TUNGSTATE AND CARBONATE IONS SORPTION USING ANION EXCHANGERS AV-17-8 AND PUROLITE A400

S. Chegrintsev[1,2], R. Kraydenko[1,3], A. Dyachenko[1,4] and A. Kiselev[1,5]

[1]Tomsk Polytechnic University, Tomsk, Russia, [2]chesen@tpu.ru , [3]kraydenko@tpu.ru, [4]atom@tpu.ru, [5]hassem@tpu.ru

Abstract. The current paper shows the results of tungstate and carbonate ion sorption using strongly basic anion exchangers AV-17-8 and Purolite A400. It has been established that anion exchanger AV-17-8 in the chloride form with parameters of 168 g of tungstate ion and 157 g of carbonate ion per 1 kg of anion exchanger has the maximum capacity for the tungstate and carbonate ions.

1 Introduction

Traditional tungsten technology consists in obtaining tungsten concentrate by physical methods of enrichment and its processing by autoclave soda leaching [1, 2]. Tungsten is usually extracted from the solution by tungstic acid precipitation or by extraction [3, 4]. In both cases the processing reagent, used for the sodium carbonate leaching, is decomposed by acids to reduce the pH level of productive solution [5, 6]. Thus, it is impossible to regenerate the processing reagent and use it repeatedly for autoclave soda leaching.

Ion exchange is an alternative method of the direct solvent extraction of tungsten from soda solution (Na_2WO_4) [7]. When using strongly basic anion exchangers, there is no necessity to change pH of the solution, and, thus, the excess of sodium carbonate is not decomposed [8]. In the alkaline solution tungsten is stable in the form of tungstate ion WO_4 [2-9]. The productive solution containing sodium carbonate and sodium tungstate as macrocomponents as well as such impurities as silicate and sodium arsenate is supplied to the ion exchange.

The Russian strongly basic anion exchanger AV-17-8 and its foreign analogue Purolite A400 are proposed to be studied as a strongly basic anion exchanger (table 1). The most important characteristic of ion-exchange anionites is a total exchange capacity indicating the amount of adsorbed substance [10, 11]. This article presents the study of the total exchange capacity of anion exchangers in a chloride, nitrate, hydroxide and sulfate form for tungstate and carbonate ions.

Table 1. Characteristics of anion exchangers AV-17-8 and Purolite A-400 [12, 13].

	AV-17-8	Purolite A-400
Type	Strongly basic anion exchanger	Strongly basic anion exchanger
Matrix	Styrene-divinylbenzene gel	
Functional Group	Quaternary amine	
Physical appearance	Spherical granules from light yellow to dark yellow	Transparent golden spherical particles
Delivery form	OH^- / Cl^-	OH^- / Cl^-
Total capacity, no less, m-mole/cm^3	1.30	1.30
Dynamic exchange capacity, no less, meq./l	850 - 900	800
Moisture content, %	42 - 48	48 - 57
Bulk density, g/ml	0.67 - 0.73	0.69
True density, g/ml	1.07 - 1.10	1.06
Granule size, mm	0.32 - 1.25	0.30 - 1.20
Effective size, mm	0.40 - 0.70	
Uniformity index, ≤	1.6	1.6

2 Experimental

All reagents used in this study were of analytical grade (A.R). They are the ammonium paratungstate (A.R.), Na_2CO_3 (A.R.), NH_4Cl (A.R.), NH_4OH (A.R.), NH_4NO_3 (A.R.), $(NH_4)_2SO_4$ (A.R.), anion exchangers AV-17-8 and Purolite A400. Using ammonium paratungstate and sodium carbonate, stock solutions for the sorption were

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prepared. Sodium chloride, hydroxide, nitrate and sulfate solutions were used to recharge the anion exchanger (table 2).

Table 2. Solutions concentration to recharge anion exchangers.

Anion	*Compound*	Solution concentration
Cl^-	NH_4Cl	350 g/l
OH^-	NH_4OH	1700 g/l
NO_3^-	NH_4NO_3	1500 g/l
SO_4^{2-}	$(NH_4)_2SO_4$	600 g/l

The content of a tungstate ion in solution was determined by atomic emission spectrometry iCAP 6300 DUO. Analytical wavelengths 207.911 and 209.475 nm were used for the analysis. The analytical method was calibrated by SSRS (State Standard Reference Sample) of tungsten solution. The content of carbonate ion in solution was measured by acid-base titration. Methyl orange was used as an indicator, and 0.1 N HCl was used as a titrant.

To determine the total exchange capacity, a 25-ml burette filled with 10 g of the studied anion was used. The anion exchanger was recharged into the required counterion before the experiment. 200 ml of the experimental stock solution was passed through the recharged anion exchanger with the rate of 1 drop per second (3 ml/min). Sampling of 1 ml was selected after each 5-8 ml of stock solution to determine the concentration.

The study has shown that the anion exchanger AV-17-8 in the chloride form with a total exchange capacity for tungsten at least 168 g/kg of anionite is most appropriate to use for the sorption of tungstate ion from the solution (table 3, figure 1). In the case of a carbonate ion, the anion exchanger AV-17-8 in the chloride form has the best indicators; the capacity of the anionite is nearly 157 g of carbonate ions per 1 kg of the anionite (table 4).

Table 3. Capacity of the anion exchangers AV-17-8 and Purolite A-400 for tungstate ion.

Counterion	anion capacity, g/kg	
	AV-17-8	Purolite A-400
Cl^-	168.42	115.92
OH^-	111.91	125.06
NO_3^-	103.22	106.35
SO_4^{2-}	127.26	117.23

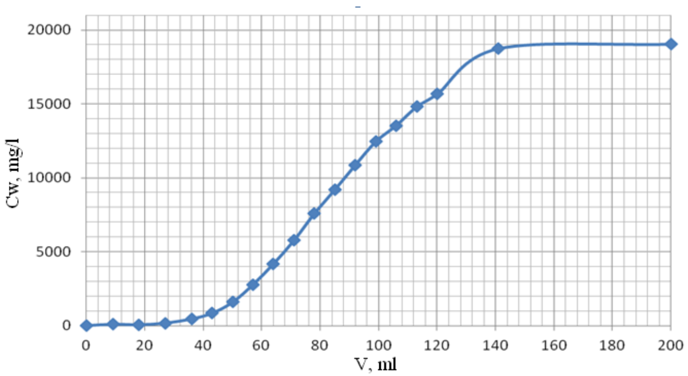

Figure 1. Dependence of the concentration of tungstate ion on the volume of solution passed through the ion-exchange column.

Table 4. Capacity of the anion exchangers AV-17-8 and Purolite A-400 for the carbonate ion.

Counterion	Anion exchange capacity, g/kg	
	AV-17-8	Purolite A-400
Cl^-	157.33	106.13
OH^-	118.32	122.74
NO_3^-	98.79	95.89
SO_4^{2-}	107.35	11.61

3 Conclusion

As anion exchangers AV-17-8 and Purolite A-400 are suitable for extracting tungsten from productive solution obtained after autoclave soda leaching.

The study has shown that the Russian anion exchanger AV-17-8 in the chloride form is the best option for the sorption of tungstate and carbonate ions.

Total exchange capacity of anion exchanger AV-17-8 in the chloride form for tungstate ion is 168 g/kg and for the carbonate ion is 157 g/kg.

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