Removal of TcO_4^- with Extractant Impregnated Resin

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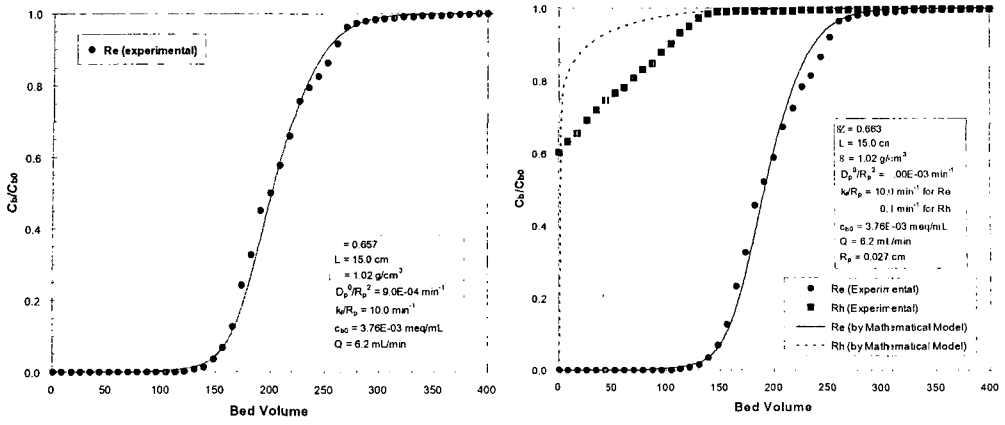
Removal of Tc-99 has long been an important issue due to its long half-life and radiotoxicity. It exists in an aqueous solution as a pertechnetate ion, TcO_4^-, which is very mobile in soil, ground and surface waters. In this study, an adsorptive separation of rhenium which is a chemical analogue of technetium and rhodium by using a jacketed glass column packed with the EIR (XAD-4 Resin Impregnated with Aliquat 336) was tentatively performed. Breakthrough behavior for the single and mixed component solutions was investigated. The breakthrough curves were modeled mathematically to understand the mass transfer resistances in the column.

Breakthrough curves for the mixed solutions of the rhenium and rhodium ions showed the breakthrough volume of about 122 BV for rhenium when 0.8 % of an initial concentration is considered as a breakthrough point. Within this volume, a very pure rhodium of more than 99 % is recovered. The breakthrough curve reaches its saturation point at about 270 BV and then the loading capacity for rhenium becomes about 1.30 meq/g. On the other hand, the breakthrough curve of rhodium starts at about 0.6 of an initial concentration and reaches its saturation point at a bed volume of less than 150 with a loading capacity of about 0.09 meq/g. As we described in our previous research [1], it is due to the fact that the rhodium ion in a nitric acid solution exists mainly in the form of oligomers with a positive charge which is hard to be adsorbed onto anion exchangers.

The breakthrough curves for the rhenium and rhodium ions were modeled to evaluate the effective diffusivities for the EIR column. Modeling examples for the single and the two component systems are shown in Figs. 1 and 2, respectively. For the single component system shown in Fig. 1, the model predicts the experimental data quite well. The diffusion time constant for rhenium obtained by the modeling is 9.0×10^{-4} min^{-1}. Since the particle radius is 0.027 cm, the effective diffusivity for rhenium is 6.6×10^{-7} cm^2/min. The modeling results for the two component system, as given in Fig. 2, also show a successful simulation for the breakthrough curve of rhenium. The diffusion time constant is almost the same as that for the single component system. However, in the case of rhodium, the model does not predict the experimental data. This might be caused by an inaccurate estimation of the equilibrium parameters due to an unfavorable adsorption of rhodium. The effective diffusivities obtained for an adsorption of rhenium and rhodium with the EIR column are rather new ones so they could not be compared with other results directly.



(a) (b)

Fig. 1. Modeling example for the breakthrough cures of the rhenium and rhodium ions in the single component (a) and Multi-component (b) Systems with an EIR column

The saturated bed was eluted fractionally with nitric acid solutions. The relation between the purity and recovery for the rhenium is summarized in Table 1. As shown in the table, the total recovery for rhenium is about 98 % and the purity is 97.5%. The recovery, however, can be controlled by fractionally collecting the elution volume depending on the desired purity. Thus, if the recovery is reduced to 94.6 %, the purity becomes more than 99 %. These results, although they are the results for a chemical analogue of Tc, show the possibility for a recovery of radioactive technetium from a nuclear stream. On the other hand, rhodium, due to its complex chemical forms in a nitric acid solution, would require other methods for a selective separation.

Table 1. Relation between recovery and purity of rhenium for the desorption steps

1st step (desorption with 0.5 M nitric acid)		2nd step (desorption with 1 M nitric acid)		Total	
Recovery (%)	Purity (%)	Recovery (%)	Purity (%)	Recovery (%)	Purity (%)
64.5	99.4	33.0	95.2	97.5	98
62.3	99.9	30.1	98.9	94.6	99.2
60.9	99.9	27.0	99.9	91.5	99.5
51.3	99.9	17.9	100.0	89.3	99.9

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