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POTENTIAL APPLICATIONS IN AGRICULTURE OF NEW MATERIALS SYNTHESIZED FROM ASH

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Abstract

In the last years, zeolites have been researched for a variety of agricultural and environmental applications because possess unique properties: cation-exchange, adsorption, and molecular sieving. Zeolite can be used as soil conditioners, amendments, remediation agents in contaminated soils with heavy metals et all. Because commercially zeolites are expensive the researches have as objectives synthesis of new materials from different materials. These materials are raw or wastes, for example power plant ash, and can to be used effectively in soil applications if understand effects of these in soils or soil-like systems.The aim of this study is synthesis and characterization of zeolitic materials synthesized from power plant ash. Two different zeolite materials, rich in zeolite phases, K–cabazite were obtained from power plant ash, using 3 M KOH solutions at atmospheric pressure, temperature below 90°C and contact time of 4 and 8 hours.New materials were analyzed for their composition and properties. The synthesized products provide a significant increase of CEC (cation exchange capacity) and the high ability to adsorb heavy metal ions (over 39 mg g^{-1}). Because synthesized materials have high cation -exchange capacities that can be used as cation-exchange in a soil. The high cation-exchange capacities determined several researches for using of materials for lead and copper removal from soil.

Key words: *ash, cation exchange, characterization, synthesis, zeolite*

INTRODUCTION

Heavy metal ions are widespread in industrial and urban areas as a result of industrial manufactures, metal mining, smelting, soil application of sewage sludge and by-products, production, obtaining of painting materials and their use etc. [1] For reduction such hazards, a lot of researches have been made to develop remediation techniques of heavy metals contaminated soils [2].

Usually remediation techniques are constituted by extraction and immobilization processes. In the case of the first ones is to remove heavy metals from the soil matrix. The immobilization techniques consist in prevent migration of heavy metals into the soil, by improving its properties, decreasing surface area across which pollutants can transfer, or by decreasing the solubility or toxicity of the compounds [3]. For treating heavy metals from contaminated soils immobilization processes are generally preferred [4].

Immobilization is usually realised by mixing contaminated soils with suitable materials which are capable to reduce heavy metals leachability (pH and alkalinity control) in order to decrease their solubility. In other case is possible adsorption, ion exchange and precipitation of pollutants [5, 6].

A variety of materials have been investigated to immobilize heavy metals in soils. Zeolites [7, 8], phosphate rock [1, 9], fly ash [10-12], calcium hydroxide [13] and phosphates [14] can be used for immobilization.
Several mechanisms, such as ion exchange, surface complexation and dissolution followed by precipitation and co-precipitation, have been proposed in the literature to explain the heavy metal immobilization properties of zeolites [15, 16]. Although such mechanisms have not yet been well understood, zeolite seems to be a promising soil additive for the immobilization of heavy metals (Zn, Pb, Cu, Cd and As) in polluted soils [1]. Because the commercially zeolites are expensive, new materials, synthesized from waste are used for soil remediation.

MATERIAL AND METHOD

Material. The studied material was ash and zeolite synthesized from ash [17, 18]. This is obtained by direct conversion of ash at different activation solution/ash ratios, with temperature below 90°C and reaction time between 4-8 hours. Potassium hydroxide solutions with concentration 3 M, at 90°C and 4 h (Z1) and 8 h (Z2)have used for synthesise 2 different zeolites from the same ash. The zeolite material was obtained by direct alkaline conversion processes in autoclaves. The ash was added to a KOH solution 10 mL/g ratio. The zeolites obtained were filtered and dried for 2 hours at 353 K.
Methods. The ash used for synthesis was characterized chemical, mineralogical and technological. For this we performed the chemical analysis, XRD analysis using Difractometer X'PERT PRO MRD, scanning electron microscopy Vega Tescan.
Adsorption capacities were determined using the batch equilibrium method, using Multi-Parameter Consort C831 and Spectro-photometer Buck Scientific for heavy metal detection by atomic spectroscopy [17].

RESULTS AND DISCUSSIONS

The potential application of ash for obtained new materials for contaminated soil results from their properties. From this very important is chemical composition, respectivellyif ash contained heavy metal ions.
From morphologic analysis it can see transformation degree of ash in conversion process, Fig. 1.

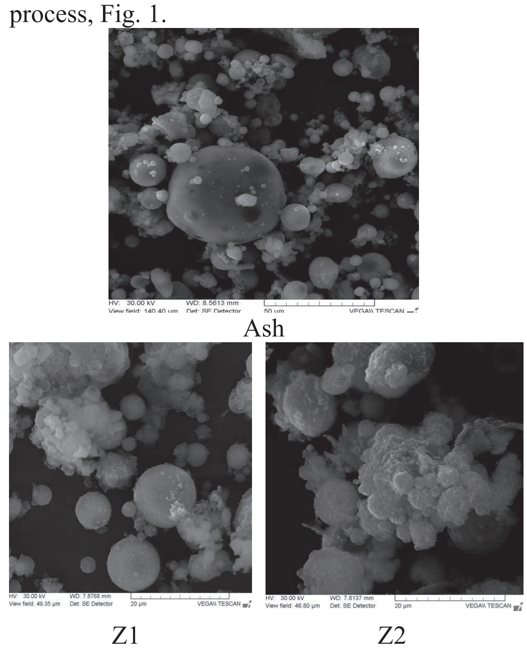


Fig. 1. SEM images for zeolite

From Fig. 1 it can observe that at 8 hours synthesized material have high modifications.
The ash and zeolites synthesized were chemically analyzed and its composition was presented in Table 1.

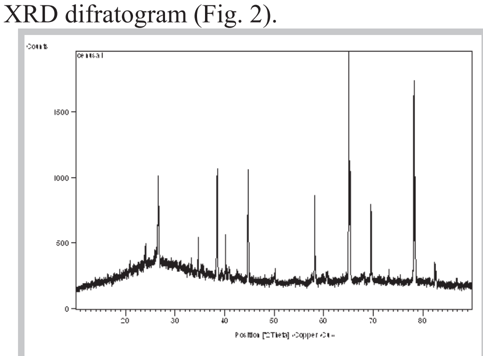
Table 1. The characterization of samples, %

Element	Ash (%)	Zeolite 1	Zeolite 2
O	27.38	26.78	28.24
K	1.38	5.65	5.89
Mg	0.83	1.98	0.76
Al	17.93	17.82	18.88
Si	39.30	38.87	36.58
Na	0.37	0.879	0.92
Ca	5.42	2.45	3.13
Ti	1.65	0.72	0.74
Fe	5.05	5.21	5.74

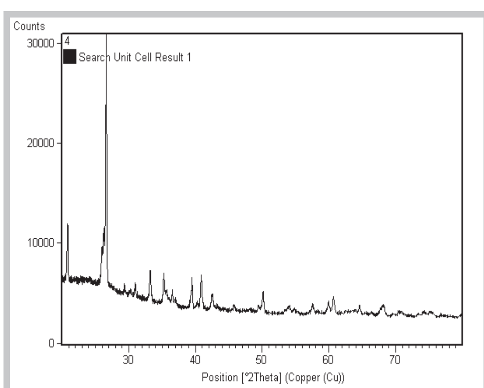
The analysis demonstrated that in ash and in zeolite principal elements the followings: Si, O, Al, Ca, Fe, Na, K, and small quantities Ti and Mg. In zeolite structure appear K ions, because the synthesis was performed with potassium hydroxides and calcium content decreases, which justify that potassium, replace the calcium in structure. Based on their chemical composition, this ash is classified in Class F [20, 21].

The analysis of IR spectrums proves that in the ash samples we can find compounds like: hematite, quartz, kaolin, illit, glow, montmorilonite, carbon. Moreover, these are the compounds which can be found in the clayey material, respectively the fuel's ballast.

The chemical analysis allows the determination of elementary or oxide compounds in the material without offering any information about "mineralogical" composition of the ash. To get some further information about the way the oxide compounds bond we have performed the XRD difratogram (Fig. 2).



ash



Z2

Fig. 2. XRD diffractogram for ash and zeolite Z2

As seen XRD diffractogram (Fig. 2) the ash contains crystalline phases: illite, kaolinite, mullite, hematite, magnetite, rutile and noncrystalline phase [22]. For zeolite Z2 it can observe that in this study K-chabazite was prepared from ash.

The adsorption capacity was studied for copper and nickel ions. Adsorption capacities were determined using the batch equilibrium method.

The zeolite Z2 provides a significant increase of CEC (cation exchange capacity) and the high ability to adsorb heavy metal ions (over 39 mg g^{-1}).

CONCLUSIONS

The aim of this study is synthesis and characterization of zeolitic materials synthesized from ash. Two different zeolite materials, rich in zeolite phases, K-cabazite were obtained from power plant ash, using 3M KOH solutions at atmospheric pressure, temperature below 90°C and contact time of 4 and 8 hours.

The ash contains prevalent silicate dioxide, alumina, iron dioxide, plus unburned carbon in different proportions function the burning conditions. XRD shows that the ash contains crystalline phases: illite, kaolinite, mullite, hematite, magnetite, rutile and noncrystalline phase.

The ash can be used as soil amendments, because not contained heavy metals, and have adequate properties.

The synthesized products provide a significant increase of CEC (cation exchange capacity) and the high ability to adsorb heavy metal ions (over 39 mg g^{-1}). Because synthesized materials have high cation -exchange capacities that can be used as cation-exchange in a soil. The high cation-exchange capacities determined several researches for using of materials for lead and copper removal from soil.

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