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THE LEACHING OF YTTRIUM FROM AVNİK (BİNGÖL -TURKEY) APATITE BY DILUTE SULFURIC ACID

BAHATTİN GÜMGÜM

Dicle University Faculty of Arts and Sciences, Dept. of Chem., Diyarbakır

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ABSTRACT

In some countries the valuable elements such as uranium (U), vanadium (V), Fluor (F) and the rare earth elements are recovered from phosphate rocks as by-products. There is 0,32 % Y_2O_3 in Avnik Apatite in addition to 21,5 % P_2O_5. A sample taken from Avnik region was ground under 100 mesh size. The sample was leached with solutions of sulfuric acid, and the effects of acid concentration, agitation time, and solid / liquid ratio on the efficiency of leaching were investigated. When 1 hour agitation time, 10 % solid/liquid ratio, and 0,3M of sulfuric acid as leach solution are applied then the best results of the leaching of yttrium were obtained.

INTRODUCTION

The recovery of rare elements as by-products from phosphate rocks is becoming very important. The 10 percent of the total uranium production of United States of America was obtained in this way in 1980 (Hurst, 1981). Also, vanadium, fluor, and rare earth elements are obtained as by-products in some countries. (Eisele, 1976; Jonescu, 1980; Kijkowska, 1977; Kijkowska, 1980; Lounamaa, 1980; Shreve, 1967) There are some investigations on the recovery of uranium (Ayan, 1979; Önal, 1976) from the phosphate rocks of Turkey, but the recovery of vanadium, fluor, and rare earth elements have not been considered. The aim of this work is to determine the best conditions for the leaching of yttrium and to make some contributions to this field.

EXPERIMENTAL

The sample of apatite which is taken from Avnik region was ground under 100 mesh size and known quantities of the sample

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were treated with dilute acid solutions. Sulfuric acid was used because it tends to limit the amount of calcium taken into solution. We have investigated the effect of some factors, such as acid concentration, agitation time, and solid/liquid ratio on solubility of phosphate, yttrium, and some other metal ions.

The Effect of Agitation Time: 10.0 g samples of Avnik Apatite were taken into 250 cc beakers and 100 cc portions of 1 M H_2SO_4 solution were added to each of them, and these were agitated by a mechanical stirer at 500 rpm for; 0.5; 1.0; 1.5; 3;4; 6 and 8 hours. Then these were filtered into 100 cc volumetric flasks.

The Effect of Acid Concentration: 10 g samples of Avnik Apatite were taken into 250 cc beakers and 100 cc portions of 0.1; 0.15; 0.20; 0.30; 0.50; 0.70; 1.0; 1.5; 2.0; 2.5; 5.0 M H_2SO_4 solutions were added in each of them. After one hour agitation, the mixtures were filtered into 100 cc volumetris flasks.

The Effect of solid/liquid ratio: 10.0; 20.0; 30.0; 40.0; 50.0; 60.0; 75.0 and 100.0 g of apatite samples were taken into 250 cc beakers and 100 cc portions of 0.3M H_2SO_4 solution are added to each of them, and the process described above was repeated.

The filtrates were taken into 100 cc volumetric flasks and analyzed for their phosphate, yttrium, and vanadium contents. The determination of phosphate in the samples was made by Bosh & Lomb Spectronic-20 spectrophotometer. Yttrium and vanadium were determined by Varian-Techtron Model 1200 Atomic Absorption Spectrophotometer (Jeffrey, 1970).

RESULTS AND DISCUSSION

As can be seen in Table-1 and Figure-1, the overall solubility of phosphate increases with increasing agitation period, but there is little change in the solubility of yttrium.

Table-1. The Effect of Agitation Periods on the Solubility of Some Components in the Apatite.

Period (hours)	0.5	1.0	1.5	3	4	6	8
P_2O_5(g/100 cc)	1.53	1.80	1.81	1.87	1.90	1.93	1.97
Y_2O_3(mg/100 cc)	5.59	5.97	6.35	6.35	5.97	5.97	5.97
V_2O_5(mg/100 cc)	0.30	0.33	0.33	0.40	0.40	0.41	0.41

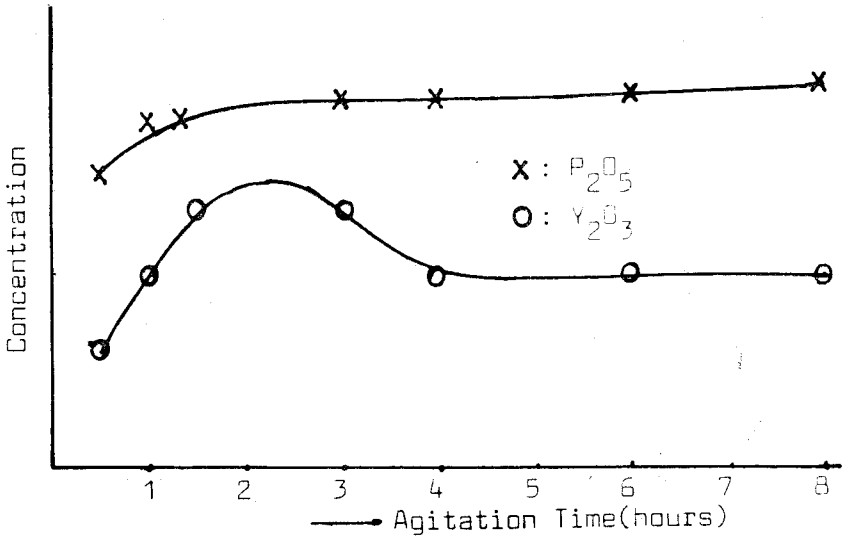

Figure-1. The Effect of Agitation Periods on the Solubility of Some Components in the Apatite

Table-2 and Figure-2 show the extraction efficiencies of phosphate and yttrium trioxide as a function of acid concentration; the optimum leaching of yttrium at the concentration of 0,3M H_2SO_4 can be seen clearly. The solubility of P_2O_5 and V_2O_5 increase by increasing acid concentration.

Table-2. The Effect of Acid Concentration on the Solubility of Some Components in the Apatite

H_2SO_4(M)	0.1	0.15	0.20	0.30	0.50	0.70	1.0	1.5	2.0
P_2O_5(g/100cc)	0.31	0.50	0.71	1.00	1.56	1.67	1.80	1.87	—
Y_2O_3(mg/100cc)	3.05	4.83	6.73	7.37	6.73	6.35	5.97	5.59	5.59
V_2O_5(mg/100cc)	0.13	0.18	0.23	0.23	0.26	0.33	0.33	0.41	0.46

As shown in Table-3 and in Figure-3, while the phosphate rock/acid ratio increases, the contents of dissolved P_2O_5, Y_2O_3, and V_2O_5 per unit weight of each sample decrease.

It can be seen from Table-4, that, when the same sample of Avnik Apatite leached in five successive steps under the optimum conditions (0.3M H_2SO_4, 10 % solid/liquid ratio, and one hour

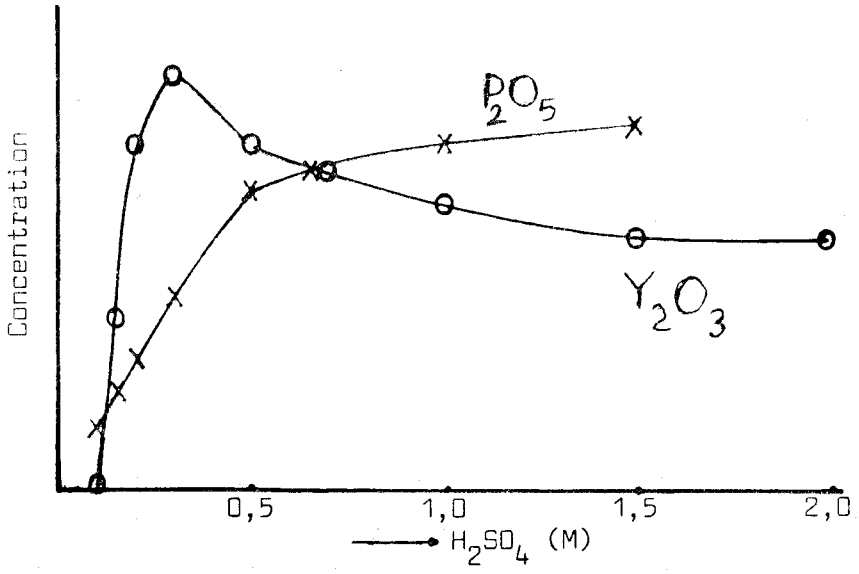

Figure-2. The Effect of Acid Concentration on the Solubility of Some Components in the Apatite.

Table-3. The Effect of Solid/Liquid Ratio on the Recovery of Some Components in The Apatite

The Apatite (g)	10.0	20.0	30.0	40.0	50.0	60.0	75.0	100.0
Rec. of total P_2O_5, %	46.5	24.7	17.2	13.5	10.5	7.8	6.1	4.4
Rec. of total Y_2O_3, %	23.0	9.9	6.2	4.4	—	2.7	2.2	0.2
Rec. of total V_2O_5, %	7.2	4.4	3.8	3.6	3.5	3.0	2.8	2.8

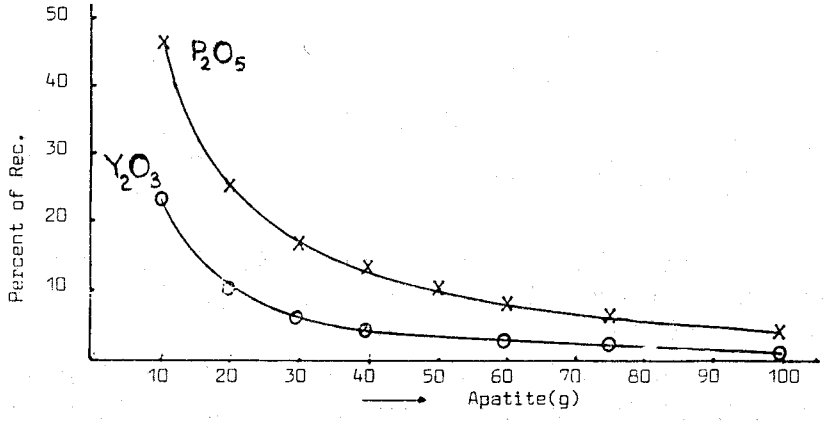

Figure-3. The Effect of Solid/Liquid Ratio on The Recovery of Some Components in The Apatite.

agitation period), the recovery of P_2O_5 and Y_2O_3 reach 96.7 and 65,8 percent respectively.

Table-4. The Recovery of P_2O_5 and Y_2O_3 by Successive Leaching Processes

	Recovery of % P_2O_5	Recovery of % Y_2O_3	Recovery of % V_2O_5
1st Leach Process	46.2	23.2	7.2
2nd Leach Process	33.6	21.0	4.0
3th Leach Process	12.5	15.0	0.6
4th Leach Process	3.7	5.2	0.0
5th Leach Process	0.7	1.1	0.0

CONCLUSION

Avnik Apatite contains 21.5 % P_2O_5, 0.32 % Y_2O_3, and 321 ppm V_2O_5. The yttrium is best solved in 0.3 M H_2SO_4 solution. The solubility of P_2O_5 and V_2O_5 increase by increasing acid concentration and agitation period. However, when the solid/liquid ratio is increased, the recovery of P_2O_5 and Y_2O_3 is highly decreased. When the same apatite sample is leached in three successive steps with 0.3M of H_2SO_4, 10 % solid/liquid ratio and one hour agitation period, 92 % of P_2O_5 and 60 % of Y_2O_3 of the sample are leached into the solution.

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