The cesium removal by using the nitric acid treated bamboo charcoal in polysulfone polymer as an adsorbent

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1. Introduction – The cesium (Cs) has been known as a dangerous radionuclide for human health and ecosystem because it has a long half-life and likes to exist as a soluble form when it is exposed to the environments [1]. The physico-chemical adsorption of Cs is one of the effective removal treatment processes from solution. In this study, the polysulfone carrier with HNO_3-treated bamboo charcoal was used to remove Cs from solution and its removal efficiency was quantitatively investigated by laboratory scale experiments.

2. Experimental – Powdered bamboo charcoal was treated by 100 mL of nitric acid (HNO_3) and 10 g of bamboo charcoal were mixed and heated in a hot plate at 120 ℃ for 6 hours. Treated bamboo charcoal was washed with distilled water using the vacuum filter until the pH is 5 or more. Ten grams of polysulfone was shaken in 90 mL of DMF (N, N-dimethyl formamide) solution at 125 rpm for 16 hours. The polysulfone solution was mixed with HNO_3-treated bamboo charcoal and the resulting slurry was dropped into 50 % of methanol solution through a syringe to produce carriers (bead type) [2]. Batch adsorption experiments for the polysulfone carriers were performed with different conditions such as carrier dosages (0.04 – 1.2 g/100 mL), contact times (10 – 240 min), solution pH (3 – 11) and temperature (5 – 30 ℃). Carriers were added to Cs contaminated solution, it was stirred at 125 rpm and the room temperature for 1 hour and the Cs concentration of the supernatant was analyzed on ICP/MASS to calculate the removal efficiency. SEM/EDS (Scanning Electron Micrograph/Energy dispersive Spectroscopy) analysis was also performed to visualize the structure of carrier and the compositional characteristics before/after the experiment.

3. Results and Discussion – From results, the Cs removal efficiency of polysulfone carrier generally increased with the increase of both the bamboo charcoal amount in the carriers and the carrier amount in solution. The Cs removal efficiency reached to 72.67% for the carrier dosage 1.2g per 100 mL of solution. The high Cs removal efficiency was maintained at the wide range of pH (even at low pH condition) and the highest removal efficiency was shown at pH of 5-7 in solution. The adsorption rate is fast and the reaction reached in equilibrium within 6 hours (mostly 1 hour). The Cs removal efficiency was maintained around 70 % at the temperature range of 5 ℃ – 30 ℃. SEM/EDS analyses of the polysulfone carrier after the experiment suggested that the bamboo charcoal carrier has a complicated porous structure and the Cs was sorbed as the form of solid phase in the boundary between the charcoal and the polysulfone matrix and /or the interior of the charcoal.

4. Conclusions – In this study, it was investigated that the polysulfone carrier with HNO_3 treated bamboo charcoal is available to remove Cs from water system such as AMD, seawater and groundwater under wide range of pH and temperature conditions.

5. References

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