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APPENDIX

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

A. Data Tables of Liquid-liquid Extraction Studies

- No. = Number of extraction.
- pH int. = pH initial, pH of initial K_2CrO_4 solution before extraction.
- pH final = pH of K_2CrO_4 solution after extraction.
- int. = Concentration of initial solution of K_2CrO_4 before extraction.
- aq. = Concentration of K_2CrO_4 solution after extraction.
- stripped = Concentration of K_2CrO_4 solution after stripping.
- org. = Concentration of K_2CrO_4 solution in organic phase after extraction which was calculated as follows:

$$[CrO_4^{2-}]_{org} = [CrO_4^{2-}]_{int} - [CrO_4^{2-}]_{aq}$$

- % R = Percent recovery of K_2CrO_4 which was calculated as follows:

$$\% R = \frac{([CrO_4^{2-}]_{aq} + [CrO_4^{2-}]_{stripped}) \times 100}{[CrO_4^{2-}]_{int}}$$

- % E = Percent extraction of K_2CrO_4 which was calculated as follows:

$$\% E = \frac{[CrO_4^{2-}]_{org} \times 100}{[CrO_4^{2-}]_{int}}$$

$\bar{X} \pm SD$ = Average percent extraction \pm standard deviation

which was calculated as follows [156]:

$$\bar{X} = \frac{\sum_{i=1}^n X_i}{n}$$

$$SD = \sqrt{\frac{\sum (X_i - \bar{X})^2}{n - 1}}$$

where X_i represent the individual values of X making up a set of n replicate extractions. **Remarks** : for $n = 2$, using n substituted $n-1$.

Where $n \geq 3$ the set of data was statistical tested by the American Society for Testing Materials (ASTM), T_n test [156], the quantity T_n serves as the rejection criterion : where

$$T_n = \frac{|X_q - \bar{X}|}{SD}$$

Here, X_q is the questionable data and \bar{X} and SD are the average and standard deviations of the entire set including the questionable data. Rejection is indicated if the calculated T_n is greater than critical values found in Table 1.

Table 1 Critical values for rejection quotient T_n [156].

Number of observations	T_n		
	95 % Confidence	97.5% Confidence	99 % Confidence
3	1.15	1.15	1.15
4	1.46	1.48	1.49
5	1.67	1.71	1.75
6	1.82	1.89	1.94
7	1.94	2.02	2.10
8	2.03	2.13	2.22
9	2.11	2.21	2.52
10	2.18	2.29	2.41

A.1. Extraction Efficiency by Chloroform (Blank Test)

(Condition used for extraction was described in section 3.3.1.1.)

Table A.1 The result of extraction Cr(VI) with chloroform

No.	[CrO ₄ ²⁻], ppm			% E
	int.	aq.	org.	
1	50.18	49.29	0.89	1.77
2		49.55	0.63	1.26
3		49.76	0.42	0.84
4		49.55	0.63	1.26
Mean =				1.28 ± 0.38

A.2. Influence of Initial pH in K₂CrO₄ Solution

(Condition used for extraction was described in section 3.3.1.2.)

Table A.2a The result of extraction Cr(VI) with compound **1b**.

No.	pH int.	pH final	[CrO ₄ ²⁻], ppm				% R	% E	$\bar{X} \pm SD$
			int.	aq.	stripped	org.			
1	2.26	2.25	50.55	23.03	21.19	27.52	87.48	54.44	54.03±0.41
2	2.26	2.26	50.09	23.23	20.94	26.86	88.18	53.62	
1	2.39	2.38	50.61	23.16	21.23	27.45	87.71	54.24	54.02±0.22
2	2.38	2.38	50.05	23.13	21.03	26.92	88.23	53.79	
1	2.64	2.62	50.58	25.93	18.05	24.65	86.95	48.73	48.37±0.36
2	2.63	2.62	49.99	25.99	17.92	24.00	87.84	48.01	
1	3.24	3.16	50.62	32.09	12.22	18.53	87.53	36.61	36.30±0.31
2	3.22	3.17	49.98	31.99	12.13	17.99	88.28	35.99	

Table A.2b The result of extraction Cr(VI) with compound **2b**.

No.	pH int.	pH final	[CrO ₄ ²⁻], ppm				% R	% E	$\bar{X} \pm SD$
			int.	aq.	stripped	org.			
1	2.26	2.26	50.60	14.69	18.13	35.91	64.86	70.97	70.94±0.03
2		2.26		14.72	18.19	35.88	65.04	70.91	
1	2.38	2.38	50.77	14.91	17.78	35.86	64.39	70.63	70.90±0.28
2		2.38		14.63	17.51	36.14	63.31	71.18	
1	2.63	2.63	50.14	16.60	16.37	33.54	65.76	66.89	66.98±0.09
2		2.62		16.51	16.07	33.63	64.98	67.07	
1	3.23	3.19	50.12	20.10	12.58	30.02	65.20	59.90	59.73±0.17
2		3.18		20.27	12.64	29.85	65.66	59.56	

Table A.2c The result of extraction Cr(VI) with compound **3**.

No.	pH int.	pH final	[CrO ₄ ²⁻], ppm			% E	$\bar{X} \pm SD$
			int.	aq.	org.		
1	2.26	2.25	50.44	48.75	1.70	3.36	3.76±0.40
2	2.25	2.26	50.31	48.23	2.09	4.15	
1	2.39	2.38	49.96	48.59	1.37	2.73	2.96±0.24
2	2.37	2.38	50.22	48.61	1.61	3.20	
1	2.64	2.63	50.41	48.61	1.80	3.57	4.32±0.76
2	2.63	2.64	50.92	48.34	2.59	5.08	
1	3.24	3.28	49.84	48.63	1.20	2.41	2.86±0.45
2	3.22	3.25	50.11	48.45	1.66	3.31	

Table A.2d The result of extraction Cr(VI) with compound **4**.

No.	pH int.	pH final	[CrO ₄ ²⁻], ppm			% E	$\bar{X} \pm SD$
			int.	aq.	org.		
1	2.25	2.25	50.54	49.20	1.34	2.65	2.79±0.14
2		2.25		49.06	1.48	2.93	
1	2.37	2.37	50.70	49.21	1.49	2.94	2.90±0.04
2		2.37		49.25	1.45	2.86	
1	2.63	2.62	50.42	49.02	1.40	2.78	2.69±0.09
2		2.63		49.11	1.31	2.60	
1	3.15	3.13	50.08	48.40	1.68	3.35	3.38±0.03
2		3.14		48.37	1.71	3.41	

A.3. Influence of Extraction Time

(Condition used for extraction was described in section 3.3.1.3.)

Table A.3a The result of extraction Cr(VI) with compound **1b**.

No.	Extraction time (min)	pH final	[CrO ₄ ²⁻], ppm			% R	% E	$\bar{X} \pm SD$
			aq.	stripped	org.			
1	15	2.37	24.96	19.64	25.52	88.35	50.55	50.54±0.02
2		2.37	24.98	19.70	25.50	88.51	50.52	
1	30	2.37	23.32	21.17	27.16	88.13	53.80	53.89±0.09
2		2.37	23.23	21.17	27.25	87.96	53.98	
1	45	2.38	23.50	21.45	26.98	89.05	53.45	53.55±0.10
2		2.37	23.40	21.41	27.08	88.77	53.65	
1	60	2.37	23.44	21.16	27.04	88.35	53.57	53.45±0.12
2		2.38	23.56	21.00	26.92	88.27	53.33	

Remarks : pH int. = 2.37 , [CrO₄²⁻]_{int} = 50.48 ppm

Table A.3b The result of extraction Cr(VI) with compound **2b**.

No.	Extraction time (min)	pH final	[CrO ₄ ²⁻], ppm			% R	% E	$\bar{X} \pm SD$
			aq.	stripped	org.			
1	15	2.37	16.46	17.25	34.02	66.78	67.39	67.26±0.12
2		2.37	16.59	17.10	33.89	66.74	67.14	
1	30	2.38	14.51	17.67	35.97	63.75	71.26	71.14±0.12
2		2.38	14.63	17.50	35.85	63.65	71.02	
1	45	2.39	11.63	17.97	38.85	58.64	76.96	77.06±0.10
2		2.39	11.53	18.11	38.95	58.72	77.16	
1	60	2.40	10.12	18.51	40.36	56.72	79.95	80.08±0.13
2		2.41	9.99	18.46	40.49	56.36	80.21	

Remarks : pH int. = 2.37 , [CrO₄²⁻]_{int} = 50.48 ppm

Table A.3c The result of extraction Cr(VI) with compound **4**.

No.	Extraction time (min)	pH final	[CrO ₄ ²⁻], ppm		% E	$\bar{X} \pm SD$
			aq.	org.		
1	15	2.38	45.66	2.14	4.48	4.22±0.26
2		2.37	45.91	1.89	3.95	
1	30	2.38	44.33	3.47	7.26	7.23±0.03
2		2.37	44.36	3.44	7.20	
1	45	2.38	43.54	4.26	8.91	8.80±0.12
2		2.39	43.65	4.15	8.68	
1	60	2.39	42.77	5.03	10.52	10.84±0.32
2		2.39	42.47	5.33	11.15	

Remarks : pH int. = 2.38 , [CrO₄²⁻]_{int} = 47.80 ppm

A.4. Influence of Type and Concentration of Mediums

(Condition used for extraction was described in section 3.3.1.4.)

Table A.4a The result of extraction Cr(VI) in KCl mediums with compound **1b**.

No.	[KCl] (M)	pH int.	pH final	[CrO ₄ ²⁻], ppm				% R	% E	$\bar{X} \pm SD$
				int.	aq.	stripped	org.			
1	0.01	2.36	2.36	50.21	23.18	21.10	27.03	88.19	53.83	53.28±0.56
2			2.36		23.74	20.82	26.47	88.75	52.72	
1	0.05	2.37	2.37	50.57	34.92	13.08	15.65	94.92	30.95	31.26±0.32
2			2.37		34.60	13.20	15.97	94.52	31.58	
1	0.10	2.36	2.36	50.66	44.18	4.48	6.48	96.05	12.79	12.77±0.02
2			2.36		44.20	4.16	6.46	95.46	12.75	
1	0.50	2.37	2.37	52.76	50.55	1.25	2.21	98.18	4.19	4.22±0.04
2			2.37		50.51	1.33	2.25	98.26	4.26	

Table A.4b The result of extraction Cr(VI) in KCl mediums with compound **2b**.

No.	[KCl] (M)	pH int.	pH final	[CrO ₄ ²⁻], ppm				% R	% E	$\bar{X} \pm SD$
				int.	aq.	stripped	org.			
1	0.01	2.36	2.36	50.23	15.00	7.33	35.23	44.46	70.14	70.11±0.03
2			2.37		15.03	7.14	35.20	44.14	70.08	
1	0.05	2.36	2.37	50.54	30.92	5.00	19.62	71.07	38.82	38.75±0.07
2			2.36		30.99	4.94	19.55	71.09	38.68	
1	0.10	2.37	2.37	50.49	35.08	3.98	15.41	77.36	30.52	30.56±0.04
2			2.38		35.04	4.00	15.45	77.32	30.60	
1	0.50	2.37	2.37	50.53	41.00	2.64	9.53	86.36	18.86	18.78±0.08
2			2.37		41.08	2.44	9.45	86.13	18.70	

Table A.4c The result of extraction Cr(VI) in KNO₃ mediums with compound **1b**.

No.	[KNO ₃] (M)	pH int.	pH final	[CrO ₄ ²⁻], ppm				% R	% E	$\bar{X} \pm SD$
				int.	aq.	stripped	org.			
1	0.01	2.36	2.36	50.58	39.49	10.56	11.09	98.95	21.93	21.84±0.09
2			2.37		39.58	10.42	11.00	98.85	21.75	
1	0.05	2.36	2.36	50.71	45.36	5.07	5.35	99.45	10.55	10.65±0.10
2			2.37		45.26	5.27	5.45	99.65	10.75	
1	0.10	2.36	2.36	50.30	48.13	1.54	2.17	98.75	4.31	4.22±0.08
2			2.36		48.22	1.48	2.08	98.81	4.14	
1	0.50	2.37	2.37	50.51	49.05	0.92	1.46	98.93	2.89	2.98±0.09
2			2.36		48.96	0.91	1.55	98.73	3.07	

Table A.4d The result of extraction Cr(VI) in KNO₃ mediums with compound **2b**.

No.	[KNO ₃] (M)	pH int.	pH final	[CrO ₄ ²⁻], ppm				% R	% E	$\bar{X} \pm SD$
				int.	aq.	stripped	org.			
1	0.01	2.36	2.36	50.58	38.89	4.52	11.69	85.82	23.11	22.76±0.36
2			2.36		39.25	4.36	11.33	86.22	22.40	
1	0.05	2.36	2.37	50.71	43.52	3.28	7.19	92.29	14.18	13.80±0.38
2			2.36		43.91	3.39	6.80	93.28	13.41	
1	0.10	2.36	2.37	50.30	47.80	1.31	2.50	97.63	4.97	4.91±0.06
2			2.37		47.86	1.30	2.44	97.73	4.85	
1	0.50	2.37	2.36	50.51	48.82	0.81	1.69	98.26	3.35	3.31±0.04
2			2.37		48.86	0.87	1.65	98.46	3.27	

A.5. Influence of Competitive Anions

(Condition used for extraction was described in section 3.3.1.5.)

Table A.5a The result of extraction Cr(VI) with compound **1b**.

No.	Anion	pH int.	pH final	[CrO ₄ ²⁻], ppm				% R	% E	$\bar{X} \pm SD$
				int.	aq.	stripped	org..			
1	K ₂ SO ₄	2.37	2.37	50.69	30.48	13.20	20.21	86.17	39.87	40.20±0.32
2			2.37		30.15	15.00	20.54	89.07	40.52	
1	KH ₂ PO ₄	2.37	2.36	50.84	31.41	15.03	19.43	91.35	38.22	38.56±0.34
2			2.37		31.06	15.86	19.78	92.29	38.91	
1	KNO ₃	2.36	2.36	49.78	35.19	10.99	14.59	92.77	29.31	29.38±0.07
2			2.36		35.12	11.00	14.66	92.65	29.45	

Table A.5b The result of extraction Cr(VI) with compound **2b**.

No.	Anion	pH int.	pH final	[CrO ₄ ²⁻], ppm				% R	% E	$\bar{X} \pm SD$
				int.	aq.	stripped	org.			
1	K ₂ SO ₄	2.37	2.37	50.77	17.45	9.94	33.32	53.95	65.63	65.64±0.01
2			2.37		17.44	11.63	33.33	57.26	65.65	
1	KH ₂ PO ₄	2.37	2.37	50.56	15.92	10.78	34.64	52.81	68.51	67.48±1.02
2			2.36		16.96	13.06	33.60	59.38	66.46	
1	KNO ₃	2.37	2.37	50.47	24.47	10.92	26.00	70.12	51.52	53.02±1.50
2			2.37		22.96	10.36	27.51	66.02	54.51	

A.6. Influence of Concentration of Extractant in Various Mediums

(Condition used for extraction was described in section 3.3.1.6.)

Table A.6a The result of extraction Cr(VI) in 0.01 M KCl with compound **1b**.

No.	[L] _{int} ×10 ⁻⁴ M	pH final	[CrO ₄ ²⁻], ppm			% R	% E	$\bar{X} \pm SD$
			aq.	stripped	org.			
1 ^a	1.54	2.38	28.35	20.26	21.93	96.68	43.62	43.93±0.28
2 ^b		2.39	28.21	19.99	22.15	95.71	43.98	
3 ^b		2.40	28.11	19.70	22.25	94.94	44.18	
1 ^a	2.57	2.38	22.56	24.04	27.72	92.68	55.13	55.33±0.18
2 ^b		2.39	22.46	23.92	27.90	92.10	55.40	
3 ^b		2.39	22.43	23.96	27.93	92.12	55.46	
1 ^a	3.60	2.38	17.81	24.44	32.47	84.03	64.58	64.74±0.15
2 ^b		2.38	17.74	24.66	32.62	84.19	64.77	
3 ^b		2.39	17.69	24.64	32.67	84.05	64.87	
1 ^a	4.63	2.37	15.01	26.66	35.27	82.88	70.15	70.27±0.11
2 ^b		2.38	14.96	26.71	35.40	82.74	70.29	
3 ^b		2.37	14.92	26.79	35.44	82.82	70.37	
1 ^a	5.65	2.37	11.63	30.11	38.65	83.02	76.87	77.01±0.14
2 ^b		2.37	11.57	29.94	38.79	82.43	77.03	
3 ^b		2.37	11.51	29.96	38.85	82.35	77.14	

Remarks : pH int. = 2.38^a, 2.39^b [CrO₄²⁻]_{int} = 50.28^a, 50.36^b ppm

Superscript a, b mean one and two replicate extractions, respectively.

[L]_{int} = initial concentration of ligand (M)

Table A.6b The calculated result for extraction mechanism test from table 6a.

No.	[L] _{int} ×10 ⁻⁴ M	[CrO ₄ ²⁻], ppm		[CrO ₄ ²⁻] _{org} (M)	[L] _{eq1} (M)	[L] _{eq2} (M)	D
		aq.	org.				
1 ^a	1.54	28.35	21.93	1.13×10 ⁻⁴	4.11×10 ⁻⁵	9.75×10 ⁻⁵	0.77
2 ^b		28.21	22.15	1.14×10 ⁻⁴	3.99×10 ⁻⁵	9.70×10 ⁻⁵	0.79
3 ^b		28.11	22.25	1.15×10 ⁻⁴	3.94×10 ⁻⁵	9.67×10 ⁻⁵	0.79
1 ^a	2.57	22.56	27.72	1.43×10 ⁻⁴	1.14×10 ⁻⁴	1.86×10 ⁻⁴	1.23
2 ^b		22.46	27.90	1.44×10 ⁻⁴	1.13×10 ⁻⁴	1.85×10 ⁻⁴	1.24
3 ^b		22.43	27.93	1.44×10 ⁻⁴	1.13×10 ⁻⁴	1.85×10 ⁻⁴	1.25
1 ^a	3.60	17.81	32.47	1.67×10 ⁻⁴	1.93×10 ⁻⁴	2.76×10 ⁻⁴	1.82
2 ^b		17.74	32.62	1.68×10 ⁻⁴	1.92×10 ⁻⁴	2.76×10 ⁻⁴	1.84
3 ^b		17.69	32.67	1.68×10 ⁻⁴	1.92×10 ⁻⁴	2.76×10 ⁻⁴	1.85
1 ^a	4.63	15.01	35.27	1.82×10 ⁻⁴	2.81×10 ⁻⁴	3.72×10 ⁻⁴	2.35
2 ^b		14.96	35.40	1.82×10 ⁻⁴	2.81×10 ⁻⁴	3.72×10 ⁻⁴	2.37
3 ^b		14.92	35.44	1.82×10 ⁻⁴	2.81×10 ⁻⁴	3.72×10 ⁻⁴	2.38
1 ^a	5.65	11.63	38.65	1.99×10 ⁻⁴	3.66×10 ⁻⁴	4.65×10 ⁻⁴	3.32
2 ^b		11.57	38.79	2.00×10 ⁻⁴	3.65×10 ⁻⁴	4.65×10 ⁻⁴	3.35
3 ^b		11.51	38.85	2.00×10 ⁻⁴	3.65×10 ⁻⁴	4.65×10 ⁻⁴	3.38

Remarks :

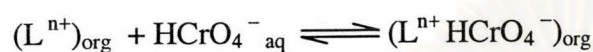
[CrO₄²⁻]_{org} = Concentration (M) of K₂CrO₄ solution in organic phase after extraction which was calculated as follows:

$$[\text{CrO}_4^{2-}]_{\text{org}} = \frac{\text{ppm} \times 10^{-3}}{\text{f.w. of K}_2\text{CrO}_4}, \text{ here f.w. of K}_2\text{CrO}_4 = 194.2$$

$[L]_{eq1}$ = Concentration of free ligand (M), $[L^{n+}]_{org}$, in equilibrium 1 (or $[L]_{eq3}$ in equilibrium 3 in case of compound **2b**) which was calculated as follows:

$$\boxed{[L]_{eq1} = [L]_{int} - [CrO_4^{2-}]_{org}} \quad , \text{ here } [CrO_4^{2-}]_{org} = [HCrO_4^-]$$

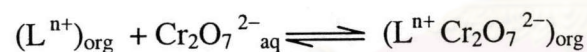
Extraction equilibrium 1 was defined as ligand extracted only $HCrO_4^-$:



$[L]_{eq2}$ = Concentration of free ligand (M), $[L^{n+}]_{org}$, in equilibrium 2 (or $[L]_{eq4}$ in equilibrium 4 in case of compound **2b**) which was calculated as follows:

$$\boxed{[L]_{eq2} = [L]_{int} - \frac{1}{2}[CrO_4^{2-}]_{org}} \quad , \text{ here } [CrO_4^{2-}]_{org} = [Cr_2O_7^{2-}]$$

Extraction equilibrium 2 was defined as ligand extracted only $Cr_2O_7^{2-}$:



where $L^{n+} = L^{2+}$ for compound **1b**

L^{3+} for compound **2b** (for extraction equilibrium 3 and 4)

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Table A.6c The result of extraction Cr(VI) in 0.01 M KCl with compound **1b**.

No.	[L] _{int} ×10 ⁻⁴ M	pH final	[CrO ₄ ²⁻], ppm			% R	% E	$\bar{X} \pm SD$
			aq.	stripped	org.			
1 ^a	1.54	2.76	35.75	14.91	14.97	99.88	29.51	29.64±0.28
2 ^b		2.78	35.39	14.51	15.14	98.75	29.96	
3 ^b		2.78	35.65	14.73	14.88	99.70	29.45	
1 ^a	2.57	2.73	27.42	21.88	23.30	97.20	45.94	45.66±0.25
2 ^b		2.75	27.50	22.14	23.03	98.24	45.58	
3 ^b		2.75	27.56	22.21	22.97	98.50	45.46	
1 ^a	3.60	2.72	22.80	27.31	27.92	98.80	55.05	55.23±0.22
2 ^b		2.73	22.50	27.06	28.03	98.08	55.47	
3 ^b		2.74	22.66	27.12	27.87	98.52	55.16	
1 ^a	4.63	2.72	19.41	31.26	31.31	99.90	61.73	61.73±0.13
2 ^b		2.73	19.27	31.24	31.26	99.96	61.86	
3 ^b		2.72	19.40	31.44	31.13	100.61	61.61	
1 ^a	5.65	2.70	14.73	32.90	35.99	93.91	70.96	70.90±0.17
2 ^b		2.71	14.80	32.57	35.73	93.75	70.71	
3 ^b		2.71	14.64	32.47	35.89	93.23	71.03	

Remarks : pH int. = 2.75^a, 2.77^b [CrO₄²⁻]_{int} = 50.72^a, 50.53^b ppm

Superscript a, b mean one and two replicate extractions, respectively.

[L]_{int} = initial concentration of ligand (M)

Table A.6d The calculated result for extraction mechanism test from table 6c.

No.	[L] _{int} ×10 ⁻⁴ M	[CrO ₄ ²⁻], ppm		[CrO ₄ ²⁻] _{org} (M)	[L] _{eq1} (M)	[L] _{eq2} (M)	D
		aq.	org.				
1 ^a	1.54	35.75	14.97	7.71×10 ⁻⁵	7.69×10 ⁻⁵	1.15×10 ⁻⁴	0.42
2 ^b		35.39	15.14	7.80×10 ⁻⁵	7.60×10 ⁻⁵	1.15×10 ⁻⁴	0.43
3 ^b		35.65	14.88	7.66×10 ⁻⁵	7.74×10 ⁻⁵	1.16×10 ⁻⁴	0.42
1 ^a	2.57	27.42	23.30	1.20×10 ⁻⁴	1.37×10 ⁻⁴	1.97×10 ⁻⁴	0.85
2 ^b		27.50	23.03	1.19×10 ⁻⁴	1.38×10 ⁻⁴	1.98×10 ⁻⁴	0.84
3 ^b		27.56	22.97	1.18×10 ⁻⁴	1.39×10 ⁻⁴	1.98×10 ⁻⁴	0.83
1 ^a	3.60	22.80	27.92	1.44×10 ⁻⁴	2.16×10 ⁻⁴	2.88×10 ⁻⁴	1.22
2 ^b		22.50	28.03	1.44×10 ⁻⁴	2.16×10 ⁻⁴	2.88×10 ⁻⁴	1.25
3 ^b		22.66	27.87	1.44×10 ⁻⁴	2.16×10 ⁻⁴	2.88×10 ⁻⁴	1.23
1 ^a	4.63	19.41	31.31	1.61×10 ⁻⁴	3.02×10 ⁻⁴	3.82×10 ⁻⁴	1.61
2 ^b		19.27	31.26	1.61×10 ⁻⁴	3.02×10 ⁻⁴	3.83×10 ⁻⁴	1.62
3 ^b		19.40	31.13	1.60×10 ⁻⁴	3.03×10 ⁻⁴	3.83×10 ⁻⁴	1.60
1 ^a	5.65	14.73	35.99	1.85×10 ⁻⁴	3.80×10 ⁻⁴	4.72×10 ⁻⁴	2.44
2 ^b		14.80	35.73	1.84×10 ⁻⁴	3.81×10 ⁻⁴	4.73×10 ⁻⁴	2.41
3 ^b		14.64	35.89	1.85×10 ⁻⁴	3.80×10 ⁻⁴	4.73×10 ⁻⁴	2.45

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Table A.6e The result of extraction Cr(VI) in 0.05 M KCl with compound **1b**.

No.	[L] _{int} ×10 ⁻⁴ M	pH final	[CrO ₄ ²⁻], ppm			% R	% E	$\bar{X} \pm SD$
			aq.	stripped	org.			
1 ^a	1.54	2.36	40.66	9.32	9.97	98.72	19.69	20.17±0.46
2 ^b		2.37	40.33	9.33	10.47	97.76	20.61	
3 ^b		2.36	40.53	9.18	10.27	97.85	20.22	
1 ^a	2.57	2.36	35.30	13.27	15.33	95.93	30.28	30.34±0.37
2 ^b		2.37	35.56	13.09	15.24	95.77	30.00	
3 ^b		2.37	35.19	13.41	15.61	95.67	30.73	
1 ^a	3.60	2.36	30.44	16.72	20.19	93.15	39.88	39.81±0.08
2 ^b		2.36	30.62	16.44	20.18	92.64	39.72	
3 ^b		2.37	30.56	16.31	20.24	92.26	39.84	
1 ^a	4.63	2.36	26.50	20.23	24.13	92.30	47.66	47.93±0.27
2 ^b		2.36	26.32	19.93	24.48	91.04	48.19	
3 ^b		2.35	26.44	20.03	24.36	91.48	47.95	
1 ^a	5.65	2.35	23.49	24.27	27.14	94.33	53.60	53.64±0.14
2 ^b		2.35	23.61	24.55	27.19	94.80	53.52	
3 ^b		2.35	23.47	24.67	27.33	94.76	53.80	

Remarks : pH int. = 2.36^a, 2.37^b [CrO₄²⁻]_{int} = 50.63^a, 50.80^b ppm

Superscript a, b mean one and two replicate extractions, respectively.

[L]_{int} = initial concentration of ligand (M)

Table A.6f The calculated result for extraction mechanism test from table 6e.

No.	[L] _{int} ×10 ⁻⁴ M	[CrO ₄ ²⁻], ppm		[CrO ₄ ²⁻] _{org} (M)	[L] _{eq1} (M)	[L] _{eq2} (M)	D
		aq.	org.				
1 ^a	1.54	40.66	9.97	5.13×10 ⁻⁵	1.03×10 ⁻⁴	1.28×10 ⁻⁴	0.25
2 ^b		40.33	10.47	5.39×10 ⁻⁵	1.00×10 ⁻⁴	1.27×10 ⁻⁴	0.26
3 ^b		40.53	10.27	5.29×10 ⁻⁵	1.01×10 ⁻⁴	1.28×10 ⁻⁴	0.25
1 ^a	2.57	35.30	15.33	7.89×10 ⁻⁵	1.78×10 ⁻⁴	2.18×10 ⁻⁴	0.43
2 ^b		35.56	15.24	7.85×10 ⁻⁵	1.79×10 ⁻⁴	2.18×10 ⁻⁴	0.43
3 ^b		35.19	15.61	8.04×10 ⁻⁵	1.77×10 ⁻⁴	2.17×10 ⁻⁴	0.44
1 ^a	3.60	30.44	20.19	1.04×10 ⁻⁴	2.56×10 ⁻⁴	3.08×10 ⁻⁴	0.66
2 ^b		30.62	20.18	1.04×10 ⁻⁴	2.56×10 ⁻⁴	3.08×10 ⁻⁴	0.66
3 ^b		30.56	20.24	1.04×10 ⁻⁴	2.56×10 ⁻⁴	3.08×10 ⁻⁴	0.66
1 ^a	4.63	26.50	24.13	1.24×10 ⁻⁴	3.39×10 ⁻⁴	4.01×10 ⁻⁴	0.91
2 ^b		26.32	24.48	1.26×10 ⁻⁴	3.37×10 ⁻⁴	4.00×10 ⁻⁴	0.93
3 ^b		26.44	24.36	1.25×10 ⁻⁴	3.38×10 ⁻⁴	4.00×10 ⁻⁴	0.92
1 ^a	5.65	23.49	27.14	1.40×10 ⁻⁴	4.25×10 ⁻⁴	4.95×10 ⁻⁴	1.16
2 ^b		23.61	27.19	1.40×10 ⁻⁴	4.25×10 ⁻⁴	4.95×10 ⁻⁴	1.15
3 ^b		23.47	27.33	1.41×10 ⁻⁴	4.24×10 ⁻⁴	4.95×10 ⁻⁴	1.16

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Table A.6g The result of extraction Cr(VI) in 0.01 M KNO₃ with compound **1b**.

No.	[L] _{int} ×10 ⁻⁴ M	pH final	[CrO ₄ ²⁻], ppm			% R	% E	$\bar{X} \pm SD$
			aq.	stripped	org.			
1 ^a	1.54	2.36	42.33	7.13	7.91	98.45	15.74*	16.62±0.05 [#]
2 ^b		2.38	42.09	7.16	8.42	97.51	16.67	
3 ^b		2.38	42.14	7.31	8.37	97.90	16.57	
1 ^a	2.57	2.36	39.36	10.72	10.88	99.68	21.66	22.08±0.38
2 ^b		2.37	39.31	10.43	11.20	98.48	22.17	
3 ^b		2.38	39.19	10.36	11.32	98.10	22.41	
1 ^a	3.60	2.36	33.70	14.39	16.54	95.72	32.92*	33.56±0.04 [#]
2 ^b		2.38	33.54	14.20	16.97	94.52	33.60	
3 ^b		2.38	33.58	14.51	16.93	95.21	33.52	
1 ^a	4.63	2.36	31.95	16.95	18.29	97.33	36.41	36.83±0.38
2 ^b		2.37	31.85	16.64	18.66	96.00	36.94	
3 ^b		2.38	31.75	16.98	18.76	96.48	37.14	
1 ^a	5.65	2.35	27.49	20.99	22.75	96.50	45.28	45.36±0.24
2 ^b		2.37	27.69	19.52	22.82	93.47	45.18	
3 ^b		2.37	27.46	19.40	23.05	92.77	45.63	

Remarks : pH int. = 2.36^a, 2.38^b [CrO₄²⁻]_{int} = 50.24^a, 50.51^b ppm

Superscript a, b mean one and two replicate extractions, respectively.

[L]_{int} = initial concentration of ligand (M)

* The data was rejected because the calculated T_n is greater than the critical values found in Table A.3 at 95% confidence.

The average and standard deviations of the entire set not including the rejected data (n = 2)

Table A.6h The calculated result for extraction mechanism test from table 6g.

No.	[L] _{int} ×10 ⁻⁴ M	[CrO ₄ ²⁻], ppm		[CrO ₄ ²⁻] _{org} (M)	[L] _{eq1} (M)	[L] _{eq2} (M)	D
		aq.	org.				
1 ^a	1.54	42.33	7.91	4.07×10 ⁻⁵	1.13×10 ⁻⁴	1.34×10 ⁻⁴	0.19
2 ^b		42.09	8.42	4.34×10 ⁻⁵	1.11×10 ⁻⁴	1.32×10 ⁻⁴	0.20
3 ^b		42.14	8.37	4.31×10 ⁻⁵	1.11×10 ⁻⁴	1.32×10 ⁻⁴	0.20
1 ^a	2.57	39.36	10.88	5.60×10 ⁻⁵	2.01×10 ⁻⁴	2.29×10 ⁻⁴	0.28
2 ^b		39.31	11.20	5.77×10 ⁻⁵	1.99×10 ⁻⁴	2.28×10 ⁻⁴	0.28
3 ^b		39.19	11.32	5.83×10 ⁻⁵	1.99×10 ⁻⁴	2.28×10 ⁻⁴	0.29
1 ^a	3.60	33.70	16.54	8.52×10 ⁻⁵	2.75×10 ⁻⁴	3.17×10 ⁻⁴	0.49
2 ^b		33.54	16.97	8.74×10 ⁻⁵	2.73×10 ⁻⁴	3.16×10 ⁻⁴	0.51
3 ^b		33.58	16.93	8.72×10 ⁻⁵	2.73×10 ⁻⁴	3.16×10 ⁻⁴	0.50
1 ^a	4.63	31.95	18.29	9.42×10 ⁻⁵	3.69×10 ⁻⁴	4.16×10 ⁻⁴	0.57
2 ^b		31.85	18.66	9.61×10 ⁻⁵	3.67×10 ⁻⁴	4.15×10 ⁻⁴	0.59
3 ^b		31.75	18.76	9.66×10 ⁻⁵	3.66×10 ⁻⁴	4.15×10 ⁻⁴	0.59
1 ^a	5.65	27.49	22.75	1.17×10 ⁻⁴	4.48×10 ⁻⁴	5.06×10 ⁻⁴	0.83
2 ^b		27.69	22.82	1.18×10 ⁻⁴	4.47×10 ⁻⁴	5.06×10 ⁻⁴	0.82
3 ^b		27.46	23.05	1.19×10 ⁻⁴	4.46×10 ⁻⁴	5.06×10 ⁻⁴	0.84

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Table A.6i The result of extraction Cr(VI) in 0.01 M KCl with compound **2b**.

No.	[L] _{int} ×10 ⁻⁴ M	pH final	[CrO ₄ ²⁻], ppm			% R	% E	$\bar{X} \pm SD$
			aq.	stripped	org.			
1 ^a	1.54	2.38	24.54	12.23	27.40	70.79	52.75	52.53±0.22
2 ^b		2.37	24.59	13.42	26.98	73.71	52.32	
3 ^b		2.38	24.48	13.67	27.09	73.98	52.53	
1 ^a	2.56	2.38	16.01	19.21	35.93	67.81	69.18	69.82±0.57
2 ^b		2.37	15.33	20.38	36.24	69.25	70.27	
3 ^b		2.37	15.46	20.19	36.11	69.13	70.02	
1 ^a	3.58	2.38	12.32	19.47	39.62	61.21	76.28	76.11±0.16
2 ^b		2.37	12.33	20.72	39.24	64.09	76.09	
3 ^b		2.37	12.40	20.95	39.17	64.67	75.96	
1 ^a	4.61	2.38	9.79	18.86	42.15	55.16	81.15	80.24±1.01
2 ^b		2.37	10.75	19.11	40.82	57.90	79.15	
3 ^b		2.36	10.10	18.90	41.47	56.23	80.41	
1 ^a	5.63	2.37	8.22	17.07	43.72	48.69	84.17	83.97±0.21
2 ^b		2.36	8.26	18.75	43.31	52.38	83.98	
3 ^b		2.36	8.38	18.51	43.19	52.14	83.75	

Remarks : pH int. = 2.38^a, 2.37^b [CrO₄²⁻]_{int} = 51.94^a, 51.57^b ppm

Superscript a, b mean one and two replicate extractions, respectively.

[L]_{int} = initial concentration of ligand (M)

Table A.6j The calculated result for extraction mechanism test from table 6i.

No.	[L] _{int} ×10 ⁻⁴ M	[CrO ₄ ²⁻], ppm		[CrO ₄ ²⁻] _{org} (M)	[L] _{eq3} (M)	[L] _{eq4} (M)	D
		aq.	org.				
1 ^a	1.54	24.54	27.40	1.41×10 ⁻⁴	1.29×10 ⁻⁵	8.35×10 ⁻⁵	1.12
2 ^b		24.59	26.98	1.39×10 ⁻⁴	1.51×10 ⁻⁵	8.45×10 ⁻⁵	1.10
3 ^b		24.48	27.09	1.39×10 ⁻⁴	1.45×10 ⁻⁵	8.43×10 ⁻⁵	1.11
1 ^a	2.56	16.01	35.93	1.85×10 ⁻⁴	7.10×10 ⁻⁵	1.63×10 ⁻⁴	2.24
2 ^b		15.33	36.24	1.87×10 ⁻⁴	6.94×10 ⁻⁵	1.63×10 ⁻⁴	2.36
3 ^b		15.46	36.11	1.86×10 ⁻⁴	7.01×10 ⁻⁵	1.63×10 ⁻⁴	2.34
1 ^a	3.58	12.32	39.62	2.04×10 ⁻⁴	1.54×10 ⁻⁴	2.56×10 ⁻⁴	3.22
2 ^b		12.33	39.24	2.02×10 ⁻⁴	1.56×10 ⁻⁴	2.57×10 ⁻⁴	3.18
3 ^b		12.40	39.17	2.02×10 ⁻⁴	1.56×10 ⁻⁴	2.57×10 ⁻⁴	3.16
1 ^a	4.61	9.79	42.15	2.17×10 ⁻⁴	2.44×10 ⁻⁴	3.52×10 ⁻⁴	4.31
2 ^b		10.75	40.82	2.10×10 ⁻⁴	2.51×10 ⁻⁴	3.56×10 ⁻⁴	3.80
3 ^b		10.10	41.47	2.14×10 ⁻⁴	2.47×10 ⁻⁴	3.54×10 ⁻⁴	4.11
1 ^a	5.63	8.22	43.72	2.25×10 ⁻⁴	3.38×10 ⁻⁴	4.50×10 ⁻⁴	5.32
2 ^b		8.26	43.31	2.23×10 ⁻⁴	3.40×10 ⁻⁴	4.51×10 ⁻⁴	5.24
3 ^b		8.38	43.19	2.22×10 ⁻⁴	3.41×10 ⁻⁴	4.52×10 ⁻⁴	5.15

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Table A.6k The result of extraction Cr(VI) in 0.01 M KCl with compound **2b**.

No.	[L] _{int} ×10 ⁻⁴ M	pH final	[CrO ₄ ²⁻], ppm			% R	% E	$\bar{X} \pm SD$
			aq.	stripped	org.			
1 ^a	1.54	2.75	27.29	12.19	24.65	76.01	47.46*	44.20±0.05 [#]
2 ^b		2.76	28.56	13.23	22.67	81.57	44.25	
3 ^b		2.77	28.61	13.28	22.62	81.77	44.15	
1 ^a	2.56	2.75	19.28	18.24	32.66	72.24	62.88	61.48±1.22
2 ^b		2.76	20.02	21.34	31.21	80.73	60.92	
3 ^b		2.76	20.17	21.49	31.06	81.32	60.63	
1 ^a	3.58	2.74	15.53	20.63	36.41	69.62	70.10	68.01±1.82
2 ^b		2.75	16.88	22.05	34.35	75.99	67.05	
3 ^b		2.76	16.97	22.02	34.26	76.11	66.87	
1 ^a	4.61	2.74	12.00	18.10	39.94	57.95	76.90	75.03±1.65
2 ^b		2.74	13.12	24.85	38.11	74.12	74.39	
3 ^b		2.74	13.42	24.99	37.81	74.98	73.80	
1 ^a	5.63	2.73	10.44	20.85	41.50	60.24	79.90	78.54±1.22
2 ^b		2.73	11.18	26.24	40.05	73.04	78.18	
3 ^b		2.73	11.50	26.34	39.73	73.86	77.55	

Remarks : pH int. = 2.75^a, 2.76^b [CrO₄²⁻]_{int} = 51.94^a, 51.23^b ppm

Superscript a, b mean one and two replicate extractions, respectively.

[L]_{int} = initial concentration of ligand (M)

* The data was rejected because the calculated T_n is greater than the critical values found in Table A.3 at 95% confidence.

The average and standard deviations of the entire set not including the rejected data (n = 2)

Table A.6I The calculated result for extraction mechanism test from table 6k.

No.	[L] _{int} ×10 ⁻⁴ M	[CrO ₄ ²⁻], ppm		[CrO ₄ ²⁻] _{org} (M)	[L] _{eq3} (M)	[L] _{eq4} (M)	D
		aq.	org.				
1 ^a	1.54	27.29	24.65	1.27×10 ⁻⁴	2.71×10 ⁻⁵	9.05×10 ⁻⁵	0.90
2 ^b		28.56	22.67	1.17×10 ⁻⁴	3.73×10 ⁻⁵	9.56×10 ⁻⁵	0.79
3 ^b		28.61	22.62	1.16×10 ⁻⁴	3.75×10 ⁻⁵	9.58×10 ⁻⁵	0.79
1 ^a	2.56	19.28	32.66	1.68×10 ⁻⁴	8.78×10 ⁻⁵	1.72×10 ⁻⁴	1.69
2 ^b		20.02	31.21	1.61×10 ⁻⁴	9.53×10 ⁻⁵	1.76×10 ⁻⁴	1.56
3 ^b		20.17	31.06	1.60×10 ⁻⁴	9.61×10 ⁻⁵	1.76×10 ⁻⁴	1.54
1 ^a	3.58	15.53	36.41	1.87×10 ⁻⁴	1.71×10 ⁻⁴	2.64×10 ⁻⁴	2.34
2 ^b		16.88	34.35	1.77×10 ⁻⁴	1.81×10 ⁻⁴	2.70×10 ⁻⁴	2.03
3 ^b		16.97	34.26	1.76×10 ⁻⁴	1.82×10 ⁻⁴	2.70×10 ⁻⁴	2.02
1 ^a	4.61	12.00	39.94	2.06×10 ⁻⁴	2.55×10 ⁻⁴	3.58×10 ⁻⁴	3.33
2 ^b		13.12	38.11	1.96×10 ⁻⁴	2.65×10 ⁻⁴	3.63×10 ⁻⁴	2.90
3 ^b		13.42	37.81	1.95×10 ⁻⁴	2.66×10 ⁻⁴	3.64×10 ⁻⁴	2.82
1 ^a	5.63	10.44	41.50	2.14×10 ⁻⁴	3.49×10 ⁻⁴	4.56×10 ⁻⁴	3.98
2 ^b		11.18	40.05	2.06×10 ⁻⁴	3.57×10 ⁻⁴	4.60×10 ⁻⁴	3.58
3 ^b		11.50	39.73	2.05×10 ⁻⁴	3.58×10 ⁻⁴	4.61×10 ⁻⁴	3.45

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Table A.6m The result of extraction Cr(VI) in 0.05 M KCl with compound **2b**.

No.	[L] _{int} ×10 ⁻⁴ M	pH final	[CrO ₄ ²⁻], ppm			% R	% E	$\bar{X} \pm SD$
			aq.	stripped	org.			
1 ^a	1.54	2.36	36.54	4.48	14.60	80.21	28.55	28.53±0.16
2 ^b		2.37	36.51	4.04	14.68	79.21	28.68	
3 ^b		2.36	36.67	3.86	14.52	79.18	28.36	
1 ^a	2.56	2.36	30.77	6.94	20.37	73.74	39.83	39.78±0.05
2 ^b		2.36	30.56	7.71	20.63	74.76	40.30*	
3 ^b		2.36	30.85	7.82	20.34	75.54	39.73	
1 ^a	3.58	2.36	24.90	10.36	26.24	68.95	51.31	51.51±0.25
2 ^b		2.37	24.68	11.66	26.51	70.99	51.79	
3 ^b		2.36	24.87	11.79	26.32	71.62	51.42	
1 ^a	4.61	2.36	21.87	12.52	29.27	67.25	57.24	57.83±0.62
2 ^b		2.36	21.26	14.18	29.93	69.23	58.47	
3 ^b		2.35	21.62	13.88	29.57	69.35	57.77	
1 ^a	5.63	2.35	18.08	17.69	33.06	69.95	64.65	64.92±0.32
2 ^b		2.35	17.78	18.21	33.41	70.31	65.27	
3 ^b		2.35	18.00	17.85	33.19	70.03	64.84	

Remarks : pH int. = 2.36^a, 2.36^b [CrO₄²⁻]_{int} = 51.14^a, 51.19^b ppm

Superscript a, b mean one and two replicate extractions, respectively.

[L]_{int} = initial concentration of ligand (M)

* The data was rejected because the calculated T_n is greater than the critical values found in Table A.3 at 95% confidence.

The average and standard deviations of the entire set not including the rejected data (n = 2)

Table A.6n Calculated result for extraction mechanism test from table 6m.

No.	[L] _{int} ×10 ⁻⁴ M	[CrO ₄ ²⁻], ppm		[CrO ₄ ²⁻] _{org} (M)	[L] _{eq3} (M)	[L] _{eq4} (M)	D
		aq.	org.				
1 ^a	1.54	36.54	14.60	7.52×10 ⁻⁵	7.88×10 ⁻⁵	1.16×10 ⁻⁴	0.40
2 ^b		36.51	14.68	7.56×10 ⁻⁵	7.84×10 ⁻⁵	1.16×10 ⁻⁴	0.40
3 ^b		36.67	14.52	7.48×10 ⁻⁵	7.92×10 ⁻⁵	1.17×10 ⁻⁴	0.40
1 ^a	2.56	30.77	20.37	1.05×10 ⁻⁴	1.51×10 ⁻⁴	2.04×10 ⁻⁴	0.66
2 ^b		30.56	20.63	1.06×10 ⁻⁴	1.50×10 ⁻⁴	2.03×10 ⁻⁴	0.68
3 ^b		30.85	20.34	1.05×10 ⁻⁴	1.51×10 ⁻⁴	2.04×10 ⁻⁴	0.66
1 ^a	3.58	24.90	26.24	1.35×10 ⁻⁴	2.23×10 ⁻⁴	2.90×10 ⁻⁴	1.05
2 ^b		24.68	26.51	1.37×10 ⁻⁴	2.21×10 ⁻⁴	2.90×10 ⁻⁴	1.07
3 ^b		24.87	26.32	1.36×10 ⁻⁴	2.22×10 ⁻⁴	2.90×10 ⁻⁴	1.06
1 ^a	4.61	21.87	29.27	1.51×10 ⁻⁴	3.10×10 ⁻⁴	3.86×10 ⁻⁴	1.34
2 ^b		21.26	29.93	1.54×10 ⁻⁴	3.07×10 ⁻⁴	3.84×10 ⁻⁴	1.41
3 ^b		21.62	29.57	1.52×10 ⁻⁴	3.09×10 ⁻⁴	3.85×10 ⁻⁴	1.37
1 ^a	5.63	18.08	33.06	1.70×10 ⁻⁴	3.93×10 ⁻⁴	4.78×10 ⁻⁴	1.83
2 ^b		17.78	33.41	1.72×10 ⁻⁴	3.91×10 ⁻⁴	4.77×10 ⁻⁴	1.88
3 ^b		18.00	33.19	1.71×10 ⁻⁴	3.92×10 ⁻⁴	4.78×10 ⁻⁴	1.84

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Table A.60 The result of extraction Cr(VI) in 0.01 M KNO₃ with compound **2b**.

No.	[L] _{int} ×10 ⁻⁴ M	pH final	[CrO ₄ ²⁻], ppm			% R	% E	$\bar{X} \pm SD$
			aq.	stripped	org.			
1 ^a	1.54	2.36	44.19	1.50	7.22	88.87	14.04	13.84±0.29
2 ^b		2.37	43.94	1.27	7.14	88.51	13.98	
3 ^b		2.38	44.18	1.19	6.90	88.82	13.51	
1 ^a	2.56	2.36	40.94	3.20	10.47	85.86	20.37	20.71±0.43
2 ^b		2.37	40.58	2.88	10.50	85.08	20.56	
3 ^b		2.37	40.25	2.98	10.83	84.63	21.20	
1 ^a	3.58	2.36	37.82	5.48	13.59	84.22	26.43	26.20±0.32
2 ^b		2.37	37.88	5.53	13.20	84.98	25.84	
3 ^b		2.36	37.63	5.66	13.45	84.75	26.33	
1 ^a	4.61	2.36	36.55	6.36	14.86	83.47	28.90	28.71±0.49
2 ^b		2.37	36.23	6.83	14.85	84.30	29.07	
3 ^b		2.36	36.70	6.68	14.38	84.93	28.15	
1 ^a	5.63	2.35	35.38	7.46	16.03	83.33	31.18	30.28±0.79
2 ^b		2.36	35.91	8.25	15.17	86.45	29.70	
3 ^b		2.35	35.77	8.16	15.31	86.00	29.97	

Remarks : pH int. = 2.36^a, 2.37^b [CrO₄²⁻]_{int} = 51.41^a, 51.08^b ppm

Superscript a, b mean one and two replicate extractions, respectively.

[L]_{int} = initial concentration of ligand (M)

Table A.6p The calculated result for extraction mechanism test from table 6o.

No.	[L] _{int} ×10 ⁻⁴ M	[CrO ₄ ²⁻], ppm		[CrO ₄ ²⁻] _{org}	[L] _{eq3}	[L] _{eq4}	D
		aq.	org.	(M)	(M)	(M)	
1 ^a	1.54	44.19	7.22	3.72×10 ⁻⁵	1.17×10 ⁻⁴	1.35×10 ⁻⁴	0.16
2 ^b		43.94	7.14	3.68×10 ⁻⁵	1.17×10 ⁻⁴	1.36×10 ⁻⁴	0.16
3 ^b		44.18	6.90	3.55×10 ⁻⁵	1.18×10 ⁻⁴	1.36×10 ⁻⁴	0.16
1 ^a	2.56	40.94	10.47	5.39×10 ⁻⁵	2.02×10 ⁻⁴	2.29×10 ⁻⁴	0.26
2 ^b		40.58	10.50	5.41×10 ⁻⁵	2.02×10 ⁻⁴	2.29×10 ⁻⁴	0.26
3 ^b		40.25	10.83	5.58×10 ⁻⁵	2.00×10 ⁻⁴	2.28×10 ⁻⁴	0.27
1 ^a	3.58	37.82	13.59	7.00×10 ⁻⁵	2.88×10 ⁻⁴	3.23×10 ⁻⁴	0.36
2 ^b		37.88	13.20	6.80×10 ⁻⁵	2.90×10 ⁻⁴	3.24×10 ⁻⁴	0.35
3 ^b		37.63	13.45	6.93×10 ⁻⁵	2.89×10 ⁻⁴	3.23×10 ⁻⁴	0.36
1 ^a	4.61	36.55	14.86	7.65×10 ⁻⁵	3.84×10 ⁻⁴	4.23×10 ⁻⁴	0.41
2 ^b		36.23	14.85	7.65×10 ⁻⁵	3.85×10 ⁻⁴	4.23×10 ⁻⁴	0.41
3 ^b		36.70	14.38	7.40×10 ⁻⁵	3.87×10 ⁻⁴	4.24×10 ⁻⁴	0.39
1 ^a	5.63	35.38	16.03	8.25×10 ⁻⁵	4.80×10 ⁻⁴	5.22×10 ⁻⁴	0.45
2 ^b		35.91	15.17	7.81×10 ⁻⁵	4.85×10 ⁻⁴	5.24×10 ⁻⁴	0.42
3 ^b		35.77	15.31	7.88×10 ⁻⁵	4.84×10 ⁻⁴	5.24×10 ⁻⁴	0.43

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A.7. Recycling of Ligand

(Condition used for extraction was described in section 3.3.1.7.)

Table A.7a The result of extraction Cr(VI) with compound **1b**.

No.	cycle	pH final	[CrO ₄ ²⁻], ppm			% R	% E	$\bar{X} \pm SD$
			aq.	stripped	org.			
1	1	2.36	23.44	21.06	27.50	87.36	53.99	53.69±0.30
2		2.38	23.68	21.07	27.12	88.09	53.39	
1	2	2.36	24.81	18.79	26.13	85.59	51.30	51.06±0.24
2		2.37	24.99	18.35	25.81	85.31	50.81	
1	3	2.36	26.01	18.06	24.93	86.51	48.94	48.70±0.24
2		2.38	26.18	17.94	24.62	86.85	48.46	
1	4	2.35	26.75	17.53	24.19	86.93	47.49	47.32±0.17
2		2.37	26.85	17.14	23.95	86.59	47.15	
1	5	2.36	27.42	17.21	23.52	87.61	46.17	45.68±0.50
2		2.37	27.85	17.01	22.95	88.31	45.18	
1	6	2.35	28.05	16.94	22.89	88.32	44.94	44.68±0.26
2		2.38	28.23	16.10	22.57	87.26	44.43	
1	7	2.36	28.30	16.68	22.64	88.30	44.44	44.05±0.39
2		2.37	28.62	15.91	22.18	87.66	43.66	

Remarks : pH int. = 2.36¹, 2.38² [CrO₄²⁻]_{int} = 50.94¹, 50.80² ppm

Superscript 1, 2 mean No.(Number of extraction) 1 and 2, respectively

Table A.7b The result of extraction Cr(VI) with compound **2b**.

No.	cycle	pH final	[CrO ₄ ²⁻], ppm			% R	% E	$\bar{X} \pm SD$
			aq.	stripped	org.			
1	1	2.36	15.17	17.86	35.02	65.81	69.77	69.73±0.04
2		2.37	15.20	17.97	34.95	66.14	69.69	
1	2	2.35	17.07	15.94	33.12	65.77	65.99	65.48±0.51
2		2.36	17.57	16.11	32.58	67.16	64.97	
1	3	2.35	18.34	13.80	31.85	64.04	63.46	62.92±0.54
2		2.37	18.87	13.44	31.28	64.43	62.37	
1	4	2.36	20.16	12.47	30.03	65.01	59.83	59.22±0.60
2		2.36	20.75	12.07	29.40	65.44	58.62	
1	5	2.36	21.28	11.02	28.91	64.36	57.60	57.18±0.42
2		2.37	21.68	11.91	28.47	66.98	56.77	
1	6	2.35	22.29	10.07	27.90	64.47	55.59	55.33±0.26
2		2.37	22.53	9.96	27.62	64.79	55.07	
1	7	2.36	22.78	9.21	27.41	63.74	54.61	54.38±0.22
2		2.36	22.99	8.79	27.16	63.37	54.16	

Remarks : pH int. = 2.36¹, 2.38² [CrO₄²⁻]_{int} = 50.19¹, 50.15² ppm

Superscript 1, 2 mean No.(Number of extraction) 1 and 2, respectively.

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B. Data Tables of Solid-liquid Extraction Studies

B.1. Extraction with SiO₂ (Blank Test)

(Condition used for extraction was described in section 3.3.2.1.)

Table B.1a The result of extraction Cr(VI) with 0.01-1.0 g SiO₂.

Extraction time (min)	Weight of SiO ₂ (g)	[CrO ₄ ²⁻] _{int} (ppm)	pH int.	pH final	[CrO ₄ ²⁻] _{aq} (ppm)	% E
30	0.0171	53.70	2.38	2.38	56.49	0
30	0.0330			2.39	54.21	0
30	0.2005	50.27	2.38	2.50	50.32	0
60	0.2007			2.56	50.38	0
30	0.5002			2.93	45.65	9.19
60	0.5003			2.96	45.64	9.21
30	1.0006	49.70	2.37	3.30	41.93	15.63
30	1.0008			3.32	41.98	15.53
30	1.0018	48.27	2.38	3.34	40.98	15.10
30	1.0018			3.35	40.96	15.14
60	1.0008	49.70	2.37	3.39	42.32	14.85
60	1.0007			3.37	42.36	14.77
60	1.0018	48.27	2.38	3.42	41.07	14.92
60	1.0018			3.42	41.06	14.94

Table B.1b The result of extraction Cr(VI) with SiO₂ 1 g.

No.	Extraction time (min)	Weight of SiO ₂ (g)	pH final	[CrO ₄ ²⁻], ppm		% E	$\bar{X} \pm SD$
				aq.	org.		
1 ^a	15	1.0008	3.28	41.66	8.04	16.18	16.93±1.05
2 ^a		1.0006	3.27	41.75	7.95	16.00	
3 ^b		1.0020	3.31	39.45	8.82	18.27	
4 ^b		1.0018	3.29	39.94	8.33	17.26	
1 ^a	30	1.0006	3.30	41.93	7.77	15.63	15.35±0.27
2 ^a		1.0008	3.32	41.98	7.72	15.53	
3 ^b		1.0018	3.34	40.98	7.29	15.10	
4 ^b		1.0018	3.35	40.96	7.31	15.14	
1 ^a	45	1.0008	3.34	42.28	7.42	14.93	14.98±0.20
2 ^a		1.0008	3.33	42.38	7.32	14.73	
3 ^b		1.0019	3.39	40.95	7.32	15.16	
4 ^b		1.0018	3.38	40.97	7.30	15.12	
1 ^a	60	1.0008	3.39	42.32	7.38	14.85	14.85±0.08
2 ^a		1.0007	3.37	42.36	7.34	14.77	
3 ^b		1.0018	3.42	41.07	7.20	14.92	
4 ^b		1.0018	3.42	41.06	7.21	14.94	

Remarks : pH int. = 2.37^a , 2.38^b [CrO₄²⁻]_{int.} = 49.70^a , 48.27^b ppm

Superscript a, b mean first and second of each two replicate extractions, respectively.

B.2 Extraction with Ligand Coated on SiO₂

(Condition used for extraction was described in section 3.3.2.2.)

Table B.2a The result of extraction Cr(VI) with compound **1b-LC**.

No.	Extraction time (min)	Weight of compound 1b-LC (g)	pH final	[CrO ₄ ²⁻], ppm		% E	$\bar{X} \pm SD$
				aq.	org.		
1 ^a	15	0.0369	2.37	14.91	34.75	69.98	70.28±0.44
2 ^a		0.0368	2.37	14.97	34.69	69.86	
3 ^b		0.0369	2.37	14.75	35.18	70.46	
4 ^b		0.0369	2.38	14.58	35.35	70.80	
1 ^a	30	0.0369	2.38	14.29	35.37	71.22	71.26±0.04 [#]
2 ^a		0.0369	2.38	14.25	35.41	71.30	
3 ^b		0.0370	2.39	14.08	35.85	71.80*	
4 ^b		0.0369	2.38	14.35	35.58	71.26	
1 ^a	45	0.0369	2.39	13.88	35.78	72.05	72.16±0.21
2 ^a		0.0368	2.38	13.91	35.75	71.99	
3 ^b		0.0370	2.39	13.75	36.18	72.46	
4 ^b		0.0369	2.39	13.91	36.02	72.14	
1 ^a	60	0.0369	2.39	13.19	36.47	73.44	73.25±0.30
2 ^a		0.0369	2.39	13.14	36.52	73.54	
3 ^b		0.0368	2.39	13.54	36.39	72.88	
4 ^b		0.0369	2.39	13.41	36.52	73.14	

Remarks : pH int. = 2.37^a, 2.37^b [CrO₄²⁻]_{int} = 49.66^a, 49.93^b ppm

Superscript a, b mean first and second of each two replicate extractions, respectively.

* The data was rejected because the calculated T_n is greater than the critical values found in Table A.3 at 95% confidence.

[#] The average and standard deviations of the entire set not including the rejected data (n = 3)

Table B.2b The result of extraction Cr(VI) with compound **1b-HC**.

No.	Extraction time (min)	Weight of compound 1b-HC (g)	pH final	[CrO ₄ ²⁻], ppm		% E	$\bar{X} \pm SD$
				aq.	org.		
1 ^a	15	0.0138	2.36	13.16	33.58	71.84	71.56±0.41
2 ^a		0.0138	2.36	13.10	33.64	71.97	
3 ^b		0.0138	2.36	13.46	33.35	71.25	
4 ^b		0.0138	2.36	13.50	33.31	71.16	
1 ^a	30	0.0138	2.36	13.00	33.74	72.19	71.95±0.22
2 ^a		0.0138	2.36	13.07	33.67	72.04	
3 ^b		0.0138	2.36	13.16	33.65	71.89	
4 ^b		0.0138	2.36	13.26	33.55	71.67	
1 ^a	45	0.0139	2.36	12.73	34.01	72.76	72.52±0.18
2 ^a		0.0138	2.36	12.83	33.91	72.55	
3 ^b		0.0138	2.36	12.95	33.86	72.33	
4 ^b		0.0138	2.36	12.89	33.92	72.46	
1 ^a	60	0.0139	2.37	12.57	34.17	73.11	72.91±0.14
2 ^a		0.0138	2.36	12.67	34.07	72.89	
3 ^b		0.0138	2.36	12.73	34.08	72.80	
4 ^b		0.0138	2.37	12.71	34.10	72.85	

Remarks : pH int. = 2.36^a, 2.36^b [CrO₄²⁻]_{int} = 46.74^a, 46.81^b ppm

Superscript a, b mean first and second of each two replicate extractions, respectively.

Table B.2c The result of extraction Cr(VI) with compound **2b-LC**.

No.	Extraction time (min)	Weight of compound 2b-LC (g)	pH final	[CrO ₄ ²⁻], ppm		% E	$\bar{X} \pm SD$
				aq.	org.		
1 ^a	15	0.0334	2.38	7.94	41.28	83.87	83.69±0.16
2 ^a		0.0334	2.38	8.02	41.20	83.71	
3 ^b		0.0334	2.37	8.03	41.22	83.70	
4 ^b		0.0333	2.37	8.13	41.12	83.49	
1 ^a	30	0.0334	2.39	7.51	41.71	84.74	84.59±0.14
2 ^a		0.0334	2.39	7.54	41.68	84.68	
3 ^b		0.0334	2.38	7.63	41.62	84.51	
4 ^b		0.0334	2.38	7.67	41.58	84.43	
1 ^a	45	0.0334	2.39	6.42	42.80	86.96	87.08±0.27
2 ^a		0.0334	2.39	6.51	42.71	86.77	
3 ^b		0.0335	2.38	6.23	43.02	87.35	
4 ^b		0.0334	2.38	6.28	42.97	87.25	
1 ^a	60	0.0335	2.39	5.19	44.03	89.46	88.82±0.67
2 ^a		0.0334	2.39	5.25	43.97	89.33	
3 ^b		0.0334	2.38	5.74	43.51	88.35	
4 ^b		0.0334	2.38	5.84	43.41	88.14	

Remarks : pH int. = 2.38^a, 2.37^b [CrO₄²⁻]_{int} = 49.22^a, 49.25^b ppm

Superscript a, b mean first and second of each two replicate extractions, respectively.

Table B.2d The result of extraction Cr(VI) with compound **2b**-HC.

No.	Extraction time (min)	Weight of compound 2b -HC (g)	pH final	[CrO ₄ ²⁻], ppm		% E	$\bar{X} \pm SD$
				aq.	org.		
1 ^a	15	0.0102	2.36	8.39	39.93	82.64	82.76±0.24
2 ^a		0.0102	2.36	8.46	39.86	82.49	
3 ^b		0.0102	2.37	8.42	40.83	82.90	
4 ^b		0.0102	2.37	8.37	40.88	83.01	
1 ^a	30	0.0102	2.36	7.46	40.86	84.56	84.48±0.09
2 ^a		0.0102	2.36	7.56	40.76	84.35	
3 ^b		0.0102	2.37	7.64	41.61	84.49	
4 ^b		0.0102	2.37	7.62	41.63	84.53	
1 ^a	45	0.0103	2.36	6.37	41.95	86.82	86.68±0.13
2 ^a		0.0102	2.36	6.52	41.80	86.51	
3 ^b		0.0102	2.37	6.57	42.68	86.66	
4 ^b		0.0102	2.37	6.54	42.71	86.72	
1 ^a	60	0.0101	2.36	5.44	42.88	88.74	89.09±0.25
2 ^a		0.0102	2.37	5.25	43.07	89.13	
3 ^b		0.0102	2.37	5.35	43.90	89.14	
4 ^b		0.0103	2.38	5.25	44.00	89.34	

Remarks : pH int. = 2.36^a, 2.37^b [CrO₄²⁻]_{int} = 48.32^a, 49.25^b ppm

Superscript a, b mean first and second of each two replicate extractions, respectively.

B.3 Recycling of Ligand Coated on SiO₂

(Condition used for extraction was described in section 3.3.2.3.)

Table B.3a The result of extraction Cr(VI) with compound **1b-LC**.

No.	Cycle	[CrO ₄ ²⁻], ppm		% R	% E	$\bar{X} \pm SD$
		aq.	stripped			
1	1	14.88	25.13	79.92	70.23	70.20±0.17
2		14.79	25.11	79.69	70.40	
3		14.90	25.03	79.67	70.19	
4		15.00	25.06	80.00	69.99	
1	2	17.10	23.91	81.94	65.79	65.65±0.29
2		17.06	24.07	82.17	65.86	
3		17.14	24.13	82.40	65.72	
4		17.38	24.21	83.10	65.22	
1	3	18.04	23.64	83.25	63.92	63.81±0.41
2		17.99	23.53	82.95	64.00	
3		17.94	23.41	82.64	64.11	
4		18.39	23.48	82.64	63.21	

Remarks :

pH int. = 2.37, [CrO₄²⁻]_{int} = 49.98 ppm, weight of compound **1b-LC** = 0.0369 g

$$\% E = \frac{([CrO_4^{2-}]_{int} - [CrO_4^{2-}]_{aq}) \times 100}{[CrO_4^{2-}]_{int}}$$

$$\% R = \frac{(\text{mol of } CrO_4^{2-} \text{ aq} + \text{mol of } CrO_4^{2-} \text{ stripped}) \times 100}{\text{mol of } CrO_4^{2-} \text{ int}}$$

Table B.3b The result of extraction Cr(VI) with compound **2b-LC**.

No.	Cycle	[CrO ₄ ²⁻], ppm		% R	% E	$\bar{X} \pm SD$
		aq.	stripped			
1	1	7.60	22.90	60.85	84.87	84.90±0.17
2		7.50	22.74	60.31	85.08	
3		7.70	22.78	60.85	84.68	
4		7.56	22.91	60.78	84.96	
1	2	9.48	21.89	62.56	81.15	81.02±0.17
2		9.59	21.86	62.71	80.91	
3		9.62	21.77	62.64	80.85	
4		9.46	21.88	62.48	81.19	
1	3	11.17	21.29	64.73	77.78	77.63±0.28
2		11.28	21.32	64.96	77.57	
3		11.43	21.34	65.35	77.26	
4		11.11	21.28	64.57	77.90	

Remarks :

pH int. = 2.37 , [CrO₄²⁻]_{int} = 50.27 ppm , weight of compound **2b-LC** = 0.0334 g

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B.4 Leaching of Ligand from SiO₂ by Chloroform

(Condition used for extraction was described in section 3.3.2.4.)

Table B.4a The result of leaching of compound **1b**-HC by chloroform.

No.	Leaching time (min)	Weight of compound 1b -HC (g)	[1b] _{final} × 10 ⁻⁵ (M)	mol leaching × 10 ⁻⁶	% Leaching	$\bar{X} \pm SD$
1	15	0.0503	5.21	1.04	21.85	22.38±0.52
2		0.0504	5.46	1.09	22.90	
1	30	0.0503	5.88	1.18	24.79	25.21±0.42
2		0.0504	6.09	1.22	25.63	
1	45	0.0504	6.12	1.22	25.63	25.74±0.10
2		0.0504	6.14	1.23	25.84	
1	60	0.0504	6.15	1.23	25.84	25.94±0.10
2		0.0504	6.18	1.24	26.05	

Remarks :

[**1b**]_{final} = Concentration (M) of compound **1b** in chloroform after compound **1b**-HC was stirred with 20 mL chloroform at different time.

mol leaching = mol of compound **1b** leached from SiO₂ after agitation with chloroform which was calculated as follows :

$$\text{mol leaching} = \frac{[\mathbf{1b}]_{\text{final}} \times \text{Volume of chloroform (mL)}}{1000}$$

% Leaching = Percent leaching compound **1b** which was calculated as follows :

$$\% \text{ Leaching} = \frac{\text{mol leaching} \times 100}{\text{total mol of ligand at initial}}$$

Here, total mol of compound **1b** and **2b** at initial are 4.76×10^{-6} and 6.43×10^{-6} , respectively.

Table B.4b The result of leaching of compound **2b**-HC by chloroform.

No.	Leaching time (min)	Weight of compound 2b -HC (g)	[2b] _{final} ×10 ⁻⁵ (M)	mol leaching ×10 ⁻⁷	% Leaching	$\bar{X} \pm SD$
1	15	0.0504	3.08	6.16	9.58	9.88±0.30
2		0.0505	3.27	6.54	10.17	
1	30	0.0504	4.45	8.90	13.84	13.90±0.06
2		0.0504	4.49	8.98	13.97	
1	45	0.0504	4.65	9.30	14.46	14.48±0.02
2		0.0504	4.66	9.32	14.49	
1	60	0.0504	4.78	9.56	14.87	14.90±0.03
2		0.0504	4.80	9.60	14.93	

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

VITA

Miss Supamane Chaiatchanarat was born on July 3, 1979 in Bangkok, Thailand. She received her Bachelor's degree of Science in Chemistry with Second Class Honors from King Mongkut's University of Technology Thonburi in 1999. Since 2000, she has been a graduate student at the Department of Chemistry, Chulalongkorn University and become a member of Environmental Analysis Research Group under the supervision of Dr. Wanlapa Aeungmaitrepirom. She finished her postgraduate study in leading of the Master's degree of Science in 2003.



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย