwanted accidents leak materials are collected in the auxiliary precipitation lakes, and dams from geotubes don't allow dispersion along the water course, or have additional control over tailing material.

Finances invested in this system, certainly are insignificant in terms of the consequences that could occur in the environment in case of discharge of polluted waters or in case of accidents, as well as the penalty which will be paid by the companies which operate with the flotation tailing dumps.

ENGINEERING FOR WATER TREATMENT WITH LAGOONS

A method commonly used for the extraction of heavy metals from water is a method of biological water treatment. This treatment is mainly carried out by aerobic bacteria and could find an important application for the treatment of water from tailing dumps.

Most favorable option for the treatment of water from tailing dumps is construction of lagoons and treatment with reeds (Figure 3), shrubs or other plants that have features for heavy metals accumulation and chemicals.

Fig. 3 Reedbeds

The location of the lagoon needs to be near the outfalls for collector and drainage water from flotation tailings. Layers of the lagoon, the water inlet and outlet pipes should be properly selected so high level of environmental protection to be achieved.

The following images present the technology for construction of reed bed lagoons for wastewater treatment from flotation tailing dumps. Construction of the structural elements of the lagoon consists of the following activities: excavations, loading and transportation of the material (Figure 4), setting impermeable layer (geomembrane) set between two layers of geotextile (Figure 5), laying pipes and filter material from gravel and sand (Figure 6). After the construction of the elements of the lagoon planting of adequate plants should be performed.

Fig. 4 Excavation of material

Fig. 5 Setting geosynthetic layers

Fig. 6 Setting pipes and filter material

Typical lagoon for water treatment to constitute a functional unit should contain the following structural elements (Figure 7):

- Stabilization bed for mechanical pretreatment;
- Sludge drying bed;
- Bed for filtration;
- Beds for treatment of leachate with vertical flow;
- Polishing beds;
- Bed reservoir for the purified leachate.

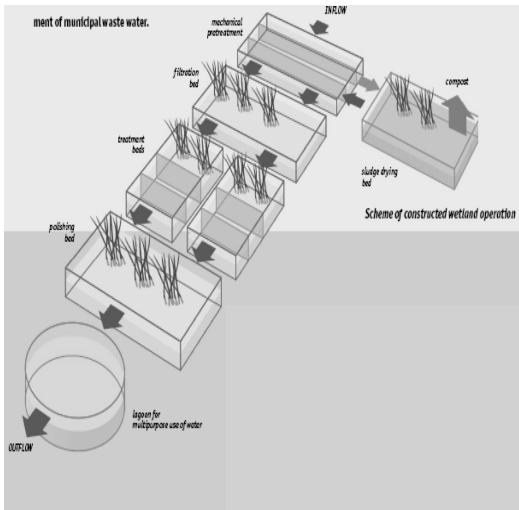

Fig. 7 Scheme of lagoon

In terms of water motion in lagoons, commonly three ways of water flow are used: surface flow, subsurface flow and vertical flow (Figure 8).

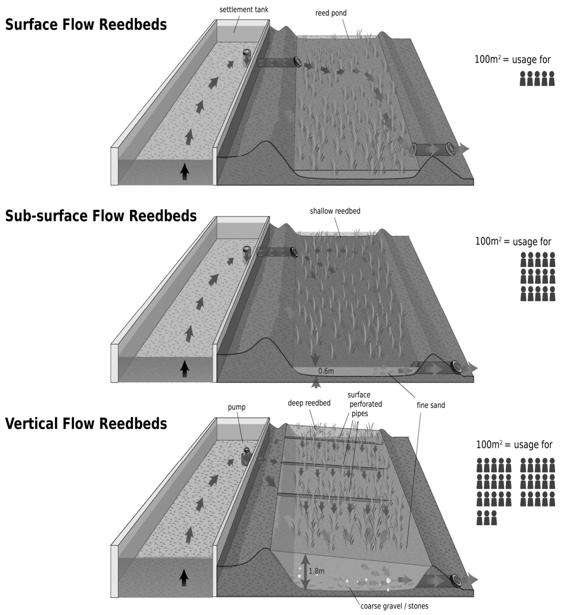

Fig. 8 Different flow configurations for reedbed treatment

All three modes of water flow should be placed in the indoor pool lined with impermeable material (geomembrane) with additional layers that may be gravel or sand.

Surface flow of wastewater is carried over the roots of the plants and it is on the surface, and the water is leading with pipes from one place, and the output is on the other end. This method is more efficient and less sensitive to winter conditions.

Vertical flow is similar to the under surface wastewater flows, by leading the wastewaters through a system of perforated pipes in the upper layer of filter material (sand). Wastewater passes through a layer of fine sand, and by collecting drainage pipes placed on the bottom layer of the filter material is expelled from the treatment pool.

Treatment pools use a wide variety of plants, depending on the local climate and other conditions. Plants that are used usually are indigenous and are characterized with optimal potential for bioaccumulation of heavy metals. Depending on the depth of the so-called treatment pools four types of plants are used, such as:

- depth from 0÷20 cm - Iris pseudacorus, Sparganium erectum;
- depth from 40÷60 cm - Stratiotes aloides, Hydrocharis morsus-ranae;
- depth from 60÷120 cm - Nymphea alba;
- a submerged water depth - Myriophyllum spicatum.

Aquatic plants are accumulating heavy metals and other contaminants through the root system, or toxic metals or organic components are binding with internal cellular structures of plants. The following table (Table 1) presents some aquatic plant organisms that accumulate heavy metals.

Because wastewater treatment with this type of lagoons represent natural ecosystem its application is very favorable in terms of environmental protection, so in future this method may be implemented at flotation tailing dumps worldwide.

Biological treatment of waste water from flotation tailing dumps is highly dependent on climatic conditions, adequate location, selection of appropriate plants (reeds, bushes and etc.), local strategy, legislation, financial resources. With well designed and constructed lagoons maintenance is minimal and with good maintenance practices lagoons will be operational for long term.

Tabl. 1 Organisms which accumulate heavy metals

	Mean value and its range, ppm			
Species	Zn	Cu	Pb	Cd
Alisma gramineum	9,48	6,41	13,75	0,08
Azolla filiculoides	45,58	5,13	16,10	0,20
Batrachium aquatile	43,56	10,22	25,16	0,38
Batrachium penicillatum	89,95	10,09	11,75	0,25
Batrachium trichophyllum	5,36	5,21	1,35	0,26
Callitriche cophocarpa	5,00	6,80	0,30	0,12
Ceratophylhum demersum	37,48	7,45	9,48	0,22
Cladophora glomerata	31,06	9,81	6,85	0,43
Elodea muttallii	8,72	5,04	4,13	0,18
Fontinalis antipyretica	37,92	10,96	21,43	0.09
Chara vulgaris	4,10	0,96	14,58	0,13
Lemna minor	14,68	3,59	2,71	0,17
Myriophylhum spicatum	61,80	6,10	10,81	0,43
Myriophylhum verticillatum	27,37	3,13	6,21	0,47
Najas marina	24,02	6,61	4,75	0,70
Potamogeton crispus	33,01	3,06	12,05	0,36
Potamogeton nodosus	4,43	7,63	5,95	0,03
Potamogeton pectinatus	47,98	5,25	14,82	0,86
Potamogeton perfoliatus	46,46	6,22	12,32	0,38
Potamogeton pusilhus	64,65	6.65	12,63	1,60
Sparganium emersum	13,57	4,67	15,03	0,07

CONCLUSION

For greater security of flotation tailing dumps and high level of protection of the environment, each flotation tailing dump to have a system composed of compartments of geotubes and system of lagoons would be good practice. With water treatment by geotubes and lagoons environmental benefits would be considerable, and the surrounding population will have a quality ambient conditions.

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TenCate Geotube® technology in Honduras.