

Supplementary Material for *Journal of Sustainable Metallurgy*
Efficient Recovery of Platinum and Palladium by Fixed-Bed Column
Adsorption Using Acylthiourea- and Amine-Modified Silica

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This document contains tables reporting the maximum adsorption capacities, volumes of adsorbents' saturation, breakthrough parameters, fixed bed modelling data and breakthrough curves of Pt and Pd recovery by DTMSP-BT-SG, TESP-BT-SG, BTMSPA-SG, and APTES-SG.

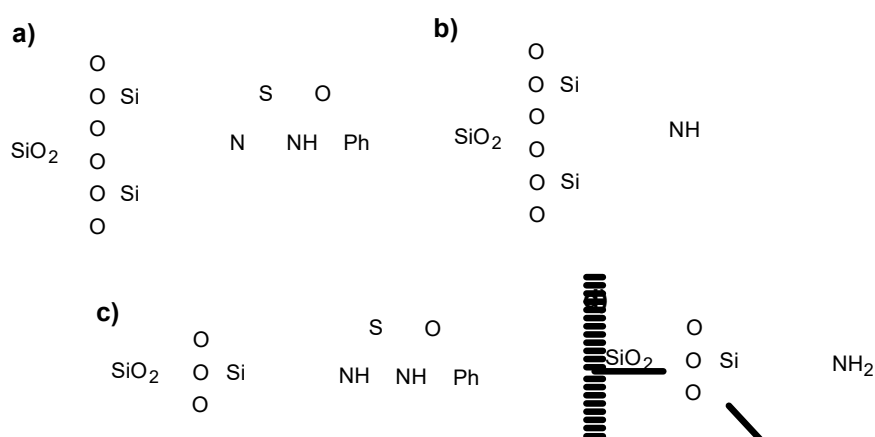


Fig. S1. Adsorbents used: a) DTMSP-BT-SG, b) BTMSPA-SG, c) TESP-BT-SG and d) APTES-SG.

Table S1. Maximum adsorption capacities (q_{max}) of the adsorbents obtained from batch studies.

Adsorbents	q_{max} (mg/g)	
	Pt	Pd
DTMSP-BT-SG	48.52	29.68
TESP-BT-SG	29.01	28.66
BTMSPA-SG	6.63	12.53
APTES-SG	25.06	32.73

Table S2. Theoretical volumes of adsorbents' saturation vs experimental.

Adsorbents	Parameters	Experimental $V_{100\%}$ (mL)		Theoretical $V_{100\%}$ (mL) *	
		Pt	Pd	Pt	Pd
	Mass (mg)				
DTMSP-BT-SG	22.50	700	660	218	134
	40.00	1020	800	388	237
	67.00	1260	1180	650	398
	Concentration (mg/L)				
	3.00	820	800	364	223

	5.00	700	660	218	134
	10.00	480	520	109	67
TESP-BT-SG	22.50 mg, 10.00 mg/L	660	600	65	64
BTMSPA-SG	22.50 mg, 10.00 mg/L	560	460	15	28
APTES-SG	22.50 mg, 10.00 mg/L	460	420	56	74

Table S3. Breakthrough parameters analysis of DTMSP-BT-SG, TESP-BT-SG, BTMSPA-SG, and APTES-SG. (bed height, 0.50 cm; concentration, 10.00 mg/L; flow rate, 2 mL/min, pH 2).

Adsorbents	q_b (mg/g)		BV		AER (g/L)		$T_{100\%}$ (min)	
	Pt	Pd	Pt	Pd	Pt	Pd	Pt	Pd
DTMSP-BT-SG	116.05	76.62	2865	1910	0.043	0.043	720	780
TESP-BT-SG	113.71	140.08	2546	3183	0.034	0.038	990	900
BTMSPA-SG	97.29	82.87	2228	1910	0.049	0.040	840	690
APTES-SG	125.09	151.93	2865	3501	0.054	0.049	690	630

Table S4. Fixed-bed column modelling adsorption data Pt and Pd recovery by DTMSP-BT-SG, TESP-BT-SG, BTMSPA-SG, and APTES-SG.

Metal/ Adsorbents	Thomas		Yoon Nelson			Bohart-Adams			
	$K_{Th} \times 10^{-4}$	q_0	R^2	$k_{YN} \times 10^{-3}$	T	R^2	$K_{AB} \times 10^{-4}$	N_0	R^2
Pt	L/min mg	mg/g		1/min	min		L/mg	minmg/L	
DTMSP-BT-SG	9.98	219	0.90	9.66	255	0.90	3.26	169	0.75
TESP-BT-SG	8.84	284	0.92	9.42	300	0.92	2.06	254	0.65
BTMSPA-SG	5.46	185	0.99	5.69	200	0.99	1.37	234	0.86
APTES-SG	7.80	317	0.94	8.13	342	0.94	4.02	191	0.78
Pd									
DTMSP-BT-SG	9.16	245	0.87	8.77	287	0.87	3.03	190	0.63
TESP-BT-SG	1.06	334	0.93	1.24	351	0.91	3.40	236	0.73

BTMSPA-SG	7.56	207	0.96	7.83	224	0.96	2.56	184	0.69
APTES-SG	8.64	318	0.95	8.96	346	0.95	4.77	178	0.82

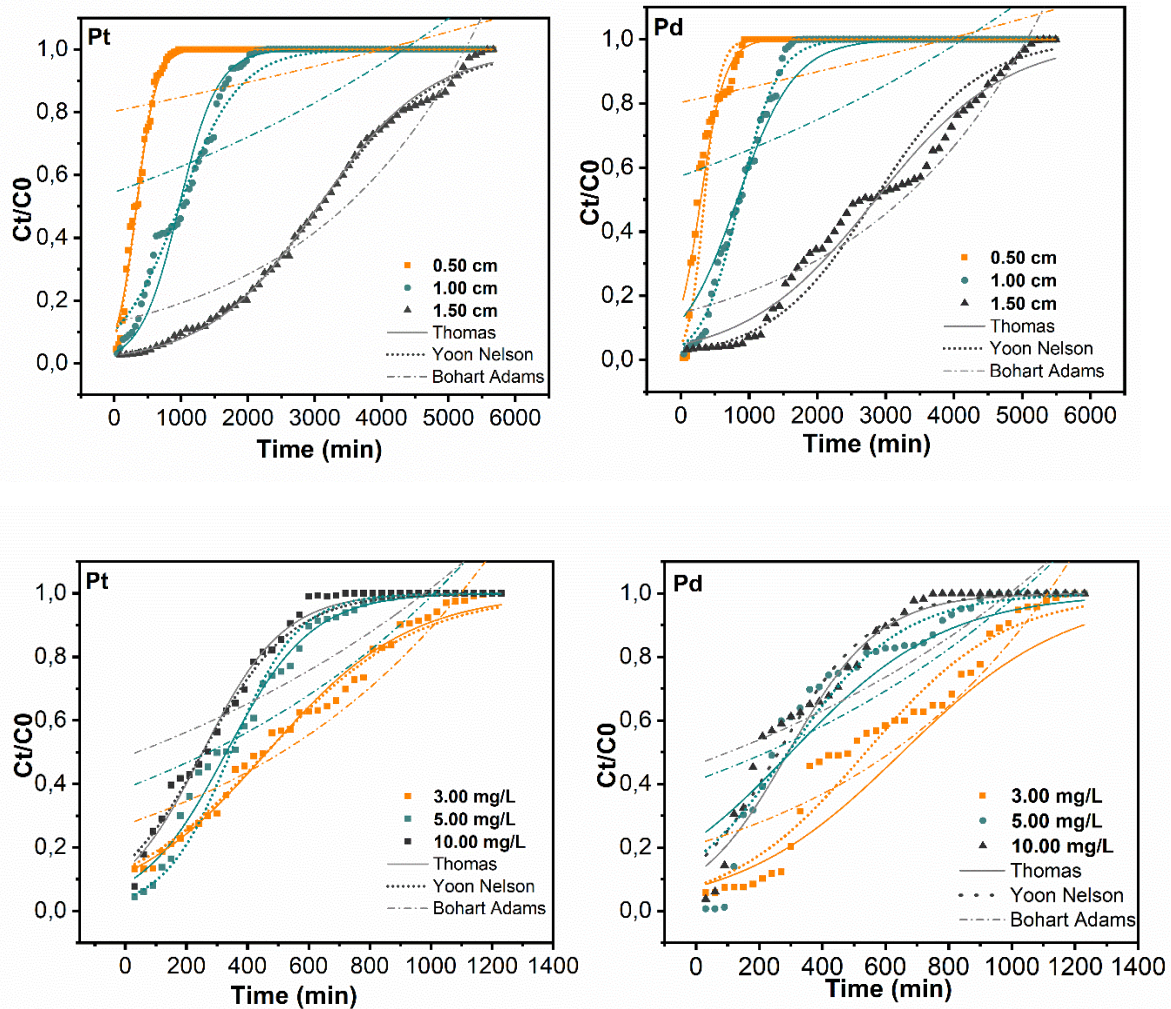


Fig. S2 Breakthrough curves of Pt and Pd adsorption by DTMSP-BT-SG with fitted modelling curves (pH 2 and flow rate 2.00 mL/min)

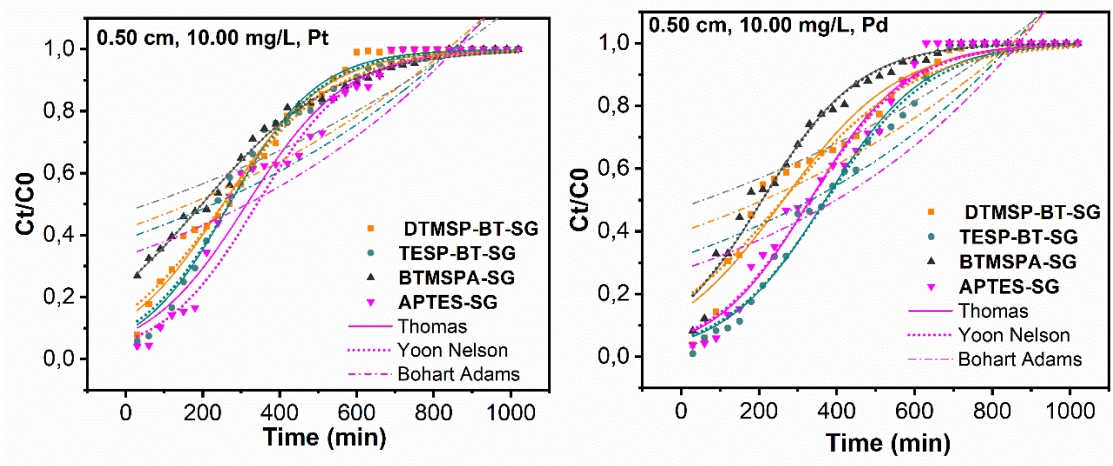


Fig. S3 Breakthrough curves of Pt and Pd adsorption by DTMSP-BT-SG, TESP-BT-SG, BTMSPA-SG and APTES-SG with fitted modelling curves (bed height 0.50 cm, concentration 10 mg/L, pH 2 and flow rate 2.00 mL/min).