

Supplementary

Table S1. Face-centred central composite experimental design illustrates various factors of time (hour), temperature (°C), and DESs combinations for the chemical leaching of Samarium-Cobalt magnets.

Run#	Factor 1 A: Leaching Time (hour)	Factor 2 B: Temperature (°C)	Factor 5 E: Combinations	Response 1 R1 (Co) (%)	Response 2 R2 (Sm) (%)
1	0.59	60	Ethaline	0.32	0.67
2	1	60	Ethaline	1.26	5.72
3	2	60	Ethaline	6.43	5.67
4	0.59	80	Ethaline	1.67	3.24
5	1	80	Ethaline	16.05	12.19
6	2	80	Ethaline	23.42	14.32
7	2	80	Ethaline	23.47	14.56
8	2	80	Ethaline	23.52	14.16
9	2	80	Ethaline	23.48	14.29
10	2	80	Ethaline	23.43	13.76
11	0.59	90	Ethaline	8.42	5.87
12	1	90	Ethaline	20.34	14.87
13	2	90	Ethaline	37.70	18.39
14	0.59	60	Oxaline	3.45	0.04
15	1	60	Oxaline	20.87	0.42
16	2	60	Oxaline	43.99	1.43
17	0.59	80	Oxaline	13.69	0.12
18	1	80	Oxaline	35.33	0.51
19	2	80	Oxaline	65.95	3.49
20	2	80	Oxaline	65.87	3.62
21	2	80	Oxaline	65.68	3.30
22	2	80	Oxaline	65.72	3.45
23	2	80	Oxaline	65.54	3.40
24	0.59	90	Oxaline	30.67	0.52
25	1	90	Oxaline	60.00	2.50
26	2	90	Oxaline	75.00	3.50
27	0.59	60	Reline	2.03	-0.30
28	1	60	Reline	15.36	2.92
29	2	60	Reline	32.25	4.46
30	0.59	80	Reline	12.85	0.15
31	1	80	Reline	25.35	6.56
32	2	80	Reline	57.34	12.72
33	2	80	Reline	57.29	12.42

34	2	80	Reline	57.87	12.98
35	2	80	Reline	57.40	12.48
36	2	80	Reline	57.89	12.37
37	0.59	90	Reline	17.56	1.34
38	1	90	Reline	40.09	8.90
39	2	90	Reline	63.98	16.36
40	0.59	60	EG-TBAC	0.87	0.56
41	1	60	EG-TBAC	3.89	0.34
42	2	60	EG-TBAC	26.58	2.23
43	0.59	80	EG-TBAC	11.41	0.90
44	1	80	EG-TBAC	20.50	2.69
45	2	80	EG-TBAC	52.76	10.28
46	2	80	EG-TBAC	52.45	10.30
47	2	80	EG-TBAC	52.65	10.34
48	2	80	EG-TBAC	52.34	10.30
49	2	80	EG-TBAC	52.73	10.30
50	0.59	90	EG-TBAC	13.45	1.45
51	1	90	EG-TBAC	24.60	4.49
52	2	90	EG-TBAC	60.43	15.67

Table S2. Face-centred central composite experimental design illustrates various factors of time (mins), RVM intensity (%), and DESs combinations.

Run#	Factor 3 A: RVM Intensity %	Factor 1 B: RVM Time min	Factor 3 C: DES Combinations	Response 1: R1 (Co) %	Response 2: R2 (Sm) %
1	10	1	Ethaline	4.7	4.2
2	40	15.5	Ethaline	7.4	9.0
3	70	30	Ethaline	26.3	16.3
4	70	1	Ethaline	5.2	9.9
5	70	15.5	Ethaline	13.5	18.3
6	70	30	Ethaline	44.0	23.4
7	70	1	Ethaline	32.7	15.3
8	70	15.5	Ethaline	38.0	18.5
9	70	1	Ethaline	33.3	15.3
10	10	1	Ethaline	33.7	14.2
11	40	1	Ethaline	6.7	13.0
12	40	15.5	Ethaline	22.3	19.0
13	70	30	Ethaline	54.2	26.8
14	10	1	Oxaline	13.3	1.1

15	40	15.5	Oxaline	30.5	1.4
16	70	30	Oxaline	62.3	2.9
17	70	1	Oxaline	26.3	3.2
18	70	15.5	Oxaline	48.2	2.6
19	70	30	Oxaline	82.3	3.2
20	70	1	Oxaline	68.5	2.5
21	70	15.5	Oxaline	77.5	2.1
22	70	1	Oxaline	68.4	2.6
23	10	1	Oxaline	65.9	2.4
24	40	1	Oxaline	40.5	1.9
25	40	15.5	Oxaline	58.5	7.6
26	70	30	Oxaline	87.9	14.8
27	10	1	Reline	0.5	0.1
28	40	15.5	Reline	16.4	5.7
29	70	30	Reline	45.4	12.7
30	70	1	Reline	18.6	6.2
31	70	15.5	Reline	34.2	11.8
32	70	30	Reline	65.8	19.5
33	70	1	Reline	53.7	11.2
34	70	15.5	Reline	55.6	14.6
35	70	1	Reline	53.6	11.2
36	10	1	Reline	53.3	10.9
37	40	1	Reline	27.4	9.2
38	40	15.5	Reline	45.3	15.7
39	70	30	Reline	75.3	22.9
40	10	1	EG-TBAC	1.0	0.1
41	40	15.5	EG-TBAC	13.6	2.2
42	70	30	EG-TBAC	46.6	7.9
43	70	1	EG-TBAC	11.6	1.9
44	70	15.5	EG-TBAC	32.6	5.2
45	70	30	EG-TBAC	68.9	14.9
46	70	1	EG-TBAC	51.6	7.3
47	70	15.5	EG-TBAC	58.7	11.0
48	70	1	EG-TBAC	52.6	7.4
49	10	1	EG-TBAC	58.9	7.0
50	40	1	EG-TBAC	25.3	5.7
51	40	15.5	EG-TBAC	40.3	11.3
52	70	30	EG-TBAC	71.3	18.2

Table S3. Experimental design based on 16 runs and involves factors of leaching time (1,2,4, and 5 hours) and leaching temperature (60, 70, 80, and 90°C).

Run#	Leaching temperature °C	Leaching time hour
1	60	1
2	70	1
3	80	1
4	90	1
5	60	2
6	70	2
7	80	2
8	90	2
9	60	4
10	70	4
11	80	4
12	90	4
13	60	5
14	70	5
15	80	5
16	90	5

Table S4. Experimental design based on 16 runs and involves the factors of leaching temperature (°C), leaching time (hours), RVM intensity (%), and RVM time (minutes) for resonant vibratory mixing after chemical leaching to study the change in the preliminary kinetic study for Sm-Co magnets.

Run#	Leaching temperature °C	Leaching time hours	RVM Intensity %	RVM Time minutes
1	60	1	10	1
2	70	1	30	12
3	80	1	50	20
4	90	1	70	30
5	60	2	10	1
6	70	2	30	12
7	80	2	50	20
8	90	2	70	30
9	60	4	10	1
10	70	4	30	12
11	80	4	50	20
12	90	4	70	30
13	60	5	10	1
14	70	5	30	12

15	80	5	50	20
16	90	5	70	30

Table S5. Factorial ANOVA parameters for the Reduced 2FI model and Fit Statistics for Co-leaching.

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	25812	13	1986	147.19	< 0.0001	significant
A-Time	12426	1	12426	921.12	< 0.0001	
B-Temp	3774	1	3774	279.80	< 0.0001	
C-DES						
Combinations	6621	3	2207	163.60	< 0.0001	
AB	282	1	282	20.88	< 0.0001	
AC	1129	3	376	27.90	< 0.0001	
BC	119	3	40	2.94	0.0454	
A ²	91	1	91	6.77	0.0131	
Residual	513	38	13			
Lack of Fit	512.02	22	23	623.96	< 0.0001	significant
Std. Dev.	3.67					
Mean	33.52					
C.V. %	10.96					
R ²	0.98					
Adjusted R ²	0.97					
Predicted R ²	0.96					
Adeq Precision	43.89					

Table S6. Factorial ANOVA parameters for Reduced 2FI model and Fit Statistics for Co RVM

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	27200	14	1940	243.00	< 0.0001	significant
A-Time	9640	1	9640	1200.00	< 0.0001	
B-Temp	3360	1	3360	419.00	< 0.0001	
C-RVM Time	46	1	46	5.68	0.0224	
D-RVM						
intensity	816	1	816	102.00	< 0.0001	
E-DES						
Combinations	6420	3	2140	267.00	< 0.0001	
AC	28	1	28	3.51	0.069	
AE	225	3	75	9.36	< 0.0001	
BE	177	3	59	7.37	0.000543	
Lack of Fit	296	33	9	51.90	0.000764	significant
Std. Dev.	2.83					

Mean	41.00
C.V. %	6.91
R ²	0.99
Adjusted R ²	0.99
Predicted R ²	0.97
Adeq Precision	60.60

Table S7. Factorial ANOVA parameters for the Reduced 2FI model and Fit Statistics for Sm leaching.

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	1554	13	120	71.66	<0.0001	significant
A-Time	551	1	551	330.21	<0.0001	
B-Temp	212	1	212	127.21	<0.0001	
C-Combinations	506	3	169	101.06	<0.0001	
AB	69	1	69	41.37	<0.0001	
AC	78	3	26	15.56	<0.0001	
BC	45	3	15	9.00	0.0001	
A ²	22	1	22	13.40	0.0008	
Residual	63	38	2			
Lack of Fit	62.73	22	3	68.97	<0.0001	significant
Std. Dev.	1.29					
Mean	6.68					
C.V. %	19.34					
R ²	0.96					
Adjusted R ²	0.95					
Predicted R ²	0.91					
Adeq Precision	30.83					

Table S8. Factorial ANOVA parameters for Reduced 2FI model and Fit Statistics for Sm RVM

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	2190	13	169	141.00	< 0.0001	significant
A-Time	109	1	109	91.60	< 0.0001	
B-Temp	450	1	450	377.00	< 0.0001	
D-RVM intensity	421	1	421	353.00	< 0.0001	
E-Combinations	861	3	287	241.00	< 0.0001	
AE	31	3	10	8.75	0.000153	

BD	23	1	23	19.30	< 0.0001	
BE	12	3	4	3.39	0.0276	
Residual	45	38	1			
Lack of Fit	45.3	34	1	533.00	< 0.0001	significant
Std. Dev.	1.09					
Mean	9.96					
C.V. %	11.00					
R ²	0.98					
Adjusted R ²	0.97					
Predicted R ²	0.95					
Adeq Precision	50.30					