SELECTIVE URANIUM ADSORPTION ON ACTIVATED CARBON

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INTRODUCTION

The environmental pollution is the most serious problem that should be taken into consideration due to increasing population and growth of technology. However, a number of investigations have been performed to prevent environmental pollution. The adsorption process has long been used in the water and waste water industry for removal of color, odor and organic pollution. In order to concentrate aqueous nuclear waste solutions containing metal ions into smaller volume, many processes are being used, such as precipitation, ion-exchange, solvent extraction and adsorption. Adsorption of uranium onto various solids is important from purification, environmental and radioactive waste disposal point of view (1-3).

The preconcentration and separation procedures on adsorption phenomena are important in nuclear and radiation chemistry, industry, medicine and daily life (3). Interest in the adsorption of metal ions for recovery purposes has increased manifold in recent years, because of its simplicity, selectivity and efficiency (1).

Uranium is an element of considerable technological importance. Nuclear power is derived from uranium, which has no significant commercial use other than as a fuel for electricity generation. For this reason, the recovery, concentration and purification of uranium are of great importance. Because of the expected shortage of uranium in near future, further researches are to be directed to the recovery of uranium from nonconventional resources such as natural waters, sea water, industrial waste waters, mine waste water, and other waste sources in relation to the pollution of the natural environment (4, 5).

Many works have been published on the adsorption of various radioisotopes from aqueous solutions on different adsorbents. Among the numerous adsorbents, activated carbon is one of the most widely used and economic adsorbent in the separation and purification.

The activated carbon has strong affinity for organic molecules and contains oxygenated functional groupings on the entire surface which are capable of sorbing metal ions from aqueous solutions. Furthermore, high chemical radiation and thermal stability, rigid porous structure and mechanical strength impart considerable advantages over polymeric materials (2). Activated carbon, due to its selective adsorption, high radiation stability and high purity is often used for the separation of ions from aqueous solutions (3).

The preconcentration of uranium based on adsorption is important because it has found many applications in nuclear industry and from the environmental and waste disposal point of view

and adsorption with activated carbon can be considered as the most effective and economic process.

Various commercial activated carbons with different properties are produced for several applications. The starting material, activation techniques and conditions are the most important factors effect the final properties of the carbon. Almost any carbonaceous material can be converted into activated carbon. Most types of commercial activated carbons are produced from naturally occurring carbonaceous materials like coal, peat, wood, and some vegetables. Activated carbon is produced in granular and powder form. The adsorptive capacity of activated carbon is dependent on its physical and chemical characteristics as well as on the characteristics of the elements in the solution. Generally, activated carbons are mainly microporous, but in addition to micropores they contain meso- and macropores, which are very important in facilitating acces of the adsorbate molecules to the interior of carbon particles (6).

Activation involves two fundamentally different processes:

(i) Chemical activation using chemicals such as phosphoric acid, zinc chloride, potassium sulphide, nitric acid, ammonia, sulphuric acid, potassium permanganate, calcium oxide, applied to the initial uncarbonized material

(ii) Physical activation using gases such as steam, carbon dioxide, carbon monoxide applied to the carbonized materials (6-8).

In comparison with physical activation, advantage of chemical activation is the lower temperature in which the process is accomplished (8).

Practically, the type of raw material and the method of activation are important parameters which may influence the type of porosity (9).

EXPERIMENTAL:

In our study, we have used commercially available activated carbon (Merck 2183) for the adsorption of uranium from aqueous solution. The preparing procedure for activated carbon before using adsorption experiments is shown in Figure 1.

In order to determine adsorption capacity, uranium stock solution was prepared by dissolving $UO_2(NO_3)_2.6H_2O$ (Merck). The experiments were carried out by batch techniques. The amount of adsorbed uranium was determined from the difference between the initial and final concentrations of uranium in aqueous solution by using Shimadzu UV-Vis 260 Recording Spectrophotometer. The uranium adsorption capacity of activated carbon was determined as 0.12 UO_2^{2+} mmol/g. After determining the uranium adsorption capacity of activated carbon, we have investigated the parameters which effect the uranium adsorption such as; shaking time, pH, concentration, temperature and amount of adsorbent. For this purpose, TOPO/DBM method was used to determine uranium in aqueous solution.

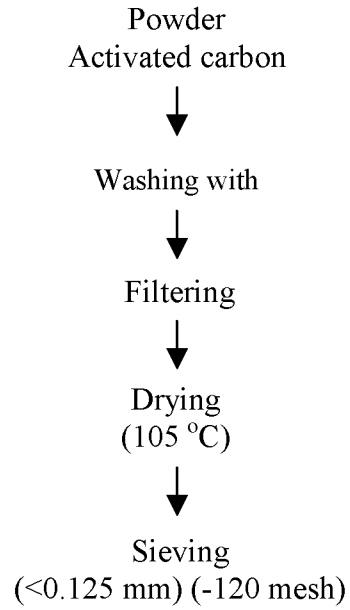

Fig. 1. Flow chart of preparing activated carbon.

RESULTS AND DISCUSSION

Different intervals of time ranging from 5 minutes to 6 hours were examined to determine the effect of shaking time. Then, the most important parameter for the adsorption experiments, effect of pH was examined in the pH range of 2 to 7. After that, the effect of concentration was studied by using five different uranium solutions varying initial concentrations from 100 to 300 ppm. Temperature effect were studied. 30, 50 and 70°C were applied to observe the effect of temperature. Lastly, amount of adsorbent was examined for 0.1, 0.5 and 1.0 g. As a result of these experiments, the optimum conditions were found as: 3 hours shaking time, pH=3, 150 ppm uranium concentration, 50°C temperature, 0.1 g charcoal. We applied these determined conditions and we found that the uranium recovery efficiency was 97.50±0.97%.

These results show that activated carbon can be treated for uranium recovery from aqueous solutions. Activated carbon process, due to its efficient and economical advantages, it can be used for preventing environmental contamination and recovery of uranium from wastes in various stages of nuclear fuel production depending on uranium fuel cycle. However, it is necessary to investigate the effects of interfering elements or ions in the medium.

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