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PREPARATION OF CONCENTRATED RHENIUM SOLUTIONS

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Abstract

The conditions of the desorption of rhenium from the anion exchange resin Dowex 1×8 by nitric acid were determined. The solution (5×10^{-3} mol/dm^3 Re in 0.15 mol/dm^3 NaCl) was passed through the column containing 0.1 g of the resin. The total sorbed amount of rhenium was 200 mg/g of the resin. It was then eluted by nitric acid in the concentration range of 0.16-7.2 mol/dm^3. The most favourable elution profile was found with 3.0 mol/dm^3 HNO_3. Over 77% of the total rhenium was desorbed with 5 ml of this eluence. Over 95% of the sorbed rhenium was recovered by using 20 ml of nitric acid in the concentration range of 0.9-7.2 mol/dm^3.

Introduction

Low concentrations of elements often restrict their intended use. Simple, rapid and effective methods are hence needed to achieve their favourable concentrations. There are reports in the literature describing several approaches to solve this problem. One of the most promising is based on ion exchange. The dilute solution of the desired element is passed through a column containing either inorganic or organic ion exchanger [1,2]. Then, it is recovered in much higher concentration by the elution with as small as possible volume of an appropriate eluent. The efficacy is determined by the elution profile, i.e. by the ratio of the desorbed element in the first fractions of the eluate and by the total volume of the eluent needed to desorb practically the whole quantity of the element from the resin.

Such concentration procedures find wide applications. They are used also in radiochemistry to achieve, for example, high radioactive concentration of a given radioisotope suitable for the preparation and use of radiopharmaceuticals [3,4].

The procedure under examination is based on the anion exchange resin Dowex 1×8 onto which rhenium, in the form of perrhenate anions, is sorbed. The paper presents the results of the determination of the conditions of its effective desorption by using nitric acid. The determinations of rhenium elution profiles and of the total elution volume in dependance on the concentration of the acid, are given.

The results of these experiments find application in the development of the procedures for the production of concentrated solutions of the radioisotope ^{188}Re whose physical, chemical and biological properties are suitable for the use in the therapeutic nuclear medicine [5,6].

Experimental

Potassium perrhenate ($KReO_4$, p.a., Aldrich) and the resin Dowex 1×8, 100-200 mesh (Aldrich) were commercially purchased p.a grade chemicals.

The experiments were performed in the glass column (5.5 mm I.D., 40 mm length) containing 0.1 g of Dowex 1×8. The freshly prepared solution containing 5×10^{-3} mol/dm^3 Re in 0.15 mol/dm^3 NaCl was passed through the column. The total amount of sorbed rhenium was 200 mg/g of the resin. The flow rate was 3 ml/min.

The elution of rhenium was performed by nitric acid, concentrations 0.16, 0.9, 1.6, 3.0, 6.0 and 7.2 mol/dm^3. The flow rate was 3 ml/min. The effluent solution was collected in 5 ml fractions.

The flow rate was kept constant by using Masterflex C/L pump (Cole Palmer Instrument Company).

The concentrations of rhenium in the solutions were determined by the direct current argon arc plasma atomic emission spectroscopy (DCP-AES) with aerosol supply [7].

The experiments were performed at room temperature.

Results and Discussion

In the experiments, the dependance of the efficiency of the elution of rhenium from the resin on the concentration of nitric acid was determined. Determined were the elution profile of Re, i.e., the ratio of the total sorbed rhenium found in the first 5 ml of the eluate and the total volume of the acid of the corresponding concentration, needed for the recovery of more than 95% of the sorbed rhenium. These results are given in Table I.

According to the data given in Table I it can be concluded that the elution profile depends on the concentration of HNO_3. The most favourable result is obtained if rhenium is desorbed by 3.0 mol/dm^3 HNO_3. In this case the first fraction of the eluate (5 ml) contains 77.2% of the total Re.

It can also be seen that the total volume of the eluent needed to desorb practically all rhenium, depends on the concentration of HNO_3, too. Except for the lowest (0.16 mol/dm^3 HNO_3), for all higher concentrations of the acid used in the experiments (0.9 – 7.2 mol/dm^3), more than 95% rhenium is desorbed by 20 ml of the eluent.

Table I. The dependance of the efficiency of the elution of rhenium from Dowex 1×8 on the concentrations of the eluent HNO_3

Sample	Volume (ml)	Eluted rhenium (%)					
		0.16 mol/dm^3	0.9 mol/dm^3	1.6 mol/dm^3	3.0 mol/dm^3	6.0 mol/dm^3	7.2 mol/dm^3
1	5	5.6	55.4	65.7	77.2	63.2	66.4
2	5	12.2	24.6	20.9	15.9	20.7	21.5
3	5	12.6	10.4	9.2	5.7	10.1	4.9
4	5	11.8	5.3	4.5	2.1	5.2	2.3
Σ	20	42.2	95.7	100.3	100.9	99.2	95.1

Column: 5.5 mm I.D., 40 mm length
Bed: 0.1 g Dowex 1×8, 100-200 mesh (Aldrich)
Total rhenium sorbed on the resin: 200 mg Re/g of the resin
Flow rate of the eluent HNO_3 solution: 3 ml/min

Conclusion

The results presented in this paper reveal that the perrhenate anions sorbed on Dowex 1×8, can be effectivelly desorbed by nitric acid. The elution profile and the total volume of the eluent needed to desorb practically all rhenium, depend on the concentation of the acid. The best results are obtained with 3.0 mol/dm^3 HNO_3.

This confirms the applicability of the proposed concept of the concentration based on the sorption of rhenium from diluted solutions on anion exchangers and its subsequent elution by acid. However, before its itroduction into routine practice, further investigations are needed.

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