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THE TREATMENT POSSIBILITY OF MINING DRAINAGE FROM HORIZON 830 IN THE SASA MINE, MACEDONIA

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ABSTRACT. The drainage system on mining area Sasa consists of surface water from the rivers Crvena, Svinja and Kozja which are flowing from field of ore deposit, and with other small mountain tributaries that flow into the River Kamenichka. The results of the measurements show that in all samples from surface waters are detected increased concentrations of heavy and toxic metals, except for the water of the River Crvena. These increased concentrations are a consequence of historical anthropogenic impact of acid mine drainage from old inactive pits, as well as the impact of current activities in mine SASA primarily from the mining drainage from the active horizon 830. The paper shows results of the treating mining drainage samples from horizon 830, by applying the method of passive treatment "diversion wells". The results show that the use of combined treatment of diversion well and treatment with flocculants gives satisfactory results in terms of reduced concentrations of metals, dissolved and suspended solids.

Keywords: mining drainage, heavy metals, diversion well, flocculants.

INTRODUCTION

Mine SASA is the largest organization for production and processing of lead-zinc ores of the Balkan Peninsula. In 2006 started a new history of mine SASA and in the same year was stable within the annual production plan of 700,000 tonnes of dry ore. Processing ore in the most modern flotation in Southeast Europe provides producing high selective lead and zinc concentrate.

Area within which belongs mine SASA has naturally increased concentrations of Pb and Zn and supporting elements Ag, Bi, Cd, In, Cu, Fe, Mn etc. The ecosystems in this mine area are exposed to the impacts of:

- Natural pollution (naturally elevated concentrations of metal),
- Anthropogenic pollution (impact of human activity).

The drainage system in the surrounding area on the mine SASA consists of surface water from the rivers Crvena, Svinja and Kozja which are flowing from field of ore deposit, and with other small mountain tributaries that flow into the River Kamenichka. These rivers gravitate to Lake Kalimanci.

The quality of the surface water is continuously monitored by the mine SASA, and sample of water are taken every 10 days from multiple measuring points. The results of the measurements show that in all samples from surface water are detected increased concentrations of heavy and toxic metals, except for the water of the River Crvena. These increased concentrations are a consequence of historical anthropogenic impact of acid mine drainage from old inactive pits, as well as the impact of current activities in mine SASA primarily from the mining drainage from the active horizon 830.

MATERIAL

Mining drainage from horizon 830 have average amounts of the flow of 30 l/s, with perspectives projected amounts of the mining drainage flow of 100 l/s, due to the development with adit. Currently, the mining drainage from horizon 830 are channelled in two chamber sludge plant with V=1.800m^3 (25x40x1,8m), where the mining drainage are gravitational sediment. In tab. 1 are given chemical-mechanical parameters of mining drainage from horizon 830 before entering in the sludge plant and wastewater that exit from the sludge plant from horizon 830 for past period from April to October 2010, in order to determine the effectiveness of existing sludge plant:

According to the results of the measurements can be concluded that the performance of the existing sludge plant horizon 830 is minimal, which implies the need for appropriate treatment of mining drainage from horizon 830.

Tabl. 1 Chemical-mechanical parameters of mining drainage from horizon 830

Measurement point	Date	pH	dry residue (mg/l)			mg/l					
			unfiltered	filtered	susp. mat.	Pb	Zn	Cd	Fe	Mn	Cu
			TS	TDS	TSS						
Mining drainage from hor. 830	09.04.2010	7,47	200	100	100	0,120	10,170	0,000	0,130	3,340	0,000
Wastewater from sludge plant 830		8,00	1000	800	200	0,180	10,480	0,000	0,120	3,500	0,000
Mining drainage from hor. 830	10.05.2010	7,39	2000	800	1200	0,000	8,990	0,040	0,000	3,300	0,000
Wastewater from sludge plant 830		7,76	1200	1000	200	0,000	8,760	0,010	0,050	3,260	0,000
Mining drainage from hor. 830	10.06.2010	7,33	900	800	100	0,100	8,840	0,040	0,080	2,390	0,000
Wastewater from sludge plant 830		7,60	900	800	100	0,060	6,310	0,000	0,120	1,820	0,000
Mining drainage from hor. 830	10.07.2010	7,23	1400	1000	400	0,190	8,130	0,070	0,090	1,810	0,000
Wastewater from sludge plant 830		7,54	1000	900	100	0,160	5,500	0,070	0,060	1,700	0,000
Mining drainage from hor. 830	10.08.2010	7,58	700	600	100	0,060	7,300	0,010	0,010	2,130	0,020
Wastewater from sludge plant 830		7,84	700	700	0	0,080	5,300	0,000	0,000	1,910	0,000
Mining drainage from hor. 830	13.09.2010	7,20	700	600	100	0,020	5,970	0,040	0,010	1,950	0,000
Wastewater from sludge plant 830		7,65	1400	1200	200	0,050	4,500	0,030	0,030	1,930	0,000
Mining drainage from hor. 830	12.10.2010	7,50	1200	1200	0	0,080	2,420	0,020	0,000	1,620	0,000
Wastewater from sludge plant 830		7,78	800	800	0	0,080	4,250	0,000	0,000	1,480	0,010
MPC		6,5-9,0	/	1.000	30-60	0,03	0,20	0,01	1,00	1,00	0,05

EXPERIMENTAL

Typical diversion wells are composed of cylindrical or vertical deviation of metal or concrete tank with a diameter of 1,5 - 1,8 m and a depth of 2-2,5 m, filled with crushed limestone rock. The big tube with a diameter of 20-30 cm enters vertically down to the centre of the source and ends just above the bottom (Figure 1).

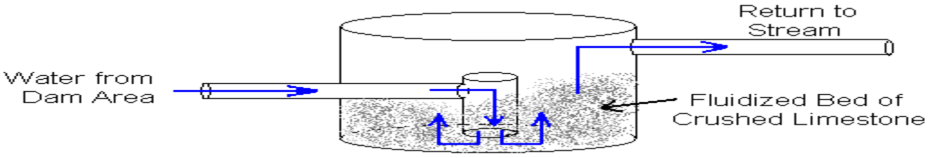

Fig. 1 Schematic view of a diversion well

According above given data, the volume of diversion well have to be 6,36m^3. Retention time = V_w / Q = 6,36m^3/30 l/s= 212s. In order simulation on diversion well, three plastic 2 l bottles are filled halfway with limestone rock with a grain size of 5-20mm and content $CaCO_3$ 93-95% and is added mine water from horizon 830. The bottles are mixed 212s, as was actually the retention time in the diversion well in flow of 30 l/s. After that the water is percolated through gauze and the first bottle is left to stand for 1 h, second bottle 2 h and third bottle 3 h (which is a simulation of the retention time in the sludge plant, which would have accepted the treated water from the diversion well). The results from tests are given in tab. 2.

Tabl. 2 The quality of the water according to retention time of sludge plant

Sample	pH	dry residue (mg/l)			mg/l					
		unfiltered	filtered	susp. mat.	Pb	Zn	Cd	Fe	Mn	Cu
		TS	TDS	TSS						
Mining water from hor.830 (untreated)	7,21	400	400	0	0,020	7,050	0,050	0,090	1,700	0,000
Sample with $CaCO_3$ after 1 h	7,38	20200	200	20000	0,000	0,600	0,030	0,120	0,500	0,000
Sample with $CaCO_3$ after 2 h	7,37	12000	500	11500	0,010	0,680	0,030	0,100	0,610	0,000
Sample with $CaCO_3$ after 3 h	7,69	12100	500	11600	0,000	0,650	0,030	0,070	0,580	0,000
MPC	6,5-9,0	/	1.000	30-60	0,03	0,20	0,01	1,00	1,00	0,05

Analysis of the concentration of heavy and toxic metals and TSS in terms of legally permissible MPC on mining drainage from horizon 830 treated with $CaCO_3$ are presented graphically (Figure 2-7):

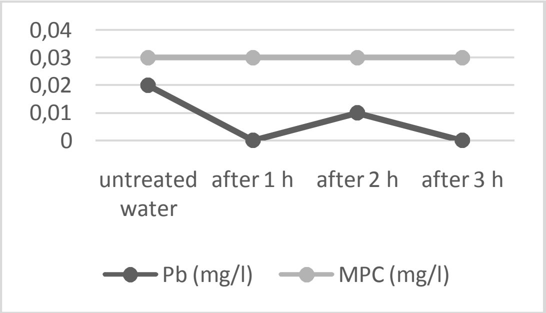

Fig. 2 Content of Pb in mine water after treating with $CaCO_3$

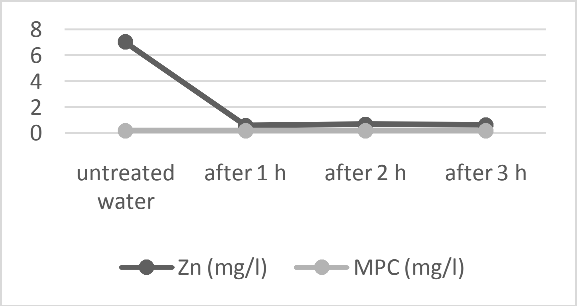

Fig. 3 Content of Zn in mine water after treating with $CaCO_3$

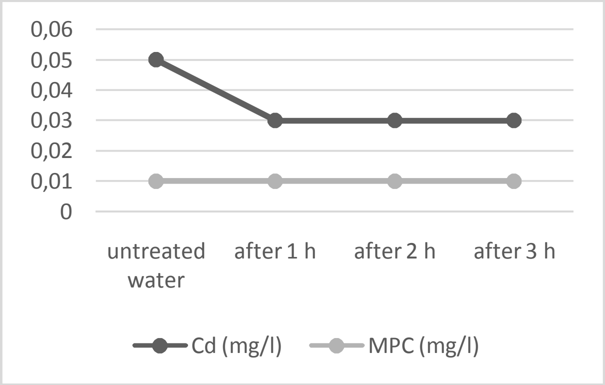

Fig. 4 Content of Cd in mine water after treating with $CaCO_3$

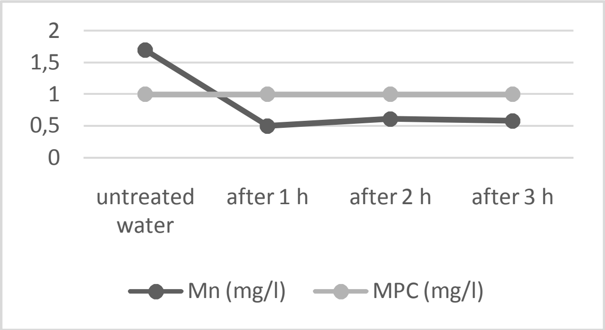

Fig. 5 Content of Mn in mine water after treating with $CaCO_3$

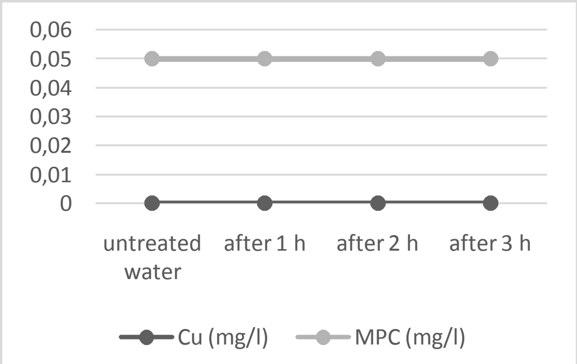

Fig. 6 Content of Cu in mine water after treating with $CaCO_3$

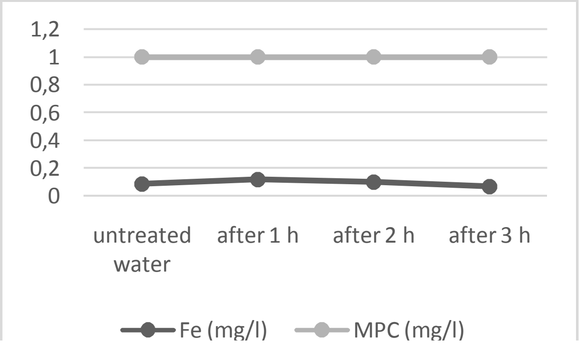

Fig. 7 Content of Fe in mine water after treating with $CaCO_3$

From the above it can be concluded that the effectiveness of treatment with limestone rock in relation to the concentration of metals (Pb, Zn, Cd and Mn) is good, but in terms of dissolved and suspended materials is ineffective. So will require additional treatment after diversion well.

Tabl. 3 The quality of the water treated with $CaCO_3$ and flocculent

Sample	pH	dry residue (mg/l)			mg/l					
		unfiltered	filtered	susp. mat.	Pb	Zn	Cd	Fe	Mn	Cu
		TS	TDS	TSS						
Mining water from hor.830 (untreated)	7,57	818	798	20	0,08	6,60	0,00	0,09	1,68	0,01
Sample treated with $CaCO_3$	7,60	38648	824	37824	0,05	0,46	0,00	0,09	0,27	0,01
Sample treated with $CaCO_3$ and 2ppm from 0,2% solution of flocculants	7,48	837	805	32	0,05	0,64	0,00	0,09	0,34	0,01
Sample treated with $CaCO_3$ and 4ppm from 0,2% solution of flocculants	7,48	723	636	87	0,05	0,66	0,00	0,09	0,35	0,01
Sample treated with $CaCO_3$ and 8ppm from 0,2% solution of flocculants	7,46				0,05	0,69	0,00	0,09	0,36	0,01
MPC	6,5-9,0	/	1.000	30-60	0,03	0,20	0,01	1,00	1,00	0,05

Plastic container of 10 l is filled halfway with limestone rocks and is added mine water from horizon 830. Water and $CaCO_3$ are mixed 212s, as was actually the retention time in the diversion well in flow of 30 l/s, after which the sample was taken from the treated water for chemical analysis. Water treated with $CaCO_3$ is then treated with flocculent Nalco 9601. Solution was made with 0.2% flocculent Nalco 9601 and is balanced in different concentrations of mine water samples from horizon 830 treated with $CaCO_3$. Added to 3 different concentrates and that is: 2 ppm, 4 ppm and 8 ppm. After 1 h (which is a simulation of the residence time of water treated with flocculent sludge plant) is performed chemical analysis of water. The results of the chemical analysis are shown in the tab. 3, and they are presented graphically (Figure 8-13):

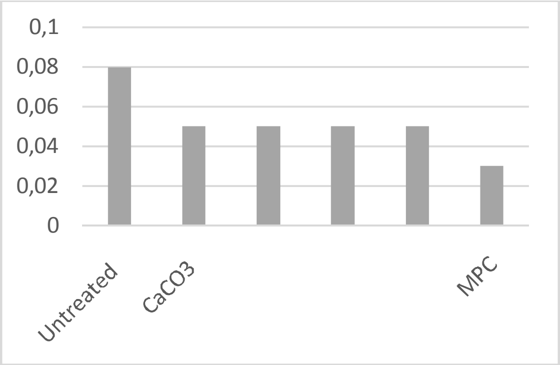

Fig. 8 Content of Pb (mg/l) in function of flocculent quantity

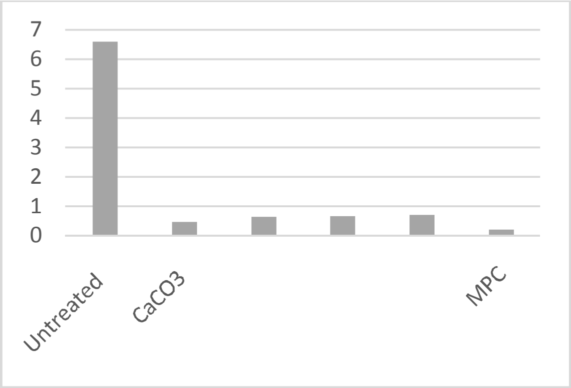

Fig. 9 Content of Zn (mg/l) in function of flocculent quantity

Fig. 10 Content of Cd (mg/l) in function of flocculent quantity

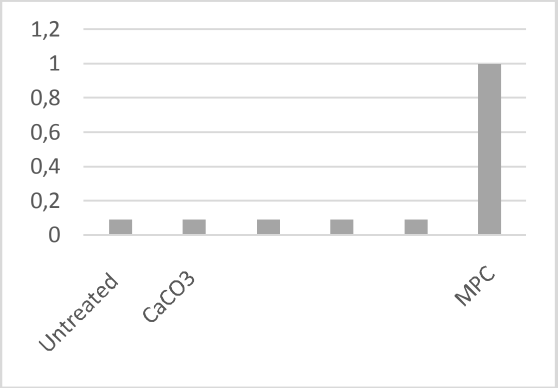

Fig. 11 Content of Fe (mg/l) in function of flocculent quantity

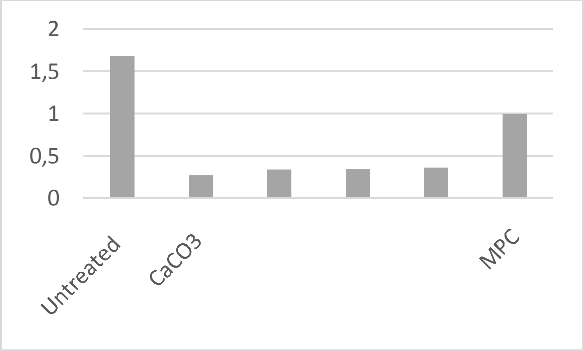

Fig. 12 Content of Mn (mg/l) in function of flocculent quantity

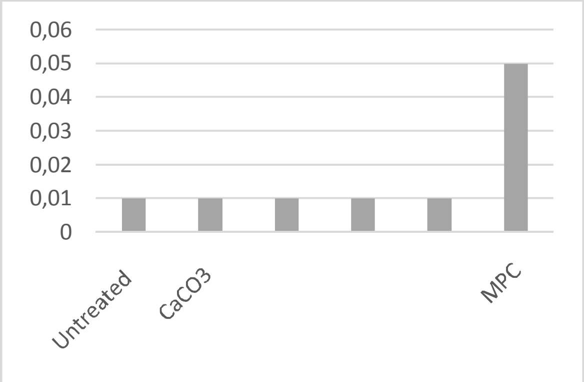

Fig. 13 Content of Cu (mg/l) in function of flocculent quantity

CONCLUSION

According to the results of the simulated treatment of diversion well and after treatment with flocculants can conclude the following:

- The concentration of TSS after simulated diversion well are increases drastically, but after additional treatment with 0,2% solution of flocculants, concentration of TSS is significantly reduced. The effect is roughly the same when adding different concentrations flocculants (2, 4 and 8 ppm);
- The concentration of Pb after simulated diversion well is decreases, and after treatment with flocculants is not changes on the concentration of Pb;
- The concentration of Zn after the simulation of diversion well is significantly reduced (degree of purification=93,03%), after treatment with flocculants comes to a slight increase on the concentration of Zn in relation to its concentration in the sample treated with the diversion well but if we consider the effectiveness of reducing the input concentration of Zn in untreated mining water from horizon 830 after application of combined treatment (diversion well and flocculants), it is extremely good, degree of purification = 89,55 - 90,30%;
- The concentration of Mn after simulation of diversion well is greatly reduced (degree of purification = 83,93%), after treatment with flocculants comes to minimally increase the concentration of Mn in terms of its concentration in the sample treated with the diversion well but if we consider the effectiveness of reducing the input concentration of Mn in untreated mining water from horizon 830 after application of combined treatment (diversion well and flocculants), it is extremely good, and the degree of purification is 78,57 - 79,76%;
- No change in the concentration of Cd, Fe and Cu after application of combined treatment of diversion well and flocculants.

The general conclusion is that the simulation of diversion well and additional treatment with flocculants give excellent results in terms of reducing the concentration of metal and of balancing the concentration of suspended solids. Since adding 2, 4 and 8 ppm of 0,2% solution of flocculants achieved approximately the same effect, the choice of optimum variant and from technical and economic point of view is the addition of a concentration of 2 ppm solution of flocculent.

The implementation of this treatment will be necessary:

- Sludge plant for deposition of mining water from horizon 830 (to use already existing or to dig up new dimensions 10x20x1,5 m);
- Diversion well (metal or concrete cylindrical container) with a diameter of 1,8 m and height 2,4 m and a plastic tube with Ø 20-30 cm;
- Lime stone with d = 1-2cm about inside diversion well (which would have filled halfway diversion well that is approximately 3 m^3 and limestone is added weekly 0,7 m^3);
- Sludge plant after diversion well in which the treatment will be done with flocculants (10x20x1,5 m);
- Equipment for preparation solution of flocculants (mixer, dispenser pump, etc.);
- Flocculants (about flow rate of 30 l/s is required 2592 l/day solution or 5,184 kg/daily consumption of flocculants).

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