INVESTIGATION OF URANIUM ADSORPTION ON ACTIVATED CARBON

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ABSTRACT

Activated carbon is widely used in the field of nuclean technology because of some specific properties, such as stability towards high temperature and high dose of radiation. The adsorption of aranium on commercially available activated carbon (Merck 2183) has been studied as a function of shaking time, pH, concentration of adsorbate and temperature. The uranium adsorption efficiency was found as 97 ± 1 %.

ÖZET

Aktif karbonun, yüksek sıcaklığa ve yüksek radyasyon dozuna karşı kararlılığı nedeniyle nükleer teknoloji alanında geniş bir kullanım alanı vardır. Ticari aktif karbon (Merck 2183) üzerine uranyum adsorpsiyonu çalkalama süresi, pH, başlangıç uranyum konsantrasyonu ve sıcaklığın bir fonsiyonu olarak incelenmiştir. Uranyum adsorpsiyon verimi %97±1 olarak bulunmuştur.

INTRODUCTION

Preconcentration and separation procedures based on adsorption phenomena are important in nuclear and especially radiation chemistry, industry, medicine and daily life. Interest in the edsorption of metal ions for recovery purpose has increased a lot in recent years, because of its simpilcit, selectivity and efficiency [1-3].

Uranium is an element of considerable technological importance. Nuclear power is derived from uranium, which has significant commercial use as a fuel for electricity generation. For this reason, the recovery, concentration and purtification 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 non-conventional resources such as natural waters, sea water, industrial waste waters and other waste sources cause environmental pollution [4, 5].

Several studies have been published on the adsorption of various radioisotopes from aqeuous 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. Activated carbon, due to its selective adsorption, high radiation stability and high purity is ofter used for the separation of ions from aqueous solutions [3].

There are various commercial activated carbons available with different properties. Almost any carbonaceous material can be converted into activated carbon. Most types of commercial activated carbons are produced from naturally occurring carbonaceous materials such as coal, lignite, coconut shells, polymers, rice husks, peach stones, almond shells and bone.

Activated carbon is produced in granular and powder form. The adsorptive capacity of activated carbon is dependent on its physical and chemical caharacteristics as well as on the characteristics of other elements or elements to be adsorbed. Activated carbons are mainly microporous, but in addition to micropores they contain meso-and macropores. Practically, the type of porosity [6, 7].

MATERIALS AND METHODS

In this study, we have used commercially available activated carbon (Merck 2183) for the adsorption of uranium from aqueous solution. Activated carbon was washed with deiozined water and then dried before using adsorption experiments.

In order to determine adsorption capacity, uranium stock solution was prepared by dissolving $U0_2(NO_3)_2.6H_2O$ (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 adsoption capacity of activated carbon, the parameters which affect the uranium adsoption such as shaking time, pH, concentration and temperature were investigated. For this purpose, TOPO/DBM method was used to determine uranium in aqueous solution.

RESULTS AND DISCUSSION

Effect of Shaking Time

25 ml of uranium solution (100 ppm) was shaken with 0.1 g of activated carbon at different intervals of time ranging from 5 minutes to 6 hours in order to examine the effect of shaking time. By increasing the shaking time from 5 minutes to 6 hours a slow increase on uranium adsorption (Fig. 1) was observed. For the economical point of view, 3 hours shaking time was selected for all further studies.

Effect of pH

25 ml of uranium solution (100 ppm) was shaken with 0.1 g of adsorbent at different pH values (2 to 7) for 3 hours. The pH was adjusted using Na_2CO_3 and HNO_3. Figure 2 shows the influence of pH on the adsorption of uranium on activated carbon. By increasing the pH from 2 to 3, a rapid increase was observed on uranium adsorption. Maximum uranium adsorption occurs at pH 3 (95.46%). The pH dependence of metal ion adsorption is a complex is a complex phenomenon and strongly influtnces the adsorption efficiency. Uranyl ion can combine easily with carbonate, sulfate and nitrate. About pH 7, the uranyl ion forms very stable complexes with carbonate. As seen from the Figure 2, decreasing adsorption percent is because of the formation of $(UO_2(CO_3)_2)^{2-}$ and/or $(UO_2(CO_3)_3)^{4-}$ stable complexes.

Effect of Initial Uranium Concentration

The effect of uranium concentration was studied by using four different uranium solutions with initial concentrations varying from 100 ppm to 300 ppm for 3 hours shaking time. The results show that uranium adsorption increase up to 150 ppm uranium concentration. At that concentration, the percent adsorption reaches a maximum (96.3%). Because of the higher mobility of uranyl ions (UO_2^{2+}) in dilute solutions, the interaction of the ions with the adsorbent increases. As seen in Fig. 3, 150 ppm uranium concentration was used for all further studies.

Effect of Temperature

The effect of temperature was investigated for 30, 50 and 70°C. Figure 4 shows that distribution coeffecient (K_D) values increase with the increasing temperature. From the results of Figure 4, by increasing temperature 30°C to 50°C, it was observed a slow increase on uranium adsorption. From the economical point of view, 30°C was selected for all further studies.

Optimum Conditions:

pH	= 3
Concentration	= 150 ppm
Shaking Time	= 3 h
Temperature	= 30°C

From those determined optimum conditions, the uranium adsorption yield was found as 97% ±1.

CONCLUSION

The results indicate that activated carbon can be treated for uranium recovery from aqueous solutions. Activated carbon process 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, due to its efficient and economical advantages. However, it is necessary to investigate the effects of interfering elements or ions in the medium.

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LEGEND OF FIGURES

Figure 1. Effect of shaking time (0.1 g adsorbent, 100 ppm uranium concentration, V=25 ml. 30C).

Figure 2. Effect of pH (0.1 g adsorbent, 100 ppm uranium concentration, V=25 ml, 30 C, 3 h shaking time).

Figure 3. Effect of uranium concentration (0.1 g adsorbent, V=25 ml, 30 C, 3 h shaking time, pH=3)

Figure 4. Effect of temperature (0.1 g adsorbent, 150 ppm uranium concentration, V=25 ml, 3 h shaking time).

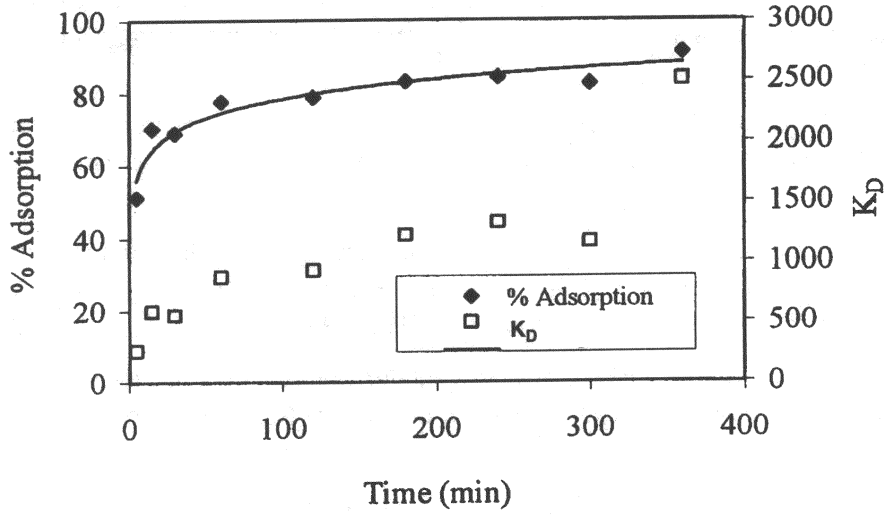


Figure 1.

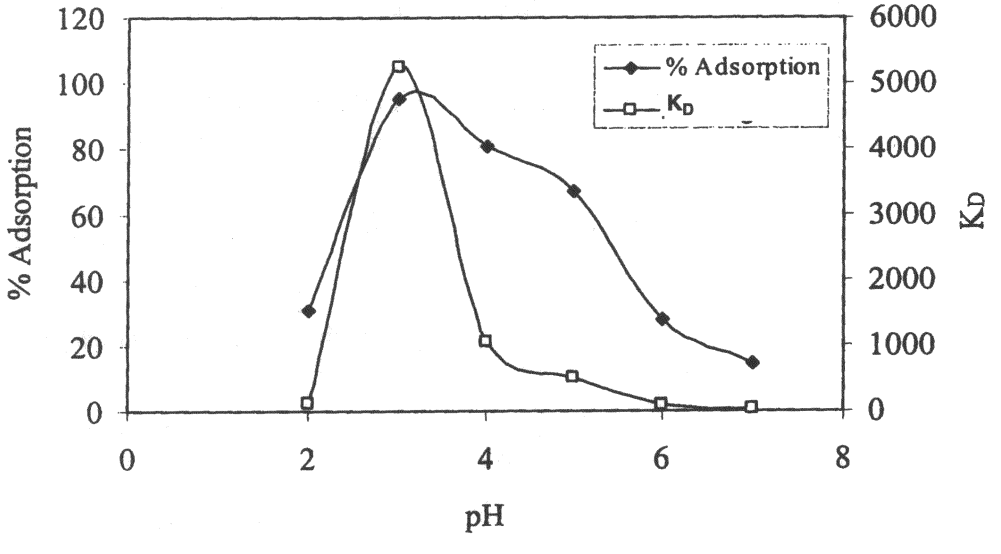
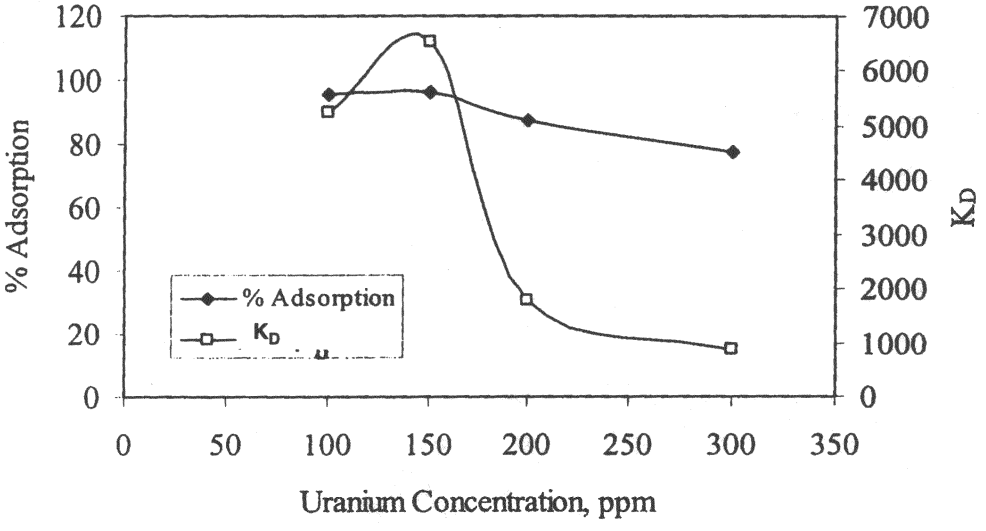


Figure 2.



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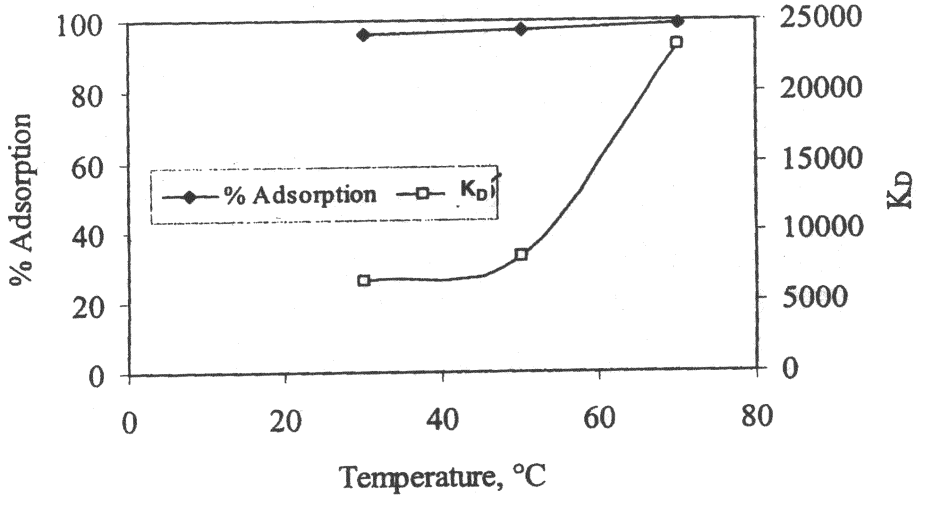

Figure 4.