Scandium Extraction from TiO_2 Pigment Production Residues by Ion Exchange: Evaluation of Two Ion Exchange Resins

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Abstract

This study investigated the potential extraction of Sc from an acidic iron chloride solution , derived from TiO_2 industry using two different ion-exchange resins. The results showed that the impregnated resin containing D_2EHPA was more effective for Sc extraction than the resin containing AMPA. However, both resins co-extracted V, Zr, and Ti. A full operation cycle was carried out using oxalic acid and ammonium fluoride as scrubbing agents to remove impurities and Sc, respectively. These findings demonstrate the potential use of ion exchange for Sc extraction from industrial solutions.

The $FeCl_2$ solution used in this study is already a commercial product!

The challenge in our work is to extract Sc without affecting the content of the solution

Materials and Methods

Table 1. Tested resins characteristics

Name of resin	Lewatit TP260	Lewatit VPOC1026
Functional group	aminomethyl-phosphonic acid (AMPA)	di-(2-ethylhexyl) phosphoric acid (D2EHPA)
Type	Functionalized, weakly acidic	Impregnated, weakly acidic
Matrix	Crosslinked polystyrene	Crosslinked polystyrene
Ionic form received	Na^+	H^+
Density	1.1	0.97
Beads size	0.4 – 1.25 mm	0.4 - 1.25 mm
Expected Capacity	2.3 eq/L (H^+ form)	0.4 eq/L (Zn based)

Table 2. Elemental concentration of $FeCl_2$, feed solution

$FeCl_2$ solution(g/L)												
Fe	Mn	Al	Mg	Na	V	Zr	Ca	Cr	Ti	Sc	Nb	Cl^-
112	19.09	9.11	8.34	6.4	4.2	3.6	2.36	1.69	0.5	**0.13**	0.3	295

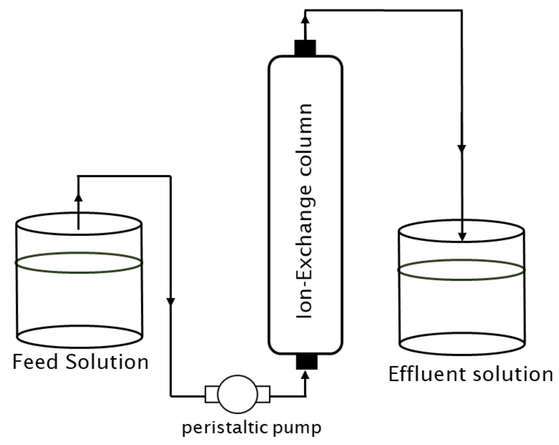


Figure 1. Experimental set-up

Experimental

Comparison of Resins Adsorption Behavior

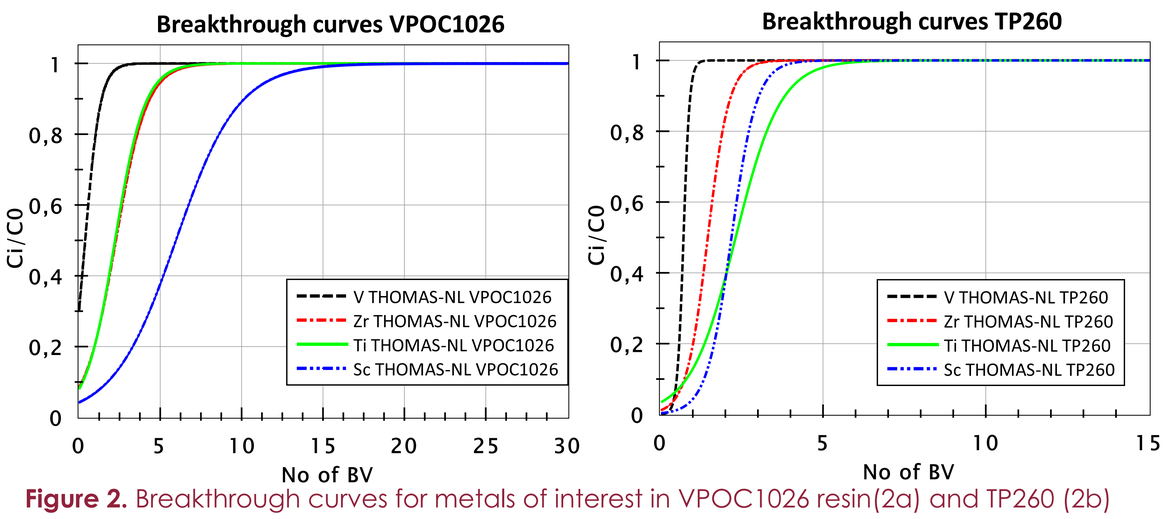


Figure 2. Breakthrough curves for metals of interest in VPOC1026 resin(2a) and TP260 (2b)

- ❖ Sc exhaustion in VPOC1026 is at 15BV while for TP260 is at ~4,5BV
- ❖ Zr, Ti and V are co-extracted in both resins
- ❖ Fe is not adsorbed in either resins

From the breakthrough curves it is shown VPOC1026 is more promising for Sc extraction

One cycle operation of IX column with VPOC1026 resin

Loading

- ❖ Sc extraction is 51% at 10BV.
- ❖ Zr is the major impurity that is loaded in resin
- ❖ Ti and V are also co-extracted
- ❖ Fe adsorption is not detectable - insignificant compared to the initial concentration

	10BV loading	
	Extraction%	qe (mg/ml)
Sc	50.9	1.24
Ti	20.8	1.99
Zr	20.0	13.46
V	3.3	2.66
Fe	<1%	

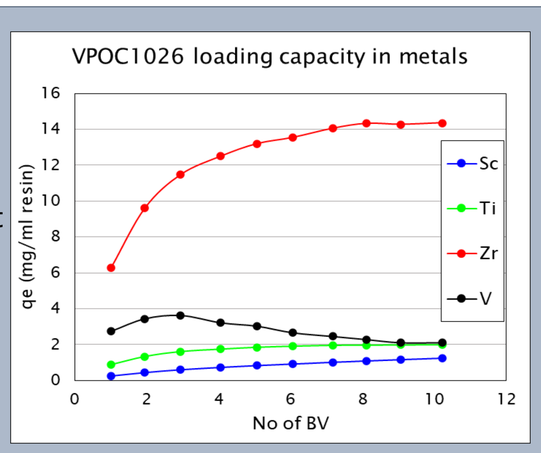
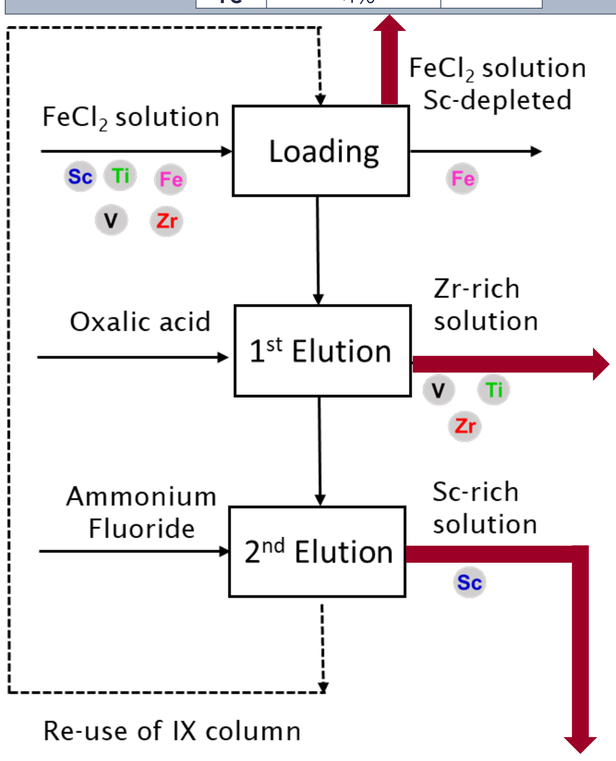


Figure 3. Loading capacity of resin, q_e (mg/mL)



1st elution – oxalic acid

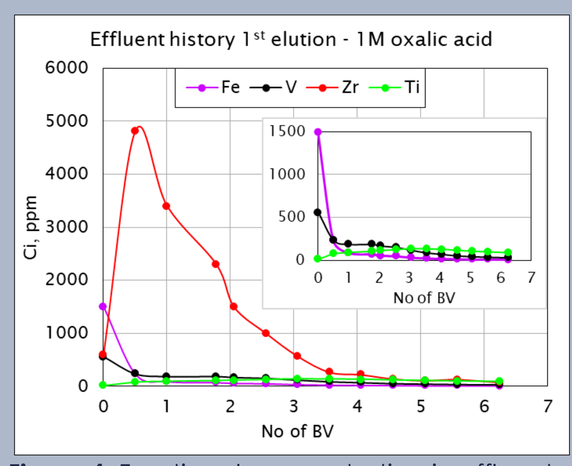


Figure 4. Fractional concentration in effluent solution during oxalic acid elution (ppm)

- ❖ Effluent solution has high concentration in Zr
- ❖ Sc was not detected in the effluent solution

2nd elution – 2M NH_4F

- ❖ Effluent solution is upgraded in Sc!
- ❖ Zr is still the major impurity.
- ❖ 60%Sc extraction is achieved in 2nd step.
- ❖ Sc elution is not over at 6BV.

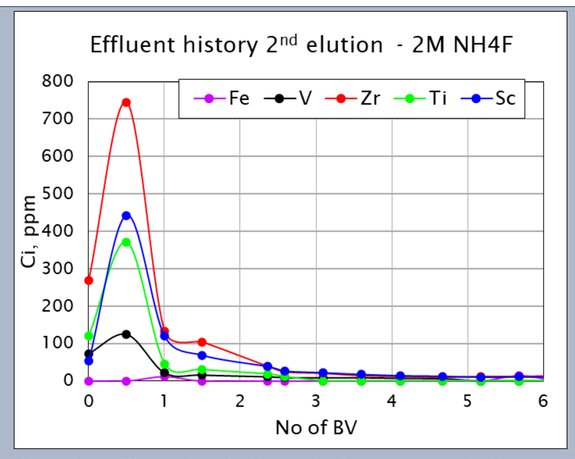


Figure 5. Fractional concentration in effluent solution during NH_4F elution (ppm)

Comments and Remarks

- ❖Lewatit VPOC1026 resin show more promising performance compared to TP260 resin
- ❖Zr, Ti and V are also coextracted with Sc, while Fe content is not affected
- ❖The proposed 2-step elution successfully separated Zr,Ti and V from the loaded resin, leading to a final solution with upgraded Sc content
- ❖Sc extraction was 51% and 64% of that was eluted from resin.

The overall extraction rate can be optimized

Impurities ratios	Fe/Sc	V/Sc	Zr/Sc	Ti/Sc
$FeCl_2$ solution	861.5	32.3	28.3	4
2nd eluate solution	<0.02	0.36	1.9	0.86

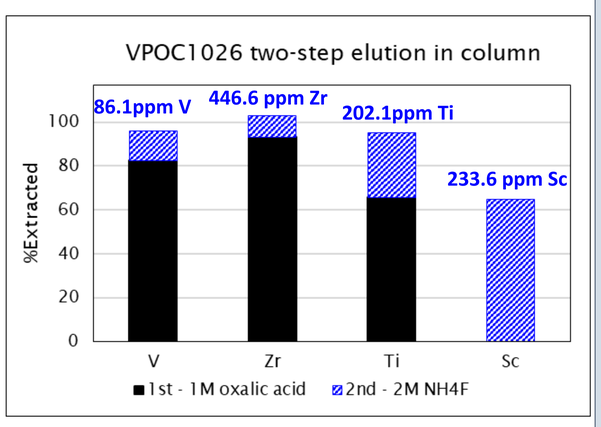


Figure 6. Overall extraction rate of Elution

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