Final degree project

Bachelor's degree in Chemical Engineering

Recovery of rare earth elements from acid mine waters by using phosphate based precipitation processes

Annex

Author: Gissela Chávez
Director: Jose Luis Cortina and Mehrez Hermassi
Ponent:
Announcement: 9 2017

Escola Tècnica Superior
d'Enginyeria Industrial de Barcelona

Annex summary

Glossary

- AMW: acid mine water.
- TAMW: treated acid mine water.
- REE: rare earth elements.
- REO: rare earth oxides.
- TE: transition elements
- BV: bed volume

A. AMW pre-treatment for removal of Fe(III) by oxidation with H2O2 and pH control

	Y	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf
AMW treated with CaO	0	4,1	8,5	9,1	8,2	7,8	0	0	11,1	0,0	0	0	0	0	0	0,0
AMW treated with NaOH	0,6	0,0	1,2	2,3	2,6	0,0	0	0	0,0	0,0	0	0	0	0	0	10,8
AMW treated with MgO	0	0	5,2	2,3	4,1	2,0	0	0	11,1	0,0	0	0	0	0	0	0,0

	Co	Cd	Ni	Ca	Mg	Cu	Zn	Al	Fe
AMW treated with CaO	0	0	0	-	0	1	0	11,6	99,9
AMW treated with NaOH	0	0	0	9	6	3	0	19,3	99,9
AMW treated with MgO	0	0	0	0	-	3	0	19,3	99,8

Tablex 1. Percentage of the concentration variation after oxidation pre-treatment of rare earth elements and transition elements present in the La Poderosa mine water system.

B. Precipitation experiments with phosphate solutions

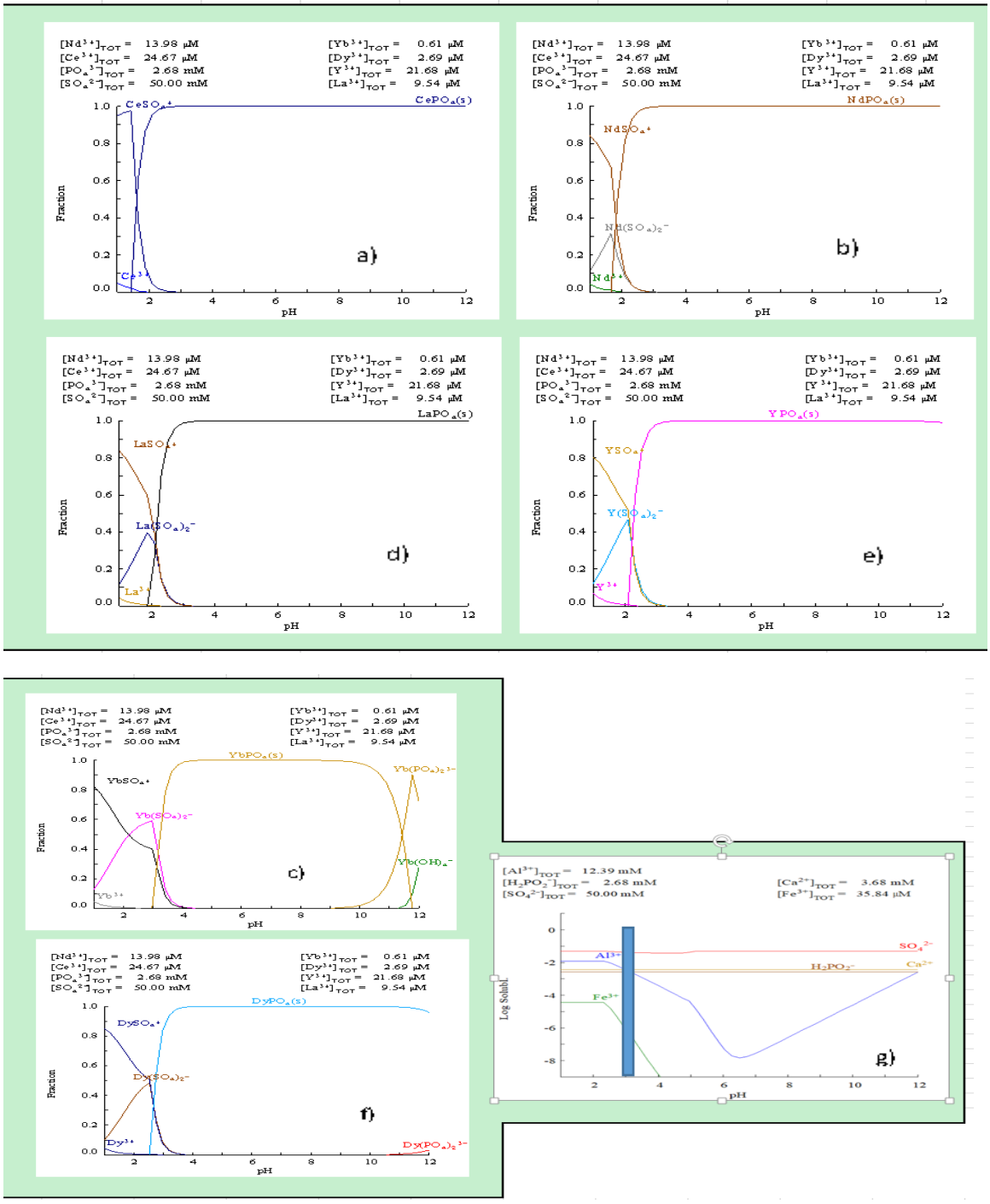
	Y	La	Ce	Pr	Nd	Sm	Dy	Gd	Total REE recovery
Sample 25	27,43	2,16	2,19	2,97	3,74	8,71	20,58	9,26	7,4
Sample 27	11,09	5,49	8,70	10,14	9,73	9,99	10,67	10,71	7,6
Sample 28	14,23	12,87	11,92	9,43	7,41	9,23	11,91	11,82	11,7

Tablex 2.% recovery of the most representative REE in the samples that showed the best results in Test 1.

	Co	Cd	Nl	Mg	Ca	Cu	Zn	Al	Fe
Sample 25	1,5	3,1	0	0	0	0,3	0,8	1,2	
Sample 27	8,5	8,6	3,7	6,8	6,2	8,2	7,2	8,2	3,6
Sample 28	15,3	15,8	3,5	16,1	10,2	17,0	14,3	10,6	

Tablex 3. .%Precipitation of the most representative transition elements in the samples that showed the best results in Test 1.

C. Solubility and fraction diagrams of La Poderosa Mine acid mine water system in SQ=40



Figurex 1. Fraction diagram of Ce (a)), Nd (b)), Yb(c)), La (d)), Y (e)) and Dy (f)) for the La Poderosa mine water system with variation in pH and SQ=40 ([PO_4^{3-}]=2.68 mM).Solubility diagram (g)) to species Al, Fe and Ca. Thermodynamic data from MEDUSA database (Puigdomènech, 2010).

ETSEIB

D. Physical characteristics of the column and calculations

Amount resin S11706	9,53 g
Resin height (h)	6,3 cm
Diameter (d)	1,5 cm
Vb	11,13
Extraction Solution	AMW treated with NaOH
pH	2
Extraction flow Rate (Q)	1 mL/min
Time for the extraction	27.6 h
Elution	H_2SO_4 10M
Elution flow Rate (Q)	0.25 mL/min
Time for the elution	1.6 h

Tablex 4. Physical characteristics of the column

$$Vb = \frac{d^2 \pi h}{4}$$

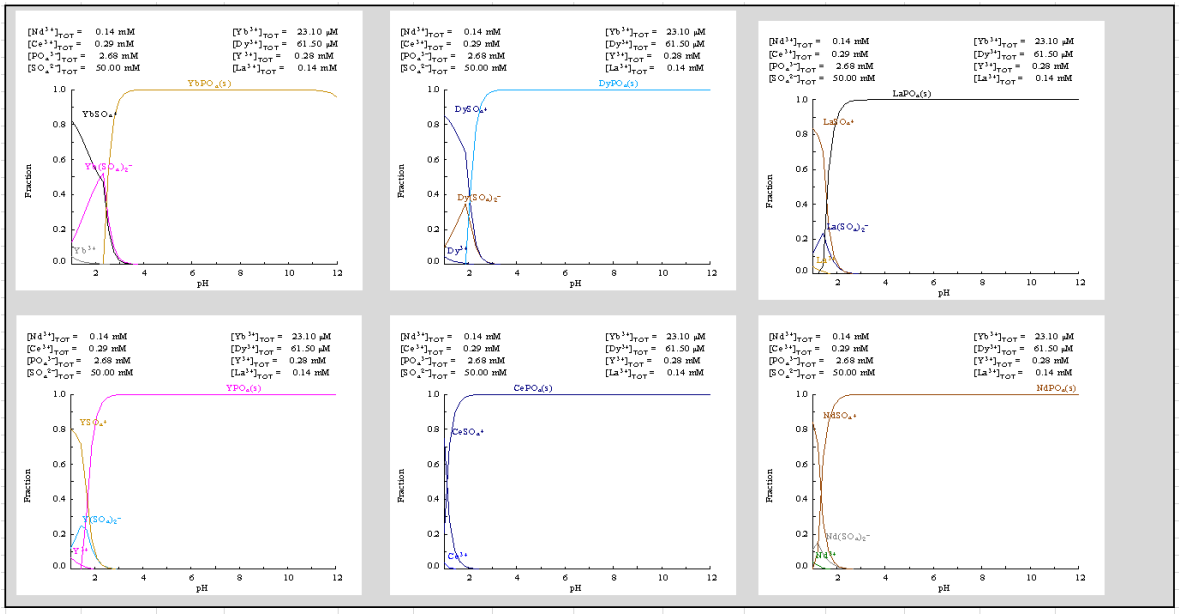
In the experiments, the volumes of solution circulating through the column have been expressed in terms of Bed Volum (BV), which is defined as:

$$BV(t) = \frac{Vs}{Vb}$$

Where Vs is the volume that solution has circulated through the column and Vb is the volume of resin bed in the column.

The representation was done in C / Ci ratio versus the solution volume (in BV): C is the concentration at the exit of the column and Ci is the concentration at the entrance. When there is a good extraction C / Ci → 0, and when there is saturation C / Ci.

E. Fraction diagrams of the system with Y, La, Ce, Nd,Dy, and Yb medium elution point of concentration and SQ=2.5



Figurex 2. Fraction diagrams of the system with Y, La, Ce, Nd,Dy, and Yb medium elution point of concentration and SQ=2.5. Thermodynamic data from MEDUSA database (Puigdomènech, 2010).