MODIFIED OF POWER PLANT ASH FOR REMOVAL OF HEAVY METAL IONS FROM SOIL

Ramona-Carla CIOCINTA[1], Gabriela BUEMA[2], Maria HARJA[2], Carmen CIMPEANU[3], Marinela BARBUTA[2], Daniel BUCUR[1], Daniela BURGHILA[3]

[1]"Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine, Romania
[2]"Gh. Asachi" Technical University of Iasi, Romania
[3]University of Agronomical Sciences and Veterinary Medicine, Bucharest, Romania

Corresponding author email: ciocinta_ramona@yahoo.com

Abstract

In the last years, modified ash has been researched for a variety of agricultural and environmental applications. Modified ash can is used as soil conditioners, amendments, remediation agents in contaminated soils with heavy metal ions. In this paper, the different methods modification of ash with KOH was studied. Ash from thermal power plant and modified ash were used for removal of heavy metal ions from soil. The ash and the modified ash were characterized by microstructure (electronic microscopy SEM), chemical and mineralogical composition (EDAX, XRD diffraction, FT-IR). According to the XRD results, it was proven that the form of modified ash was K-chabazite. The determination removal capacity of heavy metals ions from soil was performed by atomic absorption.

Keywords: *ash, characterization, heavy metal, soil.*

INTRODUCTION

Ash is waste produced by burning coal in power plant. According to the report of American Coal Ash Association in agriculture, wasteland reclamation and civil engineering purposes use 32% of the fly ash, 30% of the bottom ash, 94% of the boiler slag and 9% of flue gas desulfurization sludge (American Coal Ash Association, 1998). Many experiments and studies on the effect and potentiality of ash as an amendment in agricultural applications have been conducted by various agencies, research institutes at dispersed locations all over the world (Basu et al., 2009). Soil properties as influenced by fly-ash application have been studied by several authors for utilizing this waste as an agronomic amendment (Ciocinta et al., 2012; Desmukh et al., 2000; Nidhi, 2003; Inam, 2007a, 2007b). Researchers have noted other beneficial effects of the application of ash soil systems: it improves soil and water retention in the treated zone, the texture of the soil; it reduces the bulk density of the soil, the crust formation, the consumption of other soil amelioration agents such as fertilizers or lime and it can decrease the mobility and availability of metal in the soil (Pandey and Singh, 2010).

The initial studies have proposed diverse hydrothermal activation methods to modified power plant materials from ash. All the methodologies proposed are based on the dissolution of Al Si-bearing ash phases with alkaline solutions NaOH or KOH (Park et al., 2000; Querol et al., 2002; Criado et al., 2007; Rios et al., 2009; Harja et al., 2012a, 2012b; Kowenje et al., 2010; Rosales et al., 2012; Ryu et al., 2006). There are some examples of the direct application of these materials in which it does not require any pre-treatment to develop the required functionality such as its use in agriculture, as an adsorbent for heavy metals.
In this study we characterized the ash and modified power plant ash by different technique, such as microstructure (electronic microscopy SEM), chemical and mineralogical composition (EDAX, XRD diffraction, FT-IR).

MATERIALS AND METHODS

Methods of analysis

In this study was synthesized 1 material based on power plant ash by hydrothermal treatment at 90^0C, 2M of KOH, corresponding to a ratio s/L of 1:3.

The chemical and the mineralogical characterizations were done with the VEGA TESCAN for SEM analysis, EDAX with QUANTA 3D - AL99/D8229 and FT-IR analysis was determined using a DIGILAB FTS 2000 (Harja et al., 2013).

RESULTS AND DISCUSSIONS

Adsorbents characterization

SEM and EDAX analysis

From figure 1 it can be observed that the particles of ash are spherical with different sizes and the modified material presents new crystals due to the hydrothermal treatment. From figure 2 it can be seen that the K content increased because the ash was treated with 2M of KOH solution.

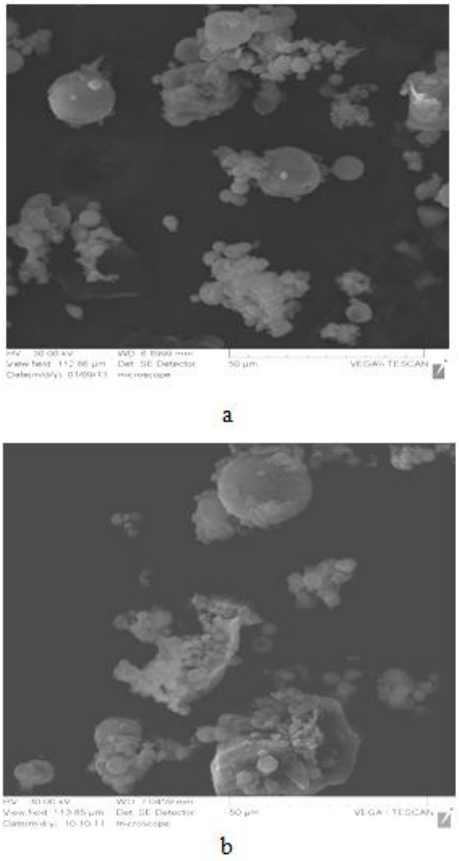

Figure 1. SEM analysis for ash (a) and modified ash (b)

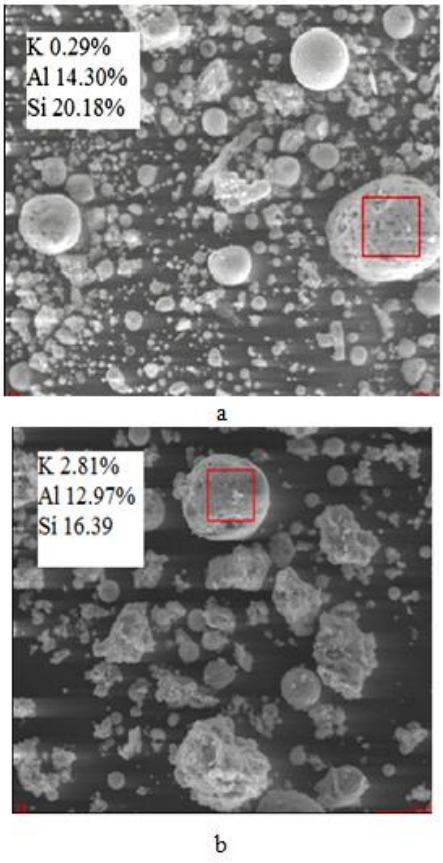

Figure 2. EDAX analysis for ash (a) and modified ash (b)

FT-IR analysis

From Fig. 3 it can be observed the different wavelengths are presented in the case of modified ash.

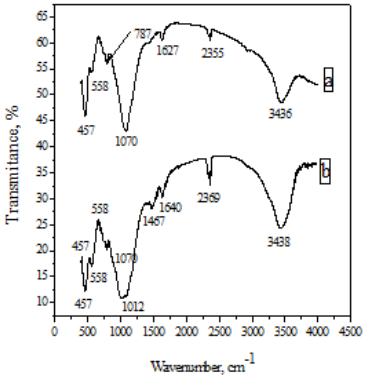

Figure 3. FT-IR analysis for ash (a) and modified ash (b)

The spectrum of materials, from Figure 3 illustrates the presence of absorptions at 457, 558, 787, 1070, 1640 and 2355 and 3436 cm^{-1}. The amorphous aluminosilicate samples showed a broad band centered at around 1070 cm^{-1} that corresponded to Me–O–Me (where Me is either Si or Al that is tetrahedrally coordinated) (Harja et al., 2013). The band at 787 and 558 cm^{-1} are due to the Me–O–Me symmetric stretching. The band at 457 cm^{-1} is assigned to the Si–O–Al symmetric bending modes. The FTIR band at 787 cm^{-1}, that can be assigned to the amorphous precursor of zeolite (Izidoro et al., 2012a, 2012b; Shigemoto et al., 1995; Rasouli et al., 2012)), not appear at modified material, because this material presented a high degree of crystallization. The band at 1640 cm^{-1} has been associated with the characteristic bending mode of water molecules. (Musyoka, et al., 2012).
It can observe that modified material presented a pick at 1467 cm^{-1}, which corresponding of K-chabazite zeolite, fact confirmed of XRD analysis.

CONCLUSIONS

For modified power plant ash we worked by direct hydrothermal treatment at 90^0C, 2M of KOH solution, ratio s/L:1-3, 4h time of contact.

From SEM images it can be seen that the new crystals were deposited on the surface of ash particles due the hydrothermal treatment.

Ash has Si/Al ratio in the range of 1.2 -1.4, which proves that is a good source to synthesized materials.

From FT-IR analysis shows that different wavelengths are presented in the case of modified power plant ash.

This type of new material can be used for retain heavy metal ions from soil.

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