



Contribution ID: 640

Type: Poster

Activated carbon as an effective pertechnetate adsorbent

Monday, 14 May 2018 18:30 (15 minutes)

Activated carbon (AC) is pores space bounded by the carbon atoms. Pores of AC are directive for its application. It was shown that, surface modified form of carbon-based materials, are promising sorbents for separation of various radionuclides. In our study 5 AC adsorbents (A-E) are prepared from cellulose wool by treating with different solutions and carbonized at the temperatures of (700-800) °C for Tc adsorption. They are characterized by FTIR for organic functional groups determination, HRTEM for microscopic imaging, liquid N₂ sorption for pore size distribution and specific surface area determination, and acid-base titration conducted potentiometrically for surface charge investigation. Surface area of the sample is within the range of (150-510) m²·g⁻¹. Samples C and E possess also mesopores. AC samples have a positive surface charge and point of zero charge lies in the range of pH 6-8.

Tc is a fission product with a long half-life ⁹⁷Tc (EC; 4.21·10⁶ a), ⁹⁸Tc (β⁻; 4.2·10⁶ a), ⁹⁹Tc (β⁻; 2.1·10⁵ a) formed in the thermal neutron fission of ²³⁵U and ^{99m}Tc is the most commonly used diagnostic tool. One option how to remove or control released Tc in the environment, is sorption process. It has been shown that AC has a relatively high efficiency for Tc retaining (^{99m}TcO₄⁻). Adsorption equilibrium of TcO₄⁻ is reached in few minutes except for sample D (60 minutes). Mechanism of TcO₄⁻ adsorption involves: R-C-OH + TcO₄⁻ = R-C-OTcO₃ + OH⁻ or if phenolic or carboxylic groups are present: R-CO-H + TcO₄⁻ = R-C-H-OTcO₃. Tc can bind direct to the C as -C-OTcO₄ or mechanism involves chemical reduction of the soluble TcO₄⁻ to TcO₂ and its adsorption on the surface. Adsorption of TcO₄⁻ on samples A - E occurs at pH of 2.

Presence of anions suppresses adsorption of TcO₄⁻. HCOO⁻, NO₃⁻, Br⁻, Cl⁻, CH₃COO⁻, SO₄²⁻, and ClO₄⁻ are used to investigate the adsorption competition between TcO₄⁻ and anions. Competition strongly depends on pH, structure of the anions, and standard absolute molar enthalpy of the hydration. The most significant decrease of TcO₄⁻ adsorption is observed in presence of NO₃⁻ and ClO₄⁻. It is due to close values of the highest standard absolute molar enthalpies of hydration. Moreover, ClO₄⁻ has similar tetrahedral structure to TcO₄⁻. Following order for sample A shows the suppression of TcO₄⁻ adsorption from the weakest to the strongest (kJ mol⁻¹): SO₄²⁻ (-1,099) < HCOO⁻ (-384) < CH₃COO⁻ (-374) < Cl⁻ (-359) < Br⁻ (-328) < NO₃⁻ (-316) < ClO₄⁻ (-205).

In order to investigate desorption of TcO₄⁻ and thus reusability of AC, simple column desorption experiments are carried out. Desorption solutions consist of anions as in the previous paragraph, respectively, at pH 12. Continuous gamma measurements show that 1 M ClO₄⁻ has the "strongest" ability to remove TcO₄⁻ from AC. Adsorptions of TcO₄⁻ on samples with oxidized and reduced surface are also studied. Immediate adsorption of TcO₄⁻ makes reduced surface sample preferable to oxidized one. The results obtained in this study improve that activated carbon is an effective sorbent for the separation of the pertechnetate. This work was supported by VEGA Project No. 1/0507/17.

Primary authors: MARTIN, Daňo (Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering, Department of Nuclear Chemistry); MICHAL, Galamboš (Comenius University in Bratislava, Faculty of Natural Sciences, Department of Inorganic Chemistry); EVA, Viglašová (Comenius University in Bratislava, Faculty of Natural Sciences, Department of Inorganic Chemistry); PAVOL, Rajec (Comenius University in Bratislava, Faculty of Natural Sciences, Department of Inorganic Chemistry)

Presenter: MARTIN, Daño (Czech Technical University in Prague, Faculty of Nuclear Sciences and Physical Engineering, Department of Nuclear Chemistry)

Session Classification: Poster SEP

Track Classification: Separation Methods, Speciation