PREPARATION OF ALUMINOSILICATES WITH A HIGH CATION EXCHANGE CAPACITY FROM AGRO-INDUSTRIAL WASTE

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Abstract—Rice husk ashes are a potential source of pollution, thus there is continued interest in its recycling. An environmentally friendly solution is its conversion into products such as aluminosilicates that are designed for use as fertilizer. Aluminosilicates that present a high cationic exchange capacity becomes an excellent material to be used in soil for accumulating and liberating nutrients slowly to the plants. The aim of this study is to investigate the effects of the alkali concentration in the cationic exchange capacity of an aluminosilicate obtained from rice husk ashes. The obtained products were characterized by X-ray diffraction, scanning electron microscopy, atomic absorption spectroscopy, and cationic exchange capacity. The particles that were produced are composed of crystals smaller than 5 μm. The experimental conditions employed in this work produced a semi-crystalline aluminosilicate with a high cationic exchange capacity. The alkali concentration used had an influence on this property.

Keywords—Aluminosilicate, cation exchange, rice husk ash, preparation.

I. INTRODUCTION

In the Federal State of Rio Grande do Sul (Brazil), rice production is approx. 5,137 million t per year. Since the husks represent 20 wt.% of this value, the annual production of this residue in the state is approximately 1,027,400 t. These husks are burned for energy production, in turn generating great amounts of ashes (~200,000 t per year). As the rice husk ashes (RHA) present more than 90 wt.% of silicon, its use as a silicon source in aluminosilicates synthesis constitutes an alternative for the reduction of costs and environmental damage. The disposal of ash in the soil is limited because of its chemical composition (Prasetyoko et al., 2006).

The ashes generally have small amounts of nutrients, an undesirable value of pH, salinity and traces of toxic elements such as As, B, Ba, Cd, Cr, Pb, Hg, Mo, and Se (Pandey et al., 2009). The RHA can be used as adsorbent in the process of gold extraction, in the production of silicon carbidic (SiC), as a load in polymers, as an additive for cement, in the manufacture of concrete, and as support for the preparation of nickel-based catalysts (Foletto et al., 2005). An alternative technology is to use the ashes as a source of silicon for aluminosilicates synthesis with a high cation exchange capacity. These aluminosilicates can be used to wrap and slowly release nutrients or micronutrients for plants, especially NH₄⁺, K⁺, Mg²⁺ e Ca²⁺, thus contributing to an increase in the efficiency of the use of fertilizers by reducing the amount required to be applied in plantations. The use of such materials in the soil has as advantages: insoluble in water, which makes it adhere to the particles of soil and remain in the root zone and, therefore, is not leached; the use of potassium aluminosilicate as fertilizer increases the content of sugar and amino acids in plants, generating greater resistance to insects and diseases; enhances the ion exchange capacity of the soil resulting in less need for the use of fertilizers; promotes better plant growth (Kikuchi, 1999).

Several works have been published on the synthesis of aluminosilicates with high cation exchange capacity obtained from different sources of silicon (Berkgaut and Singer, 1996; Inada et al., 2005; Yaping et al., 2008), however, reports on the preparation of aluminosilicates with a high cation exchange capacity obtained from rice husk ashes are scarce in the literature.

In this sense, this work aimed to synthesize an aluminosilicate with a high cation exchange capacity using rice husk ash as a source of silicon.

II. MATERIALS AND METHODS

A. Synthesis

As a silicon source, rice husk ashes generated from an industrial burner of a local industry (INDUBER, Santa Maria, RS, Brazil) was used. As an aluminum source, potassium aluminates were used. They were prepared by the dissolution of 6 g of a aluminum wire (1mm diam., 99.99%, Aldrich) in 288 mL of a potassium hydroxide solution (11 wt.%), using a heating system with reflux. The use of potassium aluminosilicate as fertilizer increases the content of sugar and amino acids in plants, generating greater resistance to insects and diseases; enhances the ion exchange capacity of the soil resulting in less need for the use of fertilizers; promotes better plant growth (Kikuchi, 1999).

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