XXI Brazilian Meeting on Inorganic Chemistry
X Brazilian Meeting on Rare Earths
III Workshop on Theoretical Bioinorganic Chemistry
Belo Horizonte, September 12 - 15th 2024

Synthesis and characterization of geopolymers for adsorption applications

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Thematic Area: Materials Chemistry

Keywords: Geopolymers, heavy metals, adsorption.

Geopolymers (GPs) are alkali-activated aluminosilicates that have been intensively studied due to their low cost, resistance to fire and chemical corrosion, facile synthesis, high durability and low carbon dioxide emissions compared to other traditional methods of materials production.[1] Over the past decade, these materials have been used in a wide range of applications including refractory ceramics, radioactive waste containers, new cements and heavy metals adsorption.[2]

In this study, 6 GPs were synthesized with SiO_2/Al_2O_3 ratios of 3.0 and 3.5 and incorporated with 0, 1 and 2% m/m of H_2O_2. Metakaolin was prepared by calcining kaolin at 700°C in a tube furnace. The activating solution was prepared by mixing a solution of alkaline Na_2SiO_3, deionized water, 35% H_2O_2 and a 10 mol/L NaOH solution. The metakaolin and the activating solution were mixed, and the resulting GP was cured at room temperature for 7 days, when the curing was interrupted, and the samples were manually grinded and characterized.

The GPs were thermally analyzed in an N_2 atmosphere, at a flow rate of 50mL/min and a heating rate of 10°C/min up to 900°C, and the results showed that the geopolymers lost 10-25% of their mass, associated to the release of water retained in the material and consistent with reports in literature.[3] The Brunauer-Emmer-Teller surface area was determined using the N_2 physisorption isotherm with a maximum surface area of 38 m^2/g. The geopolymers were also analyzed via XRD and the results showed that their structure was non-crystalline.

For adsorption analysis, contact tests were conducted with 10 mg of each GP weighed in triplicate and placed in contact with 10mL of 300mg/L solutions -in pHs of 2.74, 5.26 and 6.69- prepared from the salts $Co(NO_3)_2.8H_2O$ and $Pb(NO_3)_2.2H_2O$. The samples were stirred constantly at 200 rpm for 24 hours using an orbital shaker. After this period, the concentration of Pb^{2+} and Co^{2+} ions was measured by atomic absorption spectroscopy. The results showed that the average removal of lead and cobalt was 108 mg/g and 50 mg/g, respectively. In conclusion, the syntheses and characterization of the GPs were successful, and the materials can be applied for heavy metal adsorption with satisfactory results. More adsorption tests will be made to analyse the relations of time and ion concentration with the metal removal.

Acknowledgments: The authors are thankful to CNPq and FAPEMIG for their funding and to the LABPEMOL for the XRD analysis.

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