Supporting Information

Multiple Model Approach to Evaluating the Performance of Time-Lapse Capsules for Trapping Heavy Metals in Waterbody

Shu-Yuan Pan*, Wei-Jhan Syu, Tsun-Kuo Chang, Cheng-Hsun Lee

Department of Bioenvironmental Systems Engineering, National Taiwan University, Taipei City, 10617 Taiwan

* Corresponding author. Department of Bioenvironmental Systems Engineering, National Taiwan University, Taipei City, 10617 Taiwan. *E-mail address*: sypan@ntu.edu.tw (S.Y.P.).

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Property	Description
Matrix	Styrene divinylbenzene copolymer
Functional group	Sulfonate
Ionic form	Na ⁺
Total exchange capacity	2.00 eq/L
Moisture holding capacity	45-50%
Cross-linkage	8%
Remark	Strong acid cation exchanger
Particle density	1.19 g/mL
Shipping weight	785 g/L
Operating pH (service cycle)	1–14
Operating Temp	5–120 °C

 Table S1. Physico-chemical characteristics of AmberliteTM IR120 resin

Table S2. Concentrations of different metal ions in the solution used in the batch experiments.

Metal concentration (mg/L)	Zn	Cu	Cr	Pb	Ni	Ca ^a	Mn ^a	Ti ^a
C1	0.5	0.3	0.2	0.1	0.1	2	0.2	0.1
C2 b	5.0	3.0	2.0	1.0	1.0	20	2.0	1
C3	50	30	20	10	10	100	20	5
C4	100	60	40	20	20	200	40	10

^a Source: Ca, Mn and Ti are excluded in the Taiwan EPA's effluent standards. ^b Taiwan EPA's effluent standards.

Source	Sum of	df	Mean	F	p-value	
	Square		Squar	Value	(Prob >	
	S		e		F)	
Model	10.45	7	1.49	123.59	< 0.0001	significant
A-Time	2.49	1	2.49	205.80	< 0.0001	
B-Stirring	2.10	1	2.10	173.47	< 0.0001	
C-Concentration	0.43	1	0.43	35.44	< 0.0001	
AB	0.45	1	0.45	36.90	< 0.0001	
AC	0.25	1	0.25	20.71	< 0.0001	
BC	0.15	1	0.15	12.80	0.0005	
A^2	1.21	1	1.21	100.34	< 0.0001	
Residual	1.64	136	0.012			
Cor Total	12.10	143				

Table S3. ANOVA of the response surface model for Zn

Source	Sum of	df	Mean	F	p-value	
	Square		Squar	Value	(Prob >	
	S		e		F)	
Model	9.67	7	1.38	108.67	< 0.0001	significant
A-Time	0.72	1	0.72	56.91	< 0.0001	
B-Stirring	2.50	1	2.50	197.01	< 0.0001	
C-Concentration	0.29	1	0.29	22.65	< 0.0001	
AB	0.56	1	0.56	43.92	< 0.0001	
AC	0.24	1	0.24	18.99	< 0.0001	
A^2	1.00	1	1.00	78.38	< 0.0001	
C^2	0.087	1	0.087	6.85	0.0099	
Residual	1.73	136	0.013			
Cor Total	11.40	143				

Table S4. ANOVA of the response surface model for Cu

Table S5. ANOVA of the response surface model for Cr

Source	Sum of	df	Mean	F	p-value	
	Square		Squar	Value	(Prob >	
	S		e		F)	
Model	11.83	7	1.69	137.08	< 0.0001	significant
A-Time	3.88	1	3.88	315.01	< 0.0001	
B-Stirring	2.40	1	2.40	194.71	< 0.0001	
C-Concentration	0.032	1	0.032	2.56	0.1119	
AB	0.65	1	0.65	52.81	< 0.0001	
A^2	1.16	1	1.16	94.13	< 0.0001	
B^2	0.11	1	0.11	9.24	0.0028	
C^2	0.032	1	0.032	2.63	0.1070	
Residual	1.68	136	0.012			
Cor Total	13.50	143				
C ² Residual Cor Total	0.032 1.68 13.50	1 136 143	0.032 0.012	2.63	0.1070	

Table S6. ANOVA of the response surface model for Mn

Source	Sum of	df	Mean	F	p-value	
	Square		Squar	Value	(Prob >	
	S		e		F)	
Model	10.14	7	1.45	115.24	< 0.0001	significant
A-Time	0.11	1	0.11	8.45	0.0043	-
B-Stirring	2.18	1	2.18	173.77	< 0.0001	
C-Concentration	0.45	1	0.45	36.08	< 0.0001	
AB	0.53	1	0.53	41.79	< 0.0001	
AC	0.26	1	0.26	21.07	< 0.0001	
A^2	1.11	1	1.11	88.48	< 0.0001	
B^2	0.14	1	0.14	11.05	0.0011	

Dagidual	1 71	126 0.012
Residual	1./1	130 0.013
Cor Total	11.84	143

Source	Sum of	df	Mean	F	p-value	
	Square		Squar	Value	(Prob >	
	S		e		F)	
Model	11.70	8	1.46	105.44	< 0.0001	significant
A-Time	0.057	1	0.057	4.08	0.0453	
B-Stirring	0.11	1	0.11	7.74	0.0062	
C-Concentration	0.043	1	0.043	3.11	0.0799	
AB	0.56	1	0.56	40.40	< 0.0001	
AC	0.022	1	0.022	1.62	0.2057	
BC	0.031	1	0.031	2.25	0.1356	
A^2	1.39	1	1.39	100.22	< 0.0001	
B^2	0.12	1	0.12	8.50	0.0042	
Residual	1.87	135	0.014			
Cor Total	13.57	143				

Table S7. ANOVA of the response surface model for Pb

Table S8. ANOVA of the response surface model for Ni

Source	Sum of Square	df	Mean Square	F Value	p-value (Prob >	
	S				F)	
Model	9.16	9	1.02	98.39	< 0.0001	significant
A-Time	0.012	1	0.012	1.18	0.2799	
B-Stirring	0.008	1	0.008	0.76	0.3852	
C-Concentration	0.066	1	0.066	6.40	0.0126	
AB	0.43	1	0.43	41.56	< 0.0001	
AC	0.22	1	0.22	21.21	< 0.0001	
BC	0.11	1	0.11	10.36	0.0016	
A^2	0.90	1	0.90	86.88	< 0.0001	
B^2	0.043	1	0.043	4.11	0.0445	
C^2	0.048	1	0.048	4.61	0.0337	
Residual	1.39	134	0.010			
Cor Total	10.54	143				

Table S9. ANOVA of the response surface model for Ti

Source	Sum of Square	df	Mean Square	F Value	p-value (Prob >	
Model	s 8.48	8	1.06	101.38	F) < 0.0001	significant
A-Time	0.46	1	0.46	43.66	< 0.0001	

B-Stirring	0.025	1	0.025	2.42	0.1222
C-Concentration	1.59	1	1.59	151.93	< 0.0001
AB	0.30	1	0.30	28.30	< 0.0001
AC	0.97	1	0.97	92.89	< 0.0001
BC	0.26	1	0.26	24.99	< 0.0001
A^2	0.78	1	0.78	74.20	< 0.0001
B^2	0.056	1	0.056	5.40	0.0216
Residual	1.41	135	0.010		
Cor Total	9.90	143			

Table S10. ANOVA of the response surface model for Ca

Source	Sum of	df	Mean	F	p-value	
	Square		Square	Value	(Prob >	
	S				F)	
Model	11.28	8	1.41	115.13	< 0.0001	significant
A-Time	3.37	1	3.37	275.14	< 0.0001	
B-Stirring	2.29	1	2.29	187.35	< 0.0001	
C-Concentration	0.19	1	0.19	15.45	0.0001	
AB	0.61	1	0.61	49.41	< 0.0001	
AC	0.095	1	0.095	7.75	0.0061	
BC	0.077	1	0.077	6.28	0.0134	
A^2	1.24	1	1.24	101.25	< 0.0001	
B^2	0.088	1	0.088	7.22	0.0081	
Residual	1.65	135	0.012			
Cor Total	12.94	143				