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TECHNOLOGY OF THE MINE WASTE WATER DISPOSAL

ABSTRACT:
This study outlines the application of electrolytic waste water treatment use for mine works out flowing water. It describes history and circumstances in the 5 mine works (tunnels) in Spišská Nová Ves region. Finally the article provides results of the experimental treatment of the mine out flowing water with high percentage removal of Cr, As, Cu and Hg.

KEYWORDS:
electrolytic water treatment, mine out flowing waters

INTRODUCTION

Nature could exist without man much effectively than with the man. Unfortunately it does not apply in reverse because the basis for human existence is the nature and its resources which the man often also wastefully uses to meet their needs. At the same time the trend of use of these resources is increasing disproportionately. From the middle of last century until now has been mined more mineral resources than in the entire previous history. At the same time, from the vast amounts of raw materials that are mined today (about 40 billion tons / year) only a very small portion gets to the final production, which produces waste that is directly or indirectly devastating the environment. Also because of this has U.N.O. adopted the activity entitled "Agenda 21", which should serve for synchronizing the environmental and economic activities at more careful use of natural resources and creation of conditions for sustainable development in all areas, hence also in the major economic sectors such as mining industry. Mining has been developing on the territory of Slovakia from the Bronze Age. The first archaeological evidence of the existence of mining in our country is from around the 6th century AD, when the Celtic settlers mined and processed iron ore. The first evidence of underground mining in Slovakia is from 12 and 13 century AD. At that time, mining of rare metals in Kremnica and Banská Štiavnica acquired the importance in Slovakia. In Slovakia there are currently mined ore, non-metallic, construction and energetic raw materials. Mining as mining industry and preparation of mineral resources, e.g. coal, ores, and non-metals, has also now undeniably great economic importance. From it derives a wide range of other industrial - economic activities, such as metallurgy, machine building, chemical industry, construction, transport and others for which mining provides the substrates or the products of which it uses. However, like any other industrial activity, also mining of mineral resources has except the primary impact (mining itself) also other various secondary effects on the quality of the environment (biosphere, pedosphere, human society, etc.).. Mining industry affects the environment, not only during the period of its operation, but also after termination of mining, after the departure of the last worker from the mines. One of the problems is that it leaves behind the old mining works constituting a burden for the environment. It is important to monitor these. List, location and monitoring of environmental burdens register and continuously update State Geological Institute of Dionýz Štúr in Bratislava. According to current information, there are 16 478 of these environmental burdens on the territory of Slovakia. The problem is also, besides the impact of current issues of mining activities effects, historical persistence and time-consuming dealing of country with this activity. Among the impacts directly related to the mining activity belongs even the existence of mining works, tunnels, shafts, pings, pings fields, heaps, dumps, scrap heaps after ore mining or associated with their processing, slag after ores smelting, and so on. Among the effects associated with the provision of mining activities may be included, in country still well visible water system of mining works, timber harvesting and subsequent inappropriate afforestation, the occurrence of radioactive particles (radon), which get to the surface from weaned unventilated mines, particularly into residential buildings constructed above such mines. Some of the mining works are a source of wastewater. They are *result of spring and following desuinting of extracted raw materials, in underground or in the mine springing water. This water may contain heavy metals, which, after mixing with surface waters disrupt the stability of the ecosystem. The waters are mainly acidic origin, but there is also alkaline waste water. To prevent or reduce the effect of either acidic or alkaline water from old mine works it is needed to adjust them to acceptable levels to avoid damaging the ecosystem. [1]*

CHARACTERISTICS OF STUDIED MINE WORKS

Based on the recommendation of the Mining Office Spišská Nova Ves, water samples were taken from the following mining works: Teplička nad Hornádom, Smolnícka Huta, Smolnícka Huta - Shaft Péch, Slovinky – tunnel Alžbeta, Rudňany – tunnel Rochus.

The new tunnel is the lowest exhausted horizontal mine work, tunneled since 1924 in ancient bearing Grétla. Ore was mined here until the end of the 1963. Chalcopyrite was mined there. The problem now is the sudden outflows of water from an abandoned Nová štôlňa (New tunnel), a former opening works on bearing Gétla in Hnilčik that threaten people. Like every phenomenon, triggering a dangerous natural processes, have periodic outflows of mine water from the Nová štôlňa its rational explanation. It is likely that early steps taken at the beginning of the liquidation of the mine within ore mining depression can prevent an existing condition. After the liquidation works, deep parts of the mining system below the level of Nová štôlňa were under water. The bulk of the throughout the centuries forming mining system stayed below the level of groundwater and drained inflows of waters from broad scopes and mining drilling the hill Grétla. Water was collected in the tunnel sewer and flowed to the surface. The mouth of the mine works was by the solvers of attenuation project left in its original state, against the intrusion of unauthorized persons was ensured by the locked bars (probably not strong enough, because it appears that the tunnel has become accessible to anyone). Upon completion of the work monitoring of out flowing water was not carried out, nor a physical inspection of the mine. The original owner (Želba SNV) failed to report to mine and contributed also the legal status – non existence of legislation on fate of mining works after realized securing works or liquidation works of attenuation program and non existing rules for ownership rights to such works. Nowadays it is a period between two torrential waves. Water in the borehole increases about 15 cm during 24 hours and its amount is growing ominously. It is very difficult to predict the effect of new breakage of falling rocks, although built dam is with its dimensions the guarantee of primary catastrophic events elimination. It is not known how much of a mixture of water, mud and rock debris will pass through the dam openings and how much remains behind it and will definitely plug the mine work. The following scenario may result in water overflowing the edge of the incrush funnel what is by part of stakeholders considered as a good final solution (creating a drain channel and diverting the water into the stream). Such a situation would be a potential source of even greater disaster and could lead to the emergence of the constantly growing carst effect in the gypsum horizon and to large callus, threatening the surrounding forest lands. As final and optimal solution, the restoration of drainage function of the mine work Nová štôlňa was adopted. [2]

The first water outlet occurred on the night from 26.9.2008 to 27.9.2008. For that reason was issued a binding order that the organization Rudné bane š.p. B. Bystrica shall [2]:

- *immediately ensure the execution of works for the disposal of the situation,*
- *organizationally provide the necessary staff and equipment,*
- *canalize the outflow of mine water into the projected channel of the local creek under the developed liquidation plan of the mining work Nová štôlňa,*
- *technically realizes a liquidation of sudden mine water outflow consequences by restoration of the mouth of mine work so that it prevents the entry into the mining work with leaving a sufficient opening for the discharge of mine water*
- *will make the local communication functioning by clean up of dirt from mine spoil heaps under Nová štôlňa and from the creek bed of Brusník and its banks.*

Despite these measures and realized technical works has come on 7.12.2008 to further outflow of water from the mine work Nová štôlňa. Rudné bane was by binding order imposed [2]:

- *to immediately ensure the repair of fault TH – reinforcement and its strengthening to withstand the expected water pressure,*
- *reduce the hole in the mouth portal of the mine work by installation of tin-plate in its upper half.*

Work has been under a mandatory order realized, although there was a third water outflow from the stated mine work on 30.1.2009. Damages were caused to the build portal of mine works; it was destroyed along with two complete TH - reinforcement. Conclusions of the meeting of involved experts were the base for further issue of binding order of the district mining inspector, which imposed [2]:

- *to immediately ensure the processing of project documentation with appropriate static calculation for dam construction in the mine work Nová štôlňa,*
- *to immediately begin with preparation for realization of works according to the project documentation.*

In the next procedure was anti breakage dam dimensioned for the water column of height 80 m. 17.2.2009 was fourth outflow of water from mining work Nová štôlňa. Because of that event were suspended works on building an anti breakage dam. At this time is the dam already built. Monitoring borehole was realized. Because less water outflows, water in the borehole increases. [2] Photographic documentation of the site in question is captured on Fig. 1 .

Figure 1 - Water outflow from Nová štôlňa and view on the dirty stream

DESCRIPTION OF LABORATORY EXPERIMENTS

The content of polluting substances in waste water should not overcome the maximum allowable level of pollution (mg/l) before discharging to usually surface waters. [3]

Figure 2 - Sampling scoops

Laboratory experiments were realized in laboratory electrolyzer with capacity 8 l at the following conditions:

- *Electrolyzer capacity: 8 l*
- *Sample capacity: 5 l*
- *Number of electrodes: 7 pcs*
- *Distance between electrodes: 4 cm*
- *Electrodes size: 100x100x2 mm*
- *Electrodes arrangement: Fe-Al-Al-Fe-Al-Al-Fe*
- *Current: direct*
- *Current amount: 10-20 A according to conductivity*
- *Tension: 42 V*
- *Electrolysis length: 8 min*
- *Sedimentation length: 40 min*

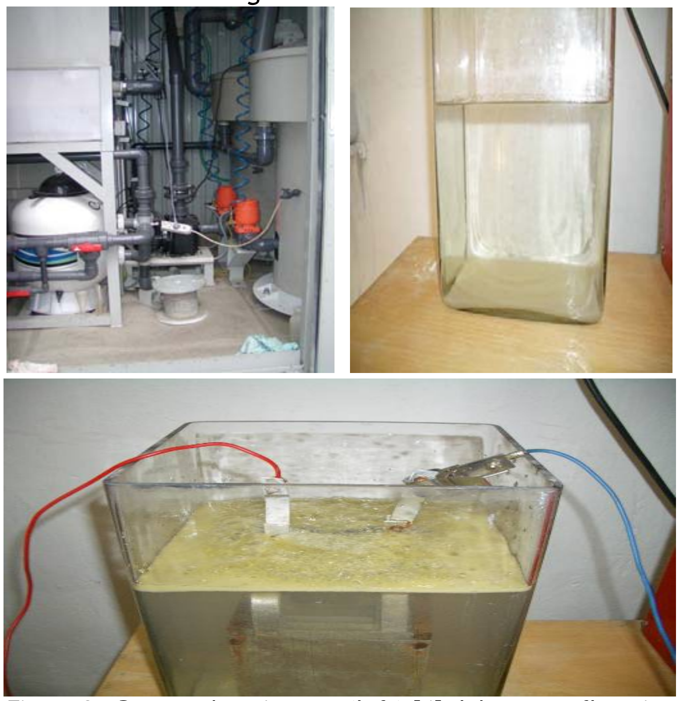

Figure 3 - Patented equipment (left) [4], laboratory flotation on the water sample(middle) and water after electro flotation(right)

Table 1 - Results of electrolytic treatment

Parameter	Alžbeta		Teplička	
	Before Adjust.	After Adjust.	Before Adjust.	After Adjust
Cr^{6+} mg/l	< 0,01	<0,01		
pH	7,93	6,49	7,90	6,62
NL 105 mg/l				
Arsenic mg/l	0,07748	<0,001	0,01385	<0,001
Copper mg/l	0,01031	0,0067	0,0117	0,0063
Mercury ug/l	<0,08	<0,08	<0,08	<0,08
Magnesium mg/l				

Parameter	Smolnická Huta	
	Before Adjust.	After Adjust
Cr^{6+} mg/l		
pH	7,90	6,62
NL 105 mg/l		
Arsenic mg/l	0,01385	<0,001
Copper mg/l	0,0117	0,0063
Mercury ug/l	<0,08	<0,08
Magnesium mg/l		

Parameter	Pech		Rochus	
	Before Adjust.	After Adjust	Before Adjust.	After Adjust
Cr^{6+} mg/l	<0,01	<0,01		
pH	3,30	3,90	7,90	6,62
NL 105 mg/l				
Arsenic mg/l			0,01385	<0,001
Copper mg/l			0,0117	0,0063
Mercury ug/l			<0,08	<0,08
Magnesium mg/l	254,9	157,0		

Electrolyser was filled with 5 litters of mine water and the current was turned on. The electrolysis was interrupted after eight minutes and the content was transferred to the sedimentation barrel. After sullage (25 – 40 min.) was the mud drained and pure solution was transfused to the sampling scoops (fig. 2)
Photo documentation from laboratory measurements is captured on fig. 3.
Results of analysis are stated in table 1.

CONCLUSION

Electrokoagulation method is very suitable for removal of heavy metals [5].Stated method is very suitable for removal of Cr, As, Cu and Hg from mine waters. From the analysis result it is obvious, that efficiency at removal of Cr is 41,18 %, As 97 – 99,9 %, Cu 35 – 91,6 % and Hg 88,57 %. Since the observed waters had various physic-chemical composition and electrolysis conditions for each water were same, process of electrolyses was not optimal. By optimization of the process for every type of mining water would be the efficiency higher.

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