HUMIC-BASED SORBENT: POTENTIAL OF TOXIC METAL REMOVAL FROM MINE WATERS OR INCREASE OF EFFICIENCY IN PASSIVE MINE WATER PURIFICATION

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Abstract
The report informs of a possibility to use natural humic-based sorbent in order to remove toxic metals from mine waters efficiently. Initial laboratory tests that focused mainly on sorptive capacity of the sorbent and possibility to leach metals from the sorbent proved high sorptive capacity of the sorbent for Pb, Cu, Cd, Cr, Zn and Ni ions as well as strength of their bond in the sorbent.
It can be assumed that the sorbent can be used successfully in purification of mine waters containing toxic metals, while main use of the sorbent can be expected mainly in passive mine water purification.

Introduction
Mine waters from coal and ore mining are characterized by highly varied contamination. In most cases these waters have to be treated before their discharge in order to comply with environmental requirements. Content of toxic metals that are present in waters from coal mining as well as from ore extraction is a significant parameter of mine water contamination.
Methods of toxic metal removal are well-known and commonly used. The most famous and widespread way of metal removal from mine waters is based on combining active technologies: pH treatment – oxidation – sludge settling. Recently close attention has also been paid to development of passive methods of mine water purification that can be applied to smaller resources for economical reasons.
Currently natural humic-based material is available that can be used both in active and passive mine water purification technology. Humic substances are high-molecular cyclic compounds containing C, O, H and N. In nature, humic substances are formed during complex processes from necrotic organic mass and they constitute a complex of substances belonging to polyphenol group. Humic substances are dark brown and they are present in relatively high concentration in a certain type of brown coal that is called oxyhumolite. From that coal, humic substances are extracted using sodium hydroxide or potassium hydroxide. Proper processing of humic extract can result in *SORBENT* with capacity to sorb toxic metals and bond them strongly.

Methods
Properties of *SORBENT* that can be considered significant in view of its use in mine water purification were determined using several laboratory tests and chemical analyses:

1) determining sorptive capacity for selected metals;
2) *SORBENT* leach test;
3) test of stabilizing toxic metals in contaminated soil using *SORBENT*.

ad 1) Defined quantity of *SORBENT* was mixed with water containing metals in concentration 500 mg/L.

ad 2) Preparation of saturated sorbent:
- 40 g of *SORBENT* (water content 23 %) were mixed with 1 L of test solution containing 10 mg of respective metal; the following metals were tested gradually: Pb, Cu, Cd, Cr, Zn and Ni;
- contact time of *SORBENT* with test solution was 12 hours at pH = 5.5;
- filtration of sorbent and its drying at 105 ^{0}C for 6 hours;

Preparation of aqueous extract of *SORBENT*:
- 10 g of *SORBENT* + 100 ml of distilled water;
- 6 hours shaking and 18 hours sedimentation;
- filtration.

ad 3) Preparation of samples of contaminated soil (sediment from a tank containing water with toxic metal content):
- types of samples: sample A - 10 g of contaminated soil + 100 ml of distilled water;
  sample B - 10 g of contaminated soil + 0.05 g of *SORBENT* + 100 ml of distilled water;
  sample C - 10 g of contaminated soil + 0.125 g of *SORBENT* + 100 ml of distilled water;

- 8 hours agitation + 16 hours sedimentation;
- drawing of water sample from above the sedimented sludge.

Results and Discussion

Table 1 shows established *SORBENT* capacity for selected metals.

Table 1. Sorbent capacity for selected metals.

	Sorptive capacity [mg of metal / g of *SORBENT*]
Pb	391
Cd	49.3
Cu	5.9
Zn	14.5
Ni	18.2
Cr	66.3

Table 2 show results of *SORBENT* leach test.

Table 2. Content of metals in aqueous extract.

	Concentration [mg / L]
Pb	0.08
Cd	0.02
Cu	0.23
Zn	0.67
Ni	0.21
Cr	0.01

Table 3 shows results of test of stabilizing toxic metals.

Table 3. pH value and content of selected metals in settled water.

		Sample A	Sample B	Sample C
pH		6.9	6.8	6.5
Cd	[mg/L]	0.012	0.001	NOT DET.
Cu	[mg/L]	0.12	0.053	NOT DET.
Ni	[mg/L]	8.1	4.1	0.44

Performed initial tests prove that it is appropriate to consider use of natural humic-based sorbent mainly for passive mine water purification. Regarding the fact that *SORBENT* can be prepared as both powder and pellets, it can also be used in active technologies in continuous or discontinuous way, e.g. as a final stage after mine water neutralizing and settling.

With respect to the favourable results of chemical analysis of aqueous extract, the most appropriate way to process used *SORBENT* seems to be its dumping. Used *SORBENT* can also be reclaimed or incinerated.

The fact that *SORBENT* is manufactured from natural material using chemical methods at temperatures that do not result in the products of thermal pyrolisis with carcinogenic effects (PAH) can also be considered as positive.

Conclusions

Although the authors of this report did not participate in testing and are not aware of all test circumstances and conditions, they consider the existing information of *SORBENT* properties interesting and promising in terms of its application in mine water purification. They are also aware of the fact that the information was obtained at the

time when passive mine water purification was at its beginning and traditional method of neutralization with subsequent aeration and settling was used in mine water purification.
Many tests and analyses will have to be carried out for potential application of *SORBENT* in active or passive mine water purification. However, the basic and essential question for use of *SORBENT* in mine water purification, i.e. knowledge of *SORBENT* production, has been solved. In order to solve other questions, related mainly to the way of potential use of sorbent, its efficiency for mine waters, balance calculations, economics etc., the authors of the contribution seek partners and financial resources.

References

Votruba J. (1993). Technology of use of semi-synthetic humate sorbents in recovery of heavy metals dissolved in water. Institute of Microbiology, Academy of Sciences of the Czech Republic, Prague.
Fast Track at Horden (2004). The Environment - News from the Coal Authority 13, 12-13.
PIRAMID Consortium (2003). Engineering guidelines for the passive remediation of acidic /and/or metalliferous mine drainage and similar wastewaters. European Commission 5th Framework RTD Project no. EVK1-CT-1999-000021 "Passive in-situ remediation of acidic mine / industrial drainage" (PIRAMID). University of Newcastle Upon Tyne, Newcastle Upon Tyne UK. 166 pp.