

Preliminary study of copper(II) ions removal from wastewater using solid residue obtained by co-pyrolysis of lignite and high density polyethylene mixture

Kojic, Ivan¹; Dojcinovic, Iljana²; Stojanovic, Ksenija³

1 University of Belgrade, Innovation Center of the Faculty of Chemistry, Studentski trg 12–16, RS-11000, Belgrade, Serbia; 2 University of Belgrade, Center of Chemistry – Institute of Chemistry, Technology and Metallurgy, Njegoševa 12, RS-11000 Belgrade, Serbia; 3 University of Belgrade, Faculty of Chemistry, Studentski trg 12–16, RS-11000 Belgrade, Serbia.

In the last decade, much attention has been given to thermal treatment (co-pyrolysis) of coal/plastic blends. The hydrocarbon plastic materials, (e.g. polyethylene and polypropylene), which production rapidly increases, should be recycled. They can be the source of hydrogen during the pyrolysis of hydrogen-depleted natural products such as coal and biomass, resulting in a balance of carbon and hydrogen contents and giving the opportunity to certain advantages of the co-pyrolysis process. The composition and quality of liquid and gaseous co-pyrolysis products were evaluated, whereas possible utilization of solid co-pyrolysis product was less investigated. In this study the solid residue obtained by the co-pyrolysis of low quality, mineral-rich lignite taken from the Kostolac Basin, Serbia (45.36 % of ash; 33.42 % of total organic carbon; net calorific value of 9.5 MJ/kg) and high density polyethylene, HDPE (mass ratio, 1:1) at 500 °C was tested as a sorbent for Cu²⁺ ions, considering that as a coaly-based material, simultaneously enriched in clays, it may have good adsorption properties. Sorption experiments were performed using 0.5 g of solid co-pyrolysis lignite/HDPE product, as sorbent which was treated with 5 cm³ of model solutions containing ~200 times higher concentration of Cu²⁺ ions (242.60 mg/dm³), in relationship to its maximal allowed content in surface water of bad quality. Model solutions were prepared using corresponding nitrates dissolved in distilled water. Two model solutions were prepared. The first model solution contained individual Cu²⁺ ions, whereas the second one contained a mixture of Cu²⁺, Pb²⁺, Co²⁺ and Cd²⁺ ions. Concentration of each ion in the latter was also ~200 times higher than its maximal allowed content in surface water of bad quality. The experiments were carried out in cuvettes by ultrasonication (30 minutes) under ambient conditions, followed by centrifugation (3,000 rpm, 10 minutes) to separate liquid (supernatant) and solid phases. Treatment with distilled water was used as a blank. Concentrations of heavy metal ions in initial model solutions and supernatants obtained after sorption experiments were measured using inductively coupled plasma – optical emission spectrometry. The obtained results indicated very efficient sorption of Cu²⁺ ions from its individual model solution, attaining 99.96 %. The efficiency of Cu²⁺ ions sorption was also high (99.95 %) from model solution, which contained mixture of metal ions. It is important to mention that sorption of other metal ions from model solution mixture was also effective (99.99 %, 80.70 % and 71.04 % for Pb²⁺, Cd²⁺ and Co²⁺, respectively). The solid residue obtained by the co-pyrolysis of lignite and HDPE showed better efficiency for Cu²⁺ removal from model waste water than polymer enhanced ultrafiltration, ferric/limestone treatment, sorption by paddy straw, papaya leaf powder and secondary strontium residue, as well as treatment by sand-chemically carbonized rubber wood sawdust column, although our model solution had higher concentration of Cu²⁺ ions (242.60 mg/dm³) than those used in comparing experiments (up to 160 mg/dm³). Furthermore, sorption capacity for Cu²⁺ ion remained high in the presence of other heavy metal ions. Therefore, the preliminary results showed promising sorption properties of solid residue obtained by the co-pyrolysis of lignite and HDPE against Cu²⁺, but also possibly for other heavy metals, particularly, Pb²⁺ ions.