

Supplementary material

Extraction of platinum and palladium from aqueous solutions using ionic-liquid-modified magnetic nanoparticles

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Table S1. Magnetic parameters for magnetite, Fe₃O₄@SiO₂ and Fe₃O₄@SiO₂-[C₃C₁Im]Cl samples.

Sample	M_s ± Δ (emu/g)	H_c ± Δ (Oe)	M_R ± Δ (emu/g)
Fe ₃ O ₄	81±1	102±11	10.4±0.4
Fe ₃ O ₄ @SiO ₂	42±1	93±7	4.2±0.1
Fe ₃ O ₄ @SiO ₂ -[C ₃ C ₁ Im]Cl	51±1	93±7	5.3±0.1

Table S2. Analysis of variance of the effects of variables in the removal efficiency of Pt at 15 min of exposure.

	Sum of squares	df	Mean square	F-value	p-value	
Model	2855.18	9	317.24	19.40	0.0022	significant
A-pH	105.13	1	105.13	6.43	0.0522	
B-Dose of sorbent	968.00	1	968.00	59.20	0.0006	
C-Concentration	1225.13	1	1225.13	74.93	0.0003	
AB	2.25	1	2.25	0.1376	0.7259	
AC	16.00	1	16.00	0.9786	0.3680	
BC	210.25	1	210.25	12.86	0.0158	
A ²	5.77	1	5.77	0.3529	0.5784	
B ²	3.69	1	3.69	0.2258	0.6547	
C ²	315.92	1	315.92	19.32	0.0070	
Residual	81.75	5	16.35			
Lack of Fit	73.75	3	24.58	6.15	0.1431	not significant
Pure Error	8.00	2	4.00			
Cor Total	2936.93	14				

Table S3. Analysis of variance of the effects of variables in the removal efficiency of Pt at 1 h of exposure.

	Sum of squares	df	Mean square	F-value	p-value	
Model	3955.32	9	439.48	7.57	0.0191	significant
A-pH	36.13	1	36.13	0.6220	0.4661	
B-Dose of sorbent	903.13	1	903.13	15.55	0.0109	
C-Concentration	2112.50	1	2112.50	36.37	0.0018	
AB	42.25	1	42.25	0.7274	0.4327	
AC	36.00	1	36.00	0.6198	0.4668	
BC	400.00	1	400.00	6.89	0.0469	
A ²	120.31	1	120.31	2.07	0.2096	
B ²	0.1603	1	0.1603	0.0028	0.9601	
C ²	330.31	1	330.31	5.69	0.0628	
Residual	290.42	5	58.08			
Lack of Fit	277.75	3	92.58	14.62	0.0647	not significant
Pure Error	12.67	2	6.33			
Cor Total	4245.73	14				

Table S4. Analysis of variance of the effects of variables in the removal efficiency of Pd at 15 min of exposure.

	Sum of squares	df	Mean square	F-value	p-value	
Model	24099.68	9	2677.74	17.23	0.0030	significant
A-pH	3828.13	1	3828.13	24.63	0.0042	
B-Dose of sorbent	1176.13	1	1176.13	7.57	0.0403	
C-Concentration	338.00	1	338.00	2.17	0.2003	
AB	1806.25	1	1806.25	11.62	0.0191	
AC	225.00	1	225.00	1.45	0.2828	
BC	16.00	1	16.00	0.1029	0.7613	
A ²	16512.98	1	16512.98	106.23	0.0001	
B ²	16.67	1	16.67	0.1073	0.7566	
C ²	96.98	1	96.98	0.6239	0.4654	
Residual	777.25	5	155.45			
Lack of Fit	777.25	3	259.08			
Pure Error	0.0000	2	0.0000			
Cor Total	24876.93	14				

Table S5. Analysis of variance of the effects of variables in the removal efficiency of Pd at 1 h of exposure.

	Sum of squares	df	Mean square	F-value	p-value	
Model	22770.15	9	2530.02	18.07	0.0027	significant
A-pH	10512.50	1	10512.50	75.06	0.0003	
B-Dose of sorbent	630.13	1	630.13	4.50	0.0874	
C-Concentration	66.13	1	66.13	0.4722	0.5226	
AB	1056.25	1	1056.25	7.54	0.0405	
AC	0.2500	1	0.2500	0.0018	0.9679	
BC	16.00	1	16.00	0.1142	0.7491	
A ²	9984.00	1	9984.00	71.29	0.0004	
B ²	144.23	1	144.23	1.03	0.3568	
C ²	194.08	1	194.08	1.39	0.2921	
Residual	700.25	5	140.05			
Lack of Fit	698.25	3	232.75	232.75	0.0043	significant
Pure Error	2.00	2	1.0000			
Cor Total	23470.40	14				