Supplementary Materials: Selective Flotation of Calcite from Fluorite: A Novel Reagent Schedule

Zhiyong Gao, Yuesheng Gao, Yiyang Zhu, Yuehua Hu and Wei Sun

1. Methodology

In the present study, an $L_{25}(5^6)$ OAD procedure is used with four factors at five levels to search for the optimal reagent scheme for the selective separation calcite from fluorite. The design involved four factors at five levels as shown in Table S1.

Table S1. Attribution of factors to the levels in $L_{25}(5^6)$ OAD experiments.

Level	pH	SOA Dosage (mg/L)	CA Dosage (mg/L)	NaF Dosage (mg/L)
1	8	2	20	50
2	9	4	30	100
3	10	6	40	200
4	11	8	50	300
5	11.5	10	60	400

As shown in Table S2, the chosen $L_{25}(5^6)$ array has 25 rows with six columns. The two response (dependent) variables were fluorite recovery (R_f) and calcite recovery (R_c).

Table S2. $L_{25}(5^6)$ OAD matrix with the experimental results.

No.	pH	SOA	CA	NaF	R_f	R_c
1	8	2	30	300	9.15	59.68
2	9	2	60	400	5.52	58.26
3	10	2	50	50	10.03	56.95
4	11	2	20	200	72.86	75.12
5	11.5	2	40	100	34.24	65.26
6	8	4	40	200	8.15	47.75
7	9	4	30	100	28.76	74.86
8	10	4	60	300	8.12	69.95
9	11	4	50	400	14.92	74.12
10	11.5	4	20	50	77.35	83.26
11	8	6	20	400	13.16	59.95
12	9	6	40	50	20.28	69.21
13	10	6	30	200	44.95	78.26
14	11	6	60	100	9.05	71.1
15	11.5	6	50	300	20.16	78.29
16	8	8	50	100	7.88	62.26
17	9	8	20	300	61.72	81.32
18	10	8	40	400	30.32	75.12
19	11	8	30	50	64.11	80.68
20	11.5	8	60	200	11.24	75.26
21	8	10	60	50	9.16	59.72
22	9	10	50	200	14.18	61.28
23	10	10	20	100	71.58	78.89
24	11	10	40	300	32.69	76.59
25	11.5	10	30	400	68.25	80.05

2. Direct Evaluation Analysis

Direct evaluation analysis was done on the four factors above, respectively, by taking fluorite recovery (R_f) and calcite recovery (R_c) as the evaluation indexes. K_{jm} denotes the flotation recovery at the m level of j factor. There are j = 4 factors and every factor has m = 5 levels, while $\overline{K}_{jm}$ denotes the average values of K_{jm}.

$$R_j = \max(\overline{K}_{j1}, \overline{K}_{j2}, \overline{K}_{j3}, \overline{K}_{j4}, \overline{K}_{j5}) - \min(\overline{K}_{j1}, \overline{K}_{j2}, \overline{K}_{j3}, \overline{K}_{j4}, \overline{K}_{j5})$$

R_j means the range of j factor. A higher R_j value means that this factor has a more significant effect on the flotation recovery, and, accordingly, is a relatively a more important influence factor.

Table S3. Results of range analysis.

		Flotation Recovery			
		pH	**SOA**	**CA**	**NaF**
R_f	$\overline{K}_1$	9.5	26.36	59.33	36.19
	$\overline{K}_2$	26.09	27.46	43.04	30.30
	$\overline{K}_3$	33	21.52	25.14	30.28
	$\overline{K}_4$	38.73	35.05	13.43	26.37
	$\overline{K}_5$	42.25	39.17	8.62	26.43
	R_f	32.75	17.65	50.72	9.82
R_c	$\overline{K}_1$	57.88	63.05	75.71	69.96
	$\overline{K}_2$	68.99	69.99	74.71	70.47
	$\overline{K}_3$	71.83	71.36	66.79	67.53
	$\overline{K}_4$	75.52	74.93	66.58	73.17
	$\overline{K}_5$	76.42	71.31	66.86	69.5
	R_c	18.55	11.87	8.85	5.63

From Table S3, for both R_f and R_c, pH level is a more important influence factor. As pH increases from 8 to 9, R_f increases from 9.5% to 26.1% and 57.9% to 69.0% for R_c. With pH level increasing from 9 to 10 or more, R_c increases very slowly while R_f increases steadily. In pursuit of a higher R_c and a lower R_f, pH 9 is a preferred pH level.

Among four influence factors, NaF dosage is a less important factor for both R_f and R_c. A dosage of 100 mg/L or more is satisfying.

CA dosage is a much more important influence factor for R_c. It has less influence on R_f. A dosage of 50 or 60 m/L is preferable.

For SOA, it is obvious that 6 mg/L is a preferred dosage.

From OAD experiments and direct evaluation analysis, the preferred reagent scheme of NaF 200 mg/L, CA 50 mg/L and SOA 6 mg/L at pH 9 obtained by the OFAT method, was acceptable for the selective removal of calcite from fluorite.