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POWER PLANT ASH USED AS ADSORBENT MATERIAL

BY

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Abstract. Ash, generated during the combustion of coal, is an industrial waste which is recognized as an environmental pollutant. In present days, approximately 70 to 75 percent of generated fly ash is still disposed in landfills or storage lagoons. Much of this ash, however, is capable to be recovered and used. Some of these applications are: additives for heavy metals immobilization used in wastewater treatment; valuable metals extraction, such as Al, Si, Fe, V, Ni, Zn; sorbents for flue gas desulfurization; fireproof materials; production for soil amendment; filter material; ceramic products obtaining.

Even the fly is considered a pollution source, it has practical applications in environmental protection. From these applications it was studied the recovery of this waste by: direct utilization for heavy metals and dye retentions.

It was demonstrated that the fly ash does not pollute ground water. Experiences were effectuated at constant temperature in continue systems: column recrosses of liquid and stirrer reactor. For the different fly ash/ deionization water ratios the chemical composition and solution conductivity variations in time were determined. Removal for lead was 97% after 40 min. In the case of Astrazone blue the obtained removal was 98% after 60 min.

Key words: capitalization, dye, fly ash, lead, removal.

1. Introduction

The fly ash produced from the burning of pulverized coal in a coal-fired boiler is a fine-grained, powdery particular material that is carried off in the flue gas and usually collected from the flue gas by means of electrostatic precipitators, baghouses, or mechanical collection devices such as cyclones.

In 2006, approximately 16.2 million tons of fly ash was used. Of this total, 13.3 million tons (approximately 22% of the total quantity produced),

were used in construction-related applications. Between 1985 and 1995, fly ash usage has fluctuated between approximately 8.8 and 13.6 million tons per year, averaging 11.3 million tons per year [1], [2]. Approximately 70 to 75 percent of fly ash generated is still disposed of in landfills or storage lagoons. Much of this ash, however, is capable of being recovered and used. Examples of these applications are [3],…,[8]:

− Additives for immobilization of industrial and water treatment wastes.
− Extraction of valuable metals, such as Al, Si, Fe, V, Ni, Zn.
− Land stabilization in mining areas.
− Sorbents for flue gas desulphurization.
− Fireproof materials.
− "Slash" (fly ash/sludge blend) production for soil amendment.
− Filter material for the production of different products.
− Ceramic applications.

From these applications the capacity of ash for removing heavy metals and dyes from wastewater was analysed. In this direction the ash was characterized by performing the chemical analysis for the oxide compounds, the thermogravimetrical and the FTIR analysis.

From the heavy metals ions, the Pb ions adsorption were studied and from the dye it was studied the capacity of removal for Astrazone-blue.

2. Experimental

The ash was characterized from the point of view of particle sizes by the granulometric analyse with difratometer type SALD-7001 with laser.

The chemical and mineralogical characterization was realized with:

− Microanalysis was determined by SEM/EDX.
− Difractometer X'PERT PRO MRD.
− Multi-Parameter Consort C831 (pH, mV, C, Conductivity), pH 0-14.00, conductivity 0 - 200 mS, temperature 0.0 - 100.0 C.
− Lead metal was determined with atomic spectroscopy - Buck Scientific.
− Quantification of dye content was realized by spectrometry of molecular absorbtion in visible domain, variant of stndardization curve, photometer Karl Zeiss Jena, type Spekol.

For determining the removal degree from the wastewater an experimental device was realized composed of glass recipient with magnetic stirred, pH-meter and conductometer. The sample was of ratio ash: wastewater 1:50, the pH and conductivity was permanently measured and at predefined time 5, 10, 20, 30, 40, 60, respectively 90 min. was taken sample that after filtering was analysed for lead ions concentration, respectively for dye concentration.

3. Results and Discussions

The colour of the ash was black, because the carbon quantity that remained unburned. The fly ash has a fine consistency, the particles having the shape from Fig. 1. The carbonated material is composed of angular particles. Texture, which influences some properties of the ash, is determined by the granulometric properties.

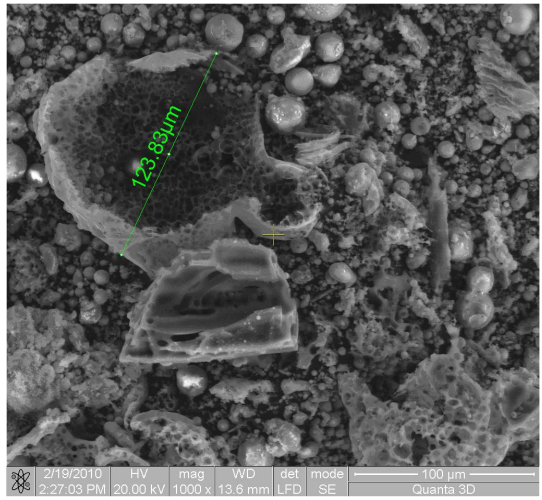

Fig. 1 – Electronic microscopy for ash.

From the SEM analysis for ash it can observe the variation domain of particles granulometry that presents irregular shape of the particles, due to the presence of great quantity of unburned carbon. Morphology is in accord with literature [9], [10].

Chemical composition of utilised ash is presented in Table 1.

Table 1

Composition of Coal Ash

SiO_2	51.21
Al_2O_3	25.08
Fe_2O_3	6.28
CaO	5.21
MgO	0.7596
Ration SiO_2/Al_2O_3	2

If the results obtained for the chemical oxide composition are in accordance with the results reported in the literature [2], [4],…,[6], the losses to calcinations obtained for ash are bigger. As consequence, for verifying the gravimetric analyze

was done with Termogravimeter MOM Budapesta Q-1500, curves TG and DTG. Analyzing the experimental data it shows that the results obtained by standard methods are confirmed [10], the ash has 12.5% unburned carbon.

The experimental researches wanted to establish the stage of adsorption process of Pb^{2+} ions from solutions. The stage was done at pH 9 (established on the base of pH influence) and on data from the literature [12]. From filter the Pb^{2+} ions content was determined for determining the removal degree.

The obtained values for the removal degree of lead ions are presented in Fig. 2.

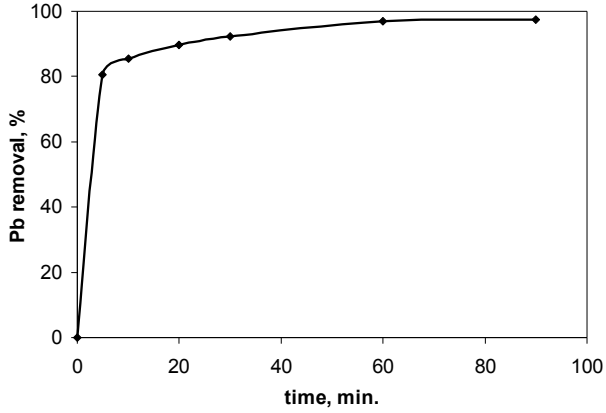

Fig. 2 – Kinetics of lead adsorption onto fly ash at pH 9.

From Fig. 2 it can observe that Pb^{2+} ions are easy removal by the studied fly ash. The removal takes place with very high speed in the first 10 min and after 60 min it exceeds 97%.

Variation of removal degree of dye is presented in Fig. 3.

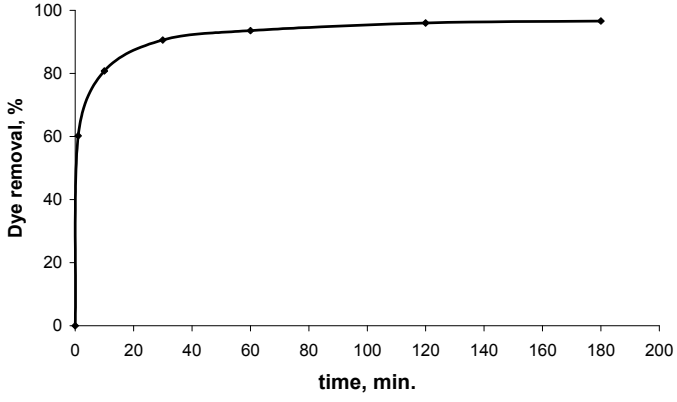

Fig. 3 – Kinetics of dye adsorption onto fly ash at pH 9.

The removal degree attains 60% in the first 5 min after the contact, the maximum of removal being after 60 min, when it exceeds 97%. The results which were obtained are justified by the cationic structure of dye. The high value of removal suggests that among the elementary processes which compose the global process of adsorption, such as: ionic change, electrostatic attraction, Van der Waals interactions, the prevalent is interaction type molecular, favored by the big size and structure of dye molecule.

4. Conclusions

Based on the experimental results it was concluded that the analyzed ash belongs to F class resulting after the combustion of a bituminous fuel.

This type of ash can be use for the removal heavy metals and dyes. The ash has a high CEC (20 mg g^{-1}).

Retention for lead from wastewater was 97% after 40 min, but this process is very quickly in the first 10 min when about 83% from Pb is removed.

In the case of Astrazone blue, the removal obtained was 98% after 60 min, but too in first 10 min about 80% was removed.

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UTILIZAREA CENUŞII DE TERMOCENTRALĂ CA MATERIAL ADSORBANT

(Rezumat)

Cenuşa generată în timpul arderii cărbunelui este un deşeu industrial cunoscut ca un poluant pentru mediu. În prezent 70-75% din cenuşa generată este depozitată în depozite de deşeuri sau pe sol. Aceasta poate fi recuperată şi utilizată. Câteva dintre aceste aplicaţii sunt: aditivi pentru reţinerea metalelor grele folosite în tratarea apelor reziduale; extracţia metalelor precum: Al, Si, Fe, V, Ni, Zn; adsorbant pentru desulfurarea gazelor de ardere; materiale rezistente la foc; producţia pentru amendamentul solului; materiale filtrante; producţia de ceramică.

Chiar dacă este considerată o sursă de poluare, are multe aplicaţii in protecţia mediului. Dintre aceste aplicaţii am studiat valorificarea acestui deşeu prin utilizarea directă pentru reţinerea metalelor grele şi a coloranţilor.

Am demonstrat că cenuşa nu poluează apa. Experimentele au fost efectuate la temperatură constantă în regim continuu. Pentru raporturi diferite cenuşă/apă am determinat compoziţia chimică şi conductivitatea soluţiei la diferite perioade de timp.

Gradul de reţinere pentru plumb a fost de 97% după 40 minute. În cazul colorantului Astrazone blue gradul de reţinere a fost de 98% după 60 minute.