PRODUCTS OF PASSIVE TREATMENT OF ACID MINE DRAINAGE AND TECHNOLOGICAL WASTEWATER

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Outflows of acid mine drainage (AMD) represents serious danger for the environment as they cause pollution of surface and ground waters, soil degradation and changes in vegetation. They can induce chemical decomposition of other minerals, which can be the potential sources of toxic elements. Passive treatment systems (PTS) or constructed wetlands are artificial ecosystems, which simulate conditions typical of natural wetlands based on observations of natural processes. Consequently, the objective of metals treatment is often to return mobile contaminants to their stable, immobile mineral forms. Many of these minerals are formed from water solution in a sedimentary environment, and the reactions are catalysed by bacteria. Mechanisms of retention within wetlands listed in their order of importance include formation of metal sulfides, formation and precipitation of metal hydroxides and carbonates:

$H_2S + Zn^{2+} \rightarrow ZnS + 2H^+$

$Fe^{2+} + HCO_3^- \rightarrow FeCO_3 + H^+$

$3\ HS^- + 6\ FeSO_4 + 4\ CrO_4^{2-} + 13\ H_2O + OH^- \rightarrow 3S^0 + 6\ Fe(OH)_3 + 4\ Cr(OH)_3 + 6\ SO_4^{2-}$

Our first trial to use the PTS for cleaning of AMD was realised in the Šobov area, near the city of Banská Štiavnica in Slovakia. AMD outflow from waste dump has a pH about 2.5 and the content of dissolved salts is over 20 g/l. Al, Fe and SO_4 are the most common components found in AMD, which already affected over 145 000 m^2 of the site. Investigation of possible use of the PTS to treat AMD from mining waste dump in Šobov was realised in three steps. The first step involved low-volume laboratory experiments. In the second step, a bench-scale system (capacity = 120 l) was built directly on the place of the planned PTS. At the same time the third step was also carried out, in which the pilot PTS was gradually built. The pH in the system stayed always at least at 4. We obtained good results of AMD treatment. Concentrations of Fe were many times reduced in comparison with original values. The same phenomena could be observed for Cu and Al, too. A considerable fall could also be measured in SO_4^{2-} concentrations, but in this case the efficiency of the PTS is a little lower.

In the second experiment with the AMD from Smolník we concentrated on the bench-scale phase. A system with a capacity of 200 l filled with substrate composed of different proportions of limestone, manure, sawdust and hay were used. In all of the containers a tendency to progressive improvement of ability of the PTS to treat Fe, Cu, Zn and Al contamination was observed, the efficiency in the final phase of the experiment was 96–97%. On the other hand, the efficiency of the system to treat Fe and SO_4^{2-} was very low. It was caused by the very short time that was spent by the wastewater in the pilot-scale system.

In the next project we tried to remove heavy metal from technological wastewaters using an anaerobic bench-scale treatment model (50 l) at Vanchang village in Vietnam. After one-month treatment, the concentrations of Cr, Ni, Fe, Al in our experimental model were significantly reduced; Cr from 131 mg/l to 0.165 mg/l, Ni from 500 mg/l to 6.75 mg/l, Fe from 1450 mg/l to 6.8 mg/l, Al from 224 mg/l to 1 mg/l. The results showed high efficiency in the removal of heavy metals from wastewater and a prospect for expanding larger-scale treatment in Vanchang and other places.

In the last project we focused on treatment of water from a technological waste dump in Bošany (Slovakia). The biological treatment of chromium was used for reduction of Cr^{6+} to Cr^{3+}.

References

KONOPELEC, J. (2004): Passive treatment of Cr and As contaminated wastewater. Department of Mineral Deposits, Faculty of Natural Sciences, Comenius University, Bratislava. Manuscript (MSc Thesis, in Slovak), 71 p.

ŠOTTNÍK, P. (2000): Passive treatment of acid mine drainage (PhD theses). Department of Mineral Deposits, Faculty of Natural Sciences, Comenius University, Bratislava. Manuscript (PhD thesis, in Slovak), 116 p.

ŠOTTNÍK, P. & ŠUCHA, V. (2000). Experiences with an in-situ and passive treatment of heavy metal polluted water – a possibility also for the Nam Dinh region? In: Book of Abstracts, International Workshop on Environmental Protection, Community Health for Sustainable Development of Craft-settlements in Nam Dinh, 26–27 October 2000, Nam Dinh, Vietnam.

WILDEMAN, T. R. & UPDEGRAFF, D. M. (1997): In: MACALADY, D. L. (ed.): Perspectives in environmental chemistry. Oxford: Oxford University Press, 473-495.