STUDIES REGARDING THE TURNING TO ACCOUNT OF THE WASTE RESULTING FROM COAL EXPLOITATION

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ABSTRACT

In this paper was studied the possibility of turning to account of the waste resulting from coal mining. One way was to use the waste in order to stabilize ash dumps. The chemical analysis of the coal waste and ash showed that both have high zinc and nickel content. As remediation method was chosen for this study the cultivation of barley as bio-indicator plant on substrates obtained by mixing the coal waste and ash in various proportions. After bio-remediation, the zinc content of the substrates fell under the maximum permitted value for all coal-ash mixtures. The nickel content decreased very much, but remained somewhat higher than the maximum permitted value. Another way was to use waste material as adsorbent in view of removal of organic dyes from wastewaters resulting from inkjet cartridge remanufacturing. The coal waste was used in various dosages (S:L = 0.1 g:25 mL; 0.2:25; 0.3:25; 0.4:25 and 0.5:25) and the suspensions were shaken for various contact times (15, 30, 45, 60 and 120 min). The highest removal efficiency (~60%) was reached for a S:L ratio of 0.5:25 after a 60 min contact time.

KEY WORDS: coal waste, stabilization, adsorption, organic dyes

INTRODUCTION

In the last decades environmental issues occurred in mining. These problems are associated with sulphide ore mining in view of metals extraction, and with coal exploitation. Human activities, especially mining, metallurgical and chemical industry, led to the transformation of once fertile land into real deserted areas [1, 2].
After coal mining wastes result that can be used either as fertilizer or for the stabilization of ash and sterile dumps and even as adsorbent materials in the treatment of some wastewaters.
In general, ink jet printers use dyes diluted in water. This can create problems on the disposal of wastewater resulting from washing. The removal of organic dyes from such wastewaters can be done by using adsorbent materials [2-8].
In this paper was studied the possibility of turning to account of the waste resulting from coal mining. One way was to use the waste in order to stabilize ash dumps. Another way was to use waste material as adsorbent in view of removal of organic dyes from wastewaters resulting from inkjet cartridge remanufacturing.

MATERIALS and METHODS

In view to include the studied waste resulting from coal mining into a certain wastes category, the material was submitted to the leaching test, according to the legislation [9]. The waste was also submitted to chemical and physico-chemical analysis [10] in view of using it as substrate for growing plants.

The waste was used as substrate for growing plants; it was mixed in various proportions with ash. The mixtures were places in vessels and as bio-indicator plant was cultivated barley. The vessels were kept 30 days in laboratory, and watered with drinking water every three days. After 30 days, the plants were harvested. In order to determine the metals content of the substrates used for cultivation, the samples were brought into solution by boiling until almost dry with a mixture of concentrated hydrochloric acid and concentrated nitric acid HCl : HNO_3 = 1 : 3. The residue was treated with water and filtered. The concentration of metal ions in the filtrate was determined by means of atomic absorption spectrometry, using a VARIAN SpectrAA 280FS spectrophotometer.

The removal of organic dyes from wastewaters resulting from inkjet cartridge remanufacturing was carried out using the waste as adsorbent material in various dosages (S:L = 0.1 g:25 mL; 0.2:25; 0.3:25; 0.4:25 and 0.5:25). The suspensions were shaken with 150 strokes/min for various contact times (15, 30, 45, 60 and 120 min) using a Shaker Bath – Kutesz Tip 609/A (Hungary). After the desired contact time elapsed, the suspensions were filtered. The resulting solutions were submitted to UV-VIS spectrometric analysis. The UV-VIS spectrum of the initial wastewater showed five absorption bands with maxima at 380, 406, 516, 563.7 and 628.5 nm corresponding to five different colors. For measurements was chosen the band at 628.5 nm that was the most intense. For absorption measurements a Varian Cary 50 UV-VIS spectrophotometer was used.

RESULTS

1. Characterization of the waste resulting from coal mining

The experimental data obtained by the leaching test showed that the waste is inert and it can be stored. The results of chemical and physico-chemical analysis are the following:

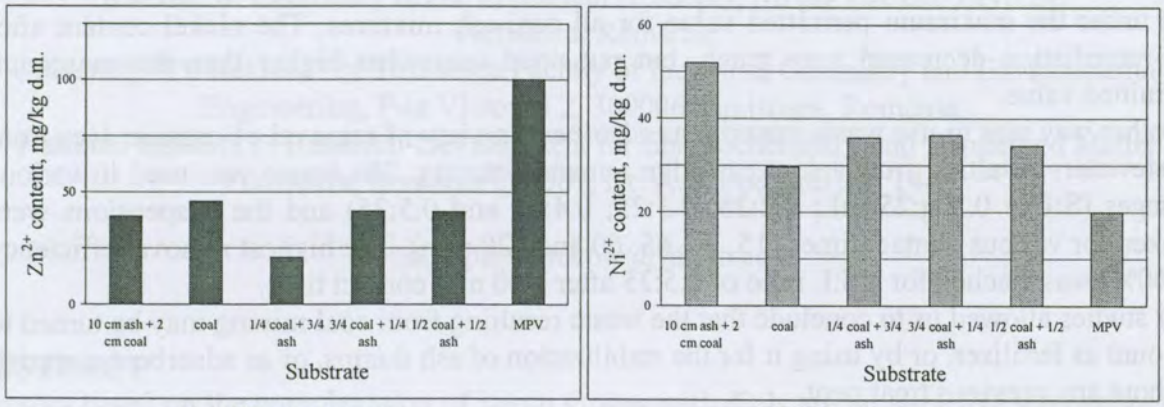
- the waste is acidic (pH = 4.71);
- the exchangeable base content (10 meq/100 g material) is within the normal range for Romania (1-50 meq/100 g material);
- high hydrolytic acidity (19.7 meq/100 g material);
- carbonates content is low (< 20 g/kg d.m.); d.m. = "dry material"
- the density (1-2 g/cm^3) is typical for humus rich soils;
- the macronutrients content is high (N-6.4%, P-445 mg/kg d.m., K-177 mg/kg d.m.).

These data allowed us to conclude that the waste presents the characteristics of peat coal, having acidic properties and typical density. At the same time, due to its high macronutrients content, the waste has fertilizing properties.

2. Studies regarding the use of the waste resulting from coal mining in view of ash dumps stabilization

The data obtained from the chemical analysis of the coal waste and ash showed that both have high zinc (waste – 586 mg/kg d.m.; ash – 455 mg/kg d.m.) and nickel (waste – 252 mg/kg d.m.; ash – 134 mg/kg d.m.) content, which indicates the need for application of remediation methods. As remediation method was chosen for this study the cultivation of barley as bio-indicator plant.

The experimental data regarding the zinc and nickel content of the substrates used for cultivation, after bio-remediation, are presented in Fig. 1.
After bio-remediation the zinc content of the substrates fell under the maximum permitted value for all coal-ash mixtures. For all mixtures used as substrates for barley cultivation, the nickel content after bio-remediation decreased very much, but remained somewhat higher than the maximum permitted value.



(a) Zinc content (b) Nickel content

Fig. 1. Zinc and nickel content of substrates after bio-remediation

3. Studies regarding the use of the waste resulting from coal mining as adsorbent material
Fig. 2 illustrates the influence of contact time between the wastewater containing dyes and the coal waste on the dyes removal efficiency, for different adsorbent material dosages. One may notice that the removal efficiency increased abruptly as the contact time was increased up to 60 min, but then remained constant as the equilibrium was attained. The removal efficiency increased as the adsorbent dosage increased; the highest value was reached for a S:L ratio of 0.5:25 (~60%).

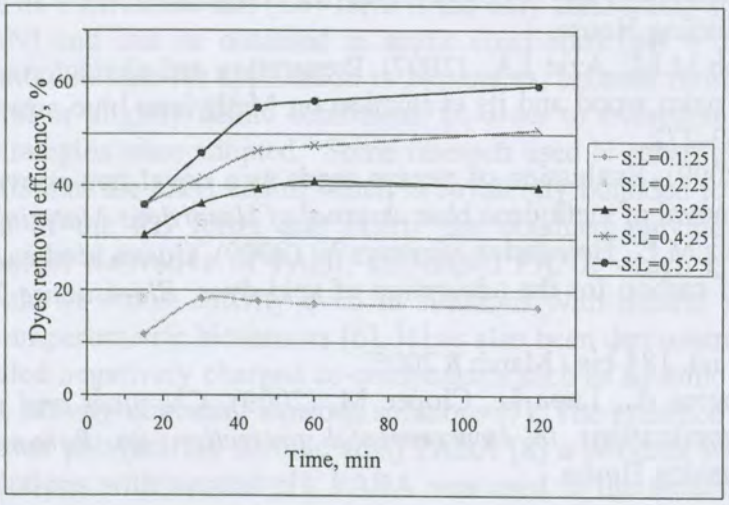


Fig. 2. Influence of contact time on dyes removal efficiency, for different adsorbent material dosages

CONCLUSIONS

In this paper was studied the possibility of turning to account of the waste resulting from coal mining.

One way was to use the waste in order to stabilize ash dumps. The chemical analysis of the coal waste and ash showed that both have high zinc and nickel content, which indicates the need for application of remediation methods. As remediation method was chosen for this study the cultivation of barley as bio-indicator plant on substrates obtained by mixing the coal waste and ash in various proportions. After bio-remediation, the zinc content of the substrates fell under the maximum permitted value for all coal-ash mixtures. The nickel content after bio-remediation decreased very much, but remained somewhat higher than the maximum permitted value.

Another way was to use waste material as adsorbent in view of removal of organic dyes from wastewaters resulting from inkjet cartridge remanufacturing. The waste was used in various dosages (S:L = 0.1 g:25 mL; 0.2:25; 0.3:25; 0.4:25 and 0.5:25) and the suspensions were shaken for various contact times (15, 30, 45, 60 and 120 min). The highest removal efficiency (~60%) was reached for a S:L ratio of 0.5:25 after a 60 min contact time.

Our studies allowed us to conclude that the waste resulting from coal mining may be turned to account as fertilizer, or by using it for the stabilization of ash dumps, or as adsorbent material, without any previous treatment.

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