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Appendices

Appendix A Experimental data for PEUF studies

Table A1 Experimental data of chromate rejection studies

[QUAT]:[Chromate]:[Sulfate] = 5:1:1

Solution Flux (L/m^2*hr) = (Volume of permeate(ml)*$100^2(cm^2)$*3600(s))/(Time interval(s)*38.5(cm^2)*100(ml))

Relative Flux = (Solution flux)/(Water flux)

Table A.1a Feed Specification : [Chromate] 1.77E-02 M Water Flux Rate = 57.720 L/m^2*hr

[Sulfate] 1.77E-02 M Filtration Area = 38.5 cm^2

[QUAT] 1.03E-01 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.9144	1185	19.660	0.341	5.13E-03	3.78E-04	1.88E-02	1.09E-01	72.69
2	25.3006	1229	19.250	0.333	5.52E-03	8.64E-05	2.07E-02	1.20E-01	73.27
3	25.0148	1284	18.217	0.316	6.61E-03	9.35E-05	2.28E-02	1.33E-01	71.05
4	25.0095	1345	17.387	0.301	6.14E-03	9.06E-05	2.58E-02	1.50E-01	76.14
5	25.0580	1433	16.351	0.283	6.74E-03	8.65E-05	2.94E-02	1.72E-01	77.05
6	24.9201	1528	15.250	0.264	5.71E-03	8.30E-05	3.44E-02	2.00E-01	83.40
7	24.9405	1685	13.840	0.240	5.80E-03	8.89E-05	4.13E-02	2.40E-01	85.95
8	24.9195	1933	12.055	0.209	5.89E-03	1.11E-04	5.16E-02	3.00E-01	88.58

Table A.1b

Feed Specification :

[Chromate]	2.61E-02	M	Water Flux Rate =	85.943	L/m^2*hr
[Sulfate]	2.61E-02	M	Filtration Area =	38.5	cm^2
[QUAT]	1.50E-01	M			

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flu (L/m²*hr)	Relative Flu	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.0093	1462	15.995	0.186	9.71E-03	1.37E-04	2.76E-02	1.64E-01	64.84
2	25.1005	1509	15.554	0.181	1.07E-02	1.21E-04	3.03E-02	1.80E-01	64.78
3	25.0222	1585	14.762	0.172	1.08E-02	1.09E-04	3.37E-02	2.00E-01	68.03
4	25.0578	1696	13.815	0.161	1.01E-02	1.18E-04	3.80E-02	2.25E-01	73.32
5	25.0499	1795	13.049	0.152	1.07E-02	1.23E-04	4.33E-02	2.57E-01	75.23
6	25.0534	2004	11.690	0.136	1.01E-02	1.12E-04	5.07E-02	3.01E-01	79.98
7	24.9889	2238	10.441	0.121	1.05E-02	1.30E-04	6.07E-02	3.61E-01	82.64
8	25.0321	2627	8.910	0.104	1.01E-02	1.38E-04	7.61E-02	4.51E-01	86.73

Table A.1c Feed Specification : [Chromate] 2.61E-02 M Water Flux Rate = 78.445 L/m^2*hr

[Sulfate] 2.61E-02 M Filtration Area = 38.5 cm^2

[QUAT] 1.50E-01 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.0880	1785	13.142	0.168	1.19E-02	1.65E-04	2.92E-02	2.18E-01	59.33
2	25.1088	1870	12.555	0.160	1.29E-02	1.24E-04	3.20E-02	2.40E-01	59.67
3	25.2416	1991	11.855	0.151	1.31E-02	1.21E-04	3.56E-02	2.67E-01	63.05
4	25.0781	2134	10.989	0.140	1.29E-02	1.24E-04	4.01E-02	3.01E-01	67.68
5	25.0576	2277	10.290	0.131	1.27E-02	1.28E-04	4.58E-02	3.44E-01	72.20
6	25.1396	2478	9.486	0.121	1.28E-02	1.17E-04	5.36E-02	4.02E-01	76.12
7	25.1154	2866	8.194	0.104	1.27E-02	1.20E-04	6.44E-02	4.83E-01	80.31
8	25.1817	3522	6.686	0.085	1.25E-02	1.27E-04	8.08E-02	6.06E-01	84.57

Table A2 Experimental data of chromate rejection studies
[QUAT]:[Chromate]:[Sulfate] = 10:1:1

Solution Flux (L/m^2*hr) = (Volume of permeate(ml)*100^2(cm^2)*3600(s))/(Time interval(s)*38.5(cm^2)*100(ml))
Relative Flux = (Solution flux)/(Water flux)

Table A.2a Feed Specification : [Chromate] 7.69E-03 M Water Flux Rate = 56.194 L/m^2*hr
[Sulfate] 7.69E-03 M Filtration Area = 38.5 cm^2
[QUAT] 9.61E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flu (L/m^2*hr)	Relative Flu	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.9151	908	25.658	0.457	7.97E-04	3.34E-04	8.31E-03	1.09E-01	90.41
2	24.9244	942	24.741	0.440	8.22E-04	9.51E-05	9.14E-03	1.20E-01	91.01
3	24.9011	998	23.331	0.415	8.25E-04	1.23E-04	1.01E-02	1.33E-01	91.87
4	24.9193	1037	22.470	0.400	8.09E-04	9.85E-05	1.14E-02	1.50E-01	92.91
5	24.9621	1150	20.297	0.361	8.10E-04	5.46E-05	1.30E-02	1.71E-01	93.79
6	25.2501	1261	18.724	0.333	8.04E-04	5.17E-05	1.52E-02	2.00E-01	94.72
7	24.9034	1372	16.973	0.302	7.93E-04	6.19E-05	1.83E-02	2.40E-01	95.66
8	24.8457	1599	14.529	0.259	7.76E-04	5.00E-05	2.28E-02	2.99E-01	96.59

Table A.2b Feed Specification : [Chromate] 1.09E-02 M Water Flux Rate = 47.707 L/m^2*hr

[Sulfate] 1.09E-02 M Filtration Area = 38.5 cm^2

[QUAT] 9.53E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flu (L/m^2*hr)	Relative Flu	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.9450	1313	17.765	0.372	1.53E-03	3.96E-05	1.17E-02	1.64E-01	86.99
2	24.9343	1355	17.207	0.361	1.60E-03	3.69E-05	1.29E-02	1.80E-01	87.63
3	25.9972	1485	16.370	0.343	1.61E-03	3.93E-05	1.44E-02	2.01E-01	88.81
4	24.8945	1503	15.488	0.325	1.67E-03	3.93E-05	1.62E-02	2.26E-01	89.69
5	24.9991	1543	15.150	0.318	1.60E-03	4.12E-05	1.85E-02	2.58E-01	91.38
6	24.9021	1876	12.412	0.260	1.60E-03	4.56E-05	2.16E-02	3.01E-01	92.60
7	25.7257	2157	11.152	0.234	1.59E-03	4.01E-05	2.61E-02	3.64E-01	93.89
8	24.9463	2092	11.150	0.234	1.55E-03	7.19E-05	3.27E-02	4.56E-01	95.27

Table A.2c Feed Specification : [Chromate] 1.70E-02 M Water Flux Rate = 47.805 L/m^2*hr

[Sulfate] 1.70E-02 M Filtration Area = 38.5 cm^2

[QUAT] 1.33E-01 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.9735	1730	13.498	0.282	2.48E-03	5.76E-05	1.83E-02	2.18E-01	86.50
2	24.946	1745	13.367	0.280	2.68E-03	6.28E-05	2.02E-02	2.40E-01	86.72
3	24.9566	1826	12.780	0.267	2.57E-03	5.98E-05	2.24E-02	2.67E-01	88.53
4	24.9493	1937	12.044	0.252	2.66E-03	6.80E-05	2.52E-02	3.00E-01	89.44
5	24.9656	2250	10.375	0.217	2.69E-03	6.46E-05	2.88E-02	3.42E-01	90.66
6	24.983	2389	9.778	0.205	2.63E-03	6.42E-05	3.36E-02	3.99E-01	92.17
7	24.9367	2904	8.029	0.168	2.59E-03	8.29E-05	4.03E-02	4.79E-01	93.57
8	24.9865	3860	6.053	0.127	2.50E-03	8.30E-05	5.03E-02	5.98E-01	95.03

Table A3 Experimental data of chromate rejection studies
[QUAT]:[Chromate]:[Sulfate] = 20:1:1

Solution Flux (L/m^2*hr) = (Volume of permeate(ml)*100^2(cm^2)*3600(s))/(Time interval(s)*38.5(cm^2)*100(ml))
Relative Flux = (Solution flux)/(Water flux)

Table A.3a Feed Specification : [Chromate] 4.01E-03 M
[Sulfate] 4.01E-03 M
[QUAT] 1.02E-01 M

Water Flux Rate = 78.709 L/m^2*hr
Filtration Area = 38.5 cm^2

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.8563	842	27.604	0.351	1.01E-04	5.86E-04	4.36E-03	1.09E-01	97.70
2	25.3117	894	26.474	0.336	1.10E-04	3.88E-04	4.80E-03	1.20E-01	97.70
3	24.8589	866	26.841	0.341	1.12E-04	4.44E-04	5.33E-03	1.33E-01	97.90
4	25.1725	961	24.493	0.311	1.07E-04	3.50E-04	6.01E-03	1.50E-01	98.22
5	24.8881	1029	22.616	0.287	1.07E-04	3.57E-04	6.86E-03	1.71E-01	98.44
6	24.8985	1133	20.549	0.261	1.09E-04	1.65E-04	8.00E-03	2.00E-01	98.63
7	24.8506	1253	18.545	0.236	1.17E-04	1.02E-04	9.59E-03	2.40E-01	98.77
8	24.8513	1547	15.021	0.191	1.02E-04	1.26E-04	1.20E-02	2.99E-01	99.15

Table A.3b Feed Specification : [Chromate] 5.43E-03 M Water Flux Rate = 49.008 L/m^2*hr

[Sulfate] 5.43E-03 M Filtration Area = 38.5 cm^2

[QUAT] 9.55E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flu (L/m^2*hr)	Relative Flu	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.7624	1225	19.665	0.401	2.60E-04	3.51E-05	5.92E-03	1.64E-01	95.61
2	24.9123	1216	19.157	0.391	2.64E-04	4.45E-05	6.51E-03	1.80E-01	95.95
3	24.8661	1278	18.194	0.371	2.55E-04	3.37E-05	7.23E-03	2.00E-01	96.47
4	24.8894	1389	16.755	0.342	2.49E-04	3.37E-05	8.13E-03	2.25E-01	96.93
5	24.8777	1542	15.086	0.308	2.42E-04	5.27E-05	9.29E-03	2.58E-01	97.39
6	24.8998	1790	13.007	0.265	2.34E-04	3.72E-05	1.08E-02	3.00E-01	97.84
7	24.8781	2069	11.243	0.229	2.22E-04	4.74E-05	1.30E-02	3.60E-01	98.29
8	24.8685	2817	8.255	0.168	2.01E-04	6.59E-05	1.62E-02	4.50E-01	98.76

Table A.3c Feed Specification : [Chromate] 2.04E-02 M Water Flux Rate = 50.819 L/m^2*hr

[Sulfate] 2.04E-02 M Filtration Area = 38.5 cm^2

[QUAT] 1.25E-01 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flu (L/m^2*hr)	Relative Flu	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.9068	1484	15.694	0.309	5.66E-04	4.02E-05	2.22E-02	2.18E-01	97.45
2	24.8464	1535	15.136	0.298	6.12E-04	3.78E-05	2.44E-02	2.40E-01	97.49
3	25.1635	1638	14.365	0.283	6.50E-04	4.01E-05	2.71E-02	2.67E-01	97.60
4	24.8575	1772	13.117	0.258	6.38E-04	4.78E-05	3.05E-02	3.00E-01	97.90
5	24.8769	2012	11.561	0.228	6.02E-04	3.98E-05	3.48E-02	3.42E-01	98.27
6	24.8976	2343	9.936	0.196	5.68E-04	5.46E-05	4.06E-02	3.99E-01	98.60
7	24.9034	2843	8.191	0.161	5.14E-04	5.20E-05	4.86E-02	4.78E-01	98.94
8	24.9821	4248	5.499	0.108	4.36E-04	4.45E-05	6.07E-02	5.97E-01	99.28

Table A4 Experimental data of chromate rejection studies
[QUAT]:[Chromate]:[Sulfate] = 20:2:1

Solution Flux (L/m^2*hr) = (Volume of permeate(ml)*$100^2(cm^2)$*3600(s))/(Time interval(s)*38.5(cm^2)*100(ml))
Relative Flux = (Solution flux)/(Water flux)

Table A.4a Feed Specification : [Chromate] 8.62E-03 M Water Flux Rate = 71.270 L/m^2*hr
[Sulfate] 4.31E-03 M Filtration Area = 38.5 cm^2
[QUAT] 6.91E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.0718	879	26.671	0.374	5.96E-04	4.10E-05	9.35E-03	7.54E-02	93.63
2	24.9237	904	25.780	0.362	5.97E-04	5.23E-05	1.03E-02	8.29E-02	94.20
3	24.9208	955	24.401	0.342	6.07E-04	4.41E-05	1.14E-02	9.20E-02	94.69
4	24.9051	1010	23.057	0.324	5.94E-04	3.17E-05	1.28E-02	1.03E-01	95.38
5	24.9024	1084	21.481	0.301	5.80E-04	4.30E-05	1.47E-02	1.18E-01	96.05
6	24.7738	1192	19.434	0.273	5.76E-04	8.25E-05	1.71E-02	1.38E-01	96.63
7	24.8893	1286	18.097	0.254	5.74E-04	4.52E-05	2.05E-02	1.65E-01	97.19
8	24.9386	1328	17.560	0.246	5.36E-04	4.97E-05	2.56E-02	2.06E-01	97.90

Table A.4b Feed Specification : [Chromate] 1.20E-02 M Water Flux Rate = 51.948 L/m^2*hr

[Sulfate] 6.01E-03 M Filtration Area = 38.5 cm^2

[QUAT] 9.81E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.9087	1244	18.723	0.360	1.33E-03	7.67E-05	1.30E-02	1.07E-01	89.79
2	24.8971	1268	18.360	0.353	1.40E-03	3.63E-05	1.43E-02	1.18E-01	90.19
3	24.9080	1316	17.698	0.341	1.38E-03	4.83E-05	1.58E-02	1.31E-01	91.28
4	25.4596	1430	16.648	0.320	1.38E-03	4.66E-05	1.79E-02	1.47E-01	92.29
5	24.8664	1644	14.143	0.272	1.34E-03	4.76E-05	2.04E-02	1.68E-01	93.46
6	24.9127	1758	13.251	0.255	1.30E-03	3.76E-05	2.38E-02	1.96E-01	94.52
7	24.8783	1985	11.719	0.226	1.24E-03	4.25E-05	2.86E-02	2.35E-01	95.66
8	24.9222	2663	8.751	0.168	1.23E-03	4.49E-05	3.57E-02	2.93E-01	96.55

Table A.4c

Feed Specification :

[Chromate]	1.83E-02	M	Water Flux Rate	=	49.318	L/m^2*hr
[Sulfate]	9.13E-03	M	Filtration Area	=	38.5	cm^2
[QUAT]	1.37E-01	M				

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.8586	1517	15.323	0.311	2.30E-03	5.65E-05	1.97E-02	1.49E-01	88.33
2	24.8972	1595	14.596	0.296	2.40E-03	4.98E-05	2.17E-02	1.64E-01	88.91
3	26.1085	1754	13.919	0.282	2.37E-03	5.41E-05	2.42E-02	1.83E-01	90.21
4	25.0070	1863	12.551	0.254	2.37E-03	4.87E-05	2.72E-02	2.06E-01	91.28
5	25.0485	2052	11.414	0.231	2.33E-03	6.38E-05	3.11E-02	2.36E-01	92.52
6	24.9318	2258	10.325	0.209	2.28E-03	5.21E-05	3.64E-02	2.75E-01	93.72
7	25.2479	2905	8.127	0.165	2.23E-03	5.54E-05	4.38E-02	3.31E-01	94.92
8	24.9789	3753	6.224	0.126	2.10E-03	6.32E-05	5.49E-02	4.15E-01	96.18

Table A5 Experimental data of chromate rejection studies
[QUAT]:[Chromate]:[Sulfate] = 20:4:1

Solution Flux (L/m^2*hr) = (Volume of permeate(ml)*$100^2(cm^2)$*3600(s))/(Time interval(s)*38.5(cm^2)*100(ml))
Relative Flux = (Solution flux)/(Water flux)

Table A.5a Feed Specification : [Chromate] 2.05E-02 M Water Flux Rate = 66.411 L/m^2*hr
[Sulfate] 5.12E-03 M Filtration Area = 38.5 cm^2
[QUAT] 8.07E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.9181	1136	20.511	0.309	2.48E-03	4.28E-05	2.21E-02	8.80E-02	88.77
2	24.8720	1173	19.827	0.299	2.78E-03	4.08E-05	2.43E-02	9.68E-02	88.56
3	24.8473	1212	19.170	0.289	2.76E-03	3.32E-05	2.69E-02	1.07E-01	89.77
4	24.8552	1335	17.409	0.262	2.80E-03	3.88E-05	3.03E-02	1.21E-01	90.75
5	24.8311	1405	16.526	0.249	2.70E-03	3.44E-05	3.46E-02	1.38E-01	92.18
6	24.8719	1552	14.985	0.226	2.72E-03	4.12E-05	4.03E-02	1.61E-01	93.26
7	24.8616	1715	13.555	0.204	2.67E-03	3.93E-05	4.82E-02	1.92E-01	94.47
8	24.9390	2016	11.567	0.174	2.59E-03	4.77E-05	6.02E-02	2.40E-01	95.69

Table A.5b Feed Specification : [Chromate] 2.84E-02 M Water Flux Rate = 50.489 L/m^2*hr

[Sulfate] 7.09E-03 M Filtration Area = 38.5 cm^2

[QUAT] 1.02E-01 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.9397	1426	16.354	0.324	5.47E-03	5.58E-05	3.04E-02	1.11E-01	82.04
2	24.9741	1434	16.285	0.323	5.80E-03	4.83E-05	3.34E-02	1.22E-01	82.66
3	24.9456	1476	15.803	0.313	6.07E-03	5.31E-05	3.71E-02	1.35E-01	83.65
4	24.9124	1628	14.309	0.283	6.06E-03	5.57E-05	4.17E-02	1.52E-01	85.49
5	24.9037	1659	14.037	0.278	6.05E-03	6.76E-05	4.77E-02	1.74E-01	87.31
6	24.8983	1963	11.860	0.235	6.07E-03	6.86E-05	5.56E-02	2.03E-01	89.08
7	24.9028	2137	10.896	0.216	6.03E-03	5.03E-05	6.66E-02	2.43E-01	90.94
8	25.0291	2630	8.899	0.176	5.89E-03	8.68E-05	8.32E-02	3.03E-01	92.92

Table A.5c

Feed Specification :

[Chromate]	4.49E-02	M	Water Flux Rate	=	50.272	L/m^2*hr
[Sulfate]	1.12E-02	M	Filtration Area	=	38.5	cm^2
[QUAT]	1.36E-01	M				

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.1868	1763	13.359	0.266	9.58E-03	6.51E-05	4.81E-02	1.48E-01	80.11
2	25.9128	1867	12.978	0.258	1.04E-02	5.45E-05	5.30E-02	1.63E-01	80.32
3	24.9033	1857	12.540	0.249	1.04E-02	6.91E-05	5.90E-02	1.81E-01	82.38
4	24.8860	2016	11.543	0.230	1.05E-02	7.53E-05	6.63E-02	2.04E-01	84.19
5	24.9416	2301	10.136	0.202	1.05E-02	5.87E-05	7.58E-02	2.33E-01	86.12
6	24.9277	2442	9.545	0.190	1.04E-02	6.28E-05	8.85E-02	2.72E-01	88.30
7	24.9403	2894	8.058	0.160	1.04E-02	6.40E-05	1.06E-01	3.27E-01	90.23
8	24.9789	3688	6.333	0.126	1.01E-02	6.75E-05	1.33E-01	4.09E-01	92.40

Table A6 Experimental data of chromate rejection studies
[QUAT]:[Chromate]:[Sulfate] = 20:6:1

Solution Flux (L/m^2*hr) = (Volume of permeate(ml)*$100^2(cm^2)$*3600(s))/(Time interval(s)*38.5(cm^2)*100(ml))
Relative Flux = (Solution flux)/(Water flux)

Table A.6a Feed Specification : [Chromate] 2.93E-02 M Water Flux Rate = 50.381 L/m^2*hr
[Sulfate] 4.88E-03 M Filtration Area = 38.5 cm^2
[QUAT] 6.65E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.8988	1306	17.827	0.354	7.92E-03	5.14E-05	3.12E-02	7.26E-02	74.61
2	24.8597	1309	17.758	0.352	9.24E-03	3.96E-05	3.42E-02	7.98E-02	72.97
3	25.7614	1370	17.583	0.349	9.49E-03	5.17E-05	3.80E-02	8.89E-02	75.06
4	24.9236	1461	15.952	0.317	8.63E-03	4.13E-05	4.29E-02	1.00E-01	79.91
5	24.8681	1500	15.502	0.308	9.15E-03	4.79E-05	4.90E-02	1.14E-01	81.32
6	24.9090	1591	14.640	0.291	9.33E-03	4.41E-05	5.71E-02	1.33E-01	83.65
7	25.0195	1806	12.954	0.257	9.53E-03	6.32E-05	6.85E-02	1.60E-01	86.09
8	24.9112	2002	11.635	0.231	9.81E-03	5.92E-05	8.55E-02	2.00E-01	88.52

Table A.6b Feed Specification : [Chromate] 3.95E-02 M Water Flux Rate = 49.527 L/m^2*hr

[Sulfate] 6.59E-03 M Filtration Area = 38.5 cm^2

[QUAT] 1.02E-01 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.1119	1568	14.975	0.302	1.27E-02	7.40E-05	4.20E-02	1.12E-01	69.67
2	24.9667	1575	14.823	0.299	1.43E-02	5.27E-05	4.60E-02	1.23E-01	68.85
3	25.2067	1635	14.416	0.291	1.47E-02	5.17E-05	5.11E-02	1.37E-01	71.32
4	24.9603	1761	13.254	0.268	1.47E-02	6.89E-05	5.75E-02	1.54E-01	74.38
5	24.9575	1957	11.925	0.241	1.50E-02	8.71E-05	6.57E-02	1.76E-01	77.15
6	25.2352	2094	11.269	0.228	1.48E-02	6.15E-05	7.68E-02	2.05E-01	80.66
7	24.9745	2286	10.216	0.206	1.50E-02	7.99E-05	9.22E-02	2.47E-01	83.74
8	24.9342	2747	8.487	0.171	1.48E-02	8.37E-05	1.15E-01	3.08E-01	87.18

Table A.6c

Feed Specification :

[Chromate]	5.82E-02	M	Water Flux Rate	=	65.116	L/m^2*hr
[Sulfate]	9.71E-03	M	Filtration Area	=	38.5	cm^2
[QUAT]	1.35E-01	M				

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.0377	1877	12.473	0.192	2.05E-02	1.28E-04	6.17E-02	1.47E-01	66.70
2	24.9231	1962	11.878	0.182	2.26E-02	1.13E-04	6.76E-02	1.62E-01	66.57
3	25.0819	2036	11.519	0.177	2.23E-02	8.69E-05	7.52E-02	1.80E-01	70.32
4	25.0212	2272	10.298	0.158	2.25E-02	1.12E-04	8.46E-02	2.03E-01	73.40
5	24.9859	2495	9.364	0.144	2.25E-02	9.87E-05	9.67E-02	2.31E-01	76.69
6	25.0866	2683	8.743	0.134	2.25E-02	1.08E-04	1.13E-01	2.70E-01	80.07
7	24.9507	3073	7.592	0.117	2.26E-02	1.02E-04	1.35E-01	3.24E-01	83.33
8	25.2997	3848	6.148	0.094	2.26E-02	1.38E-04	1.70E-01	4.07E-01	86.69

Table A7 Experimental data of chromate rejection studies
[QUAT]:[Chromate]:[Sulfate] = 20:8:1

Solution Flux (L/m^2*hr) = (Volume of permeate(ml)*$100^2(cm^2)$*3600(s))/(Time interval(s)*38.5(cm^2)*100(ml))
Relative Flux = (Solution flux)/(Water flux)

Table A.7a Feed Specification : [Chromate] 3.27E-02 M Water Flux Rate = 45.927 L/m^2*hr
[Sulfate] 4.09E-03 M Filtration Area = 38.5 cm^2
[QUAT] 6.75E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.9826	1368	17.076	0.372	1.27E-02	3.93E-05	3.46E-02	7.36E-02	63.33
2	25.5293	1384	17.248	0.376	1.47E-02	3.67E-05	3.79E-02	8.11E-02	61.19
3	25.1673	1423	16.538	0.360	1.50E-02	3.57E-05	4.21E-02	9.03E-02	64.39
4	24.9363	1481	15.744	0.343	1.59E-02	4.94E-05	4.73E-02	1.02E-01	66.27
5	24.9528	1572	14.843	0.323	1.56E-02	5.17E-05	5.41E-02	1.16E-01	71.20
6	25.0075	1688	13.853	0.302	1.58E-02	4.01E-05	6.31E-02	1.35E-01	74.92
7	24.9496	1877	12.429	0.271	1.62E-02	5.32E-05	7.57E-02	1.63E-01	78.57
8	25.2824	2107	11.220	0.244	1.60E-02	4.57E-05	9.49E-02	2.04E-01	83.10

Table A.7b Feed Specification : [Chromate] 5.85E-02 M Water Flux Rate = 52.532 L/m^2*hr

[Sulfate] 7.32E-03 M Filtration Area = 38.5 cm^2

[QUAT] 9.18E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.0232	1698	13.780	0.262	2.18E-02	7.83E-05	6.19E-02	1.00E-01	64.72
2	24.9723	1745	13.382	0.255	2.41E-02	7.29E-05	6.79E-02	1.10E-01	64.48
3	24.9374	1775	13.137	0.250	2.41E-02	6.78E-05	7.54E-02	1.22E-01	67.99
4	24.9640	1976	11.813	0.225	2.42E-02	8.45E-05	8.48E-02	1.38E-01	71.50
5	24.9979	2078	11.249	0.214	2.44E-02	8.52E-05	9.68E-02	1.57E-01	74.84
6	24.9775	2283	10.230	0.195	2.47E-02	7.82E-05	1.13E-01	1.83E-01	78.13
7	24.9917	2543	9.189	0.175	2.45E-02	7.68E-05	1.35E-01	2.20E-01	81.92
8	25.1707	2895	8.130	0.155	2.50E-02	8.79E-05	1.69E-01	2.75E-01	85.27

Table A.7c Feed Specification : [Chromate] 8.37E-02 M Water Flux Rate = 65.116 L/m^2*hr

[Sulfate] 1.05E-02 M Filtration Area = 38.5 cm^2

[QUAT] 1.34E-01 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.0387	2081	11.251	0.195	3.38E-02	1.06E-04	8.82E-02	1.46E-01	61.70
2	25.0565	2107	11.120	0.193	3.74E-02	8.09E-05	9.67E-02	1.61E-01	61.30
3	25.0456	2241	10.450	0.181	3.70E-02	7.82E-05	1.08E-01	1.79E-01	65.61
4	25.0642	2478	9.458	0.164	3.69E-02	8.07E-05	1.21E-01	2.01E-01	69.48
5	25.0542	2582	9.073	0.157	3.70E-02	8.04E-05	1.38E-01	2.30E-01	73.28
6	25.0550	2818	8.314	0.144	3.71E-02	1.13E-04	1.61E-01	2.69E-01	77.00
7	25.0673	3349	6.999	0.121	3.89E-02	1.14E-04	1.94E-01	3.23E-01	79.89
8	25.0820	4066	5.768	0.100	3.86E-02	9.13E-05	2.42E-01	4.04E-01	84.06

Table A8 Experimental data of chromate rejection studies
[QUAT]:[Chromate]:[Sulfate] = 20:10:1

Solution Flux (L/m^2*hr) = (Volume of permeate(ml)*$100^2(cm^2)$*3600(s))/(Time interval(s)*38.5(cm^2)*100(ml))
Relative Flux = (Solution flux)/(Water flux)

Table A.8a Feed Specification : [Chromate] 4.82E-02 M Water Flux Rate = 45.837 L/m^2*hr
[Sulfate] 4.82E-03 M Filtration Area = 38.5 cm^2
[QUAT] 6.56E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.9669	1432	16.303	0.356	2.14E-02	4.35E-05	5.06E-02	7.16E-02	57.84
2	25.0366	1422	16.463	0.359	2.34E-02	4.38E-05	5.55E-02	7.87E-02	57.76
3	26.2282	1601	15.319	0.334	2.38E-02	4.26E-05	6.18E-02	8.80E-02	61.53
4	25.0103	1509	15.498	0.338	2.37E-02	4.70E-05	6.98E-02	9.90E-02	65.97
5	24.9860	1705	13.703	0.299	2.40E-02	4.40E-05	7.98E-02	1.13E-01	69.96
6	25.0007	1756	13.313	0.290	2.46E-02	4.74E-05	9.31E-02	1.32E-01	73.55
7	25.0475	1937	12.091	0.264	2.49E-02	4.78E-05	1.12E-01	1.59E-01	77.71
8	25.2644	2232	10.584	0.231	2.56E-02	5.36E-05	1.40E-01	2.00E-01	81.74

Table A.8b Feed Specification : [Chromate] 7.14E-02 M Water Flux Rate = 55.004 L/m^2*hr

[Sulfate] 7.14E-03 M Filtration Area = 38.5 cm^2

[QUAT] 9.83E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.0410	1784	13.125	0.239	3.24E-02	1.12E-04	7.50E-02	1.07E-01	56.80
2	25.8321	1887	12.801	0.233	3.52E-02	8.35E-05	8.24E-02	1.18E-01	57.24
3	25.6522	1900	12.624	0.230	3.56E-02	7.36E-05	9.18E-02	1.32E-01	61.26
4	25.0180	2034	11.501	0.209	3.62E-02	1.03E-04	1.03E-01	1.49E-01	64.95
5	24.9963	2186	10.692	0.194	3.62E-02	7.64E-05	1.18E-01	1.70E-01	69.42
6	25.0337	2376	9.852	0.179	3.66E-02	1.08E-04	1.38E-01	1.99E-01	73.48
7	25.0384	2620	8.936	0.162	3.70E-02	9.56E-05	1.66E-01	2.39E-01	77.70
8	25.0149	3058	7.649	0.139	3.74E-02	1.01E-04	2.08E-01	3.00E-01	82.04

Table A.8c

Feed Specification :

[Chromate]	1.06E-01	M	Water Flux Rate	=	54.746	L/m^2*hr
[Sulfate]	1.06E-02	M	Filtration Area	=	38.5	cm^2
[QUAT]	1.31E-01	M				

Permeate No.	Permeate Weight (g)	Time interval (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.7255	2217	10.850	0.198	5.18E-02	9.13E-05	1.11E-01	1.43E-01	53.30
2	25.5838	2236	10.699	0.195	5.46E-02	1.11E-04	1.22E-01	1.58E-01	55.21
3	25.0825	2261	10.373	0.189	5.35E-02	1.02E-04	1.36E-01	1.75E-01	60.63
4	25.2605	2473	9.551	0.174	5.22E-02	9.25E-05	1.53E-01	1.98E-01	65.94
5	25.1684	2753	8.549	0.156	5.26E-02	1.16E-04	1.76E-01	2.26E-01	70.05
6	25.0177	2949	7.933	0.145	5.30E-02	8.94E-05	2.05E-01	2.65E-01	74.16
7	25.0737	3313	7.077	0.129	5.34E-02	9.18E-05	2.47E-01	3.19E-01	78.38
8	25.1784	4011	5.870	0.107	5.33E-02	1.09E-04	3.10E-01	4.01E-01	82.83

Table A9 Experimental data of chromate rejection studies
[QUAT]:[Chromate]:[Sulfate] = 20:1:2

Solution Flux (L/m^2*hr) = (Volume of permeate(ml)*$100^2(cm^2)$*3600(s))/(Time interval(s)*38.5(cm^2)*100(ml))
Relative Flux = (Solution flux)/(Water flux)

Table A.9a Feed Specification : [Chromate] 4.66E-03 M Water Flux Rate = 45.837 L/m^2*hr
[Sulfate] 9.33E-03 M Filtration Area = 38.5 cm^2
[QUAT] 7.82E-02 M

Permeate No.	Permeate Weight (g)	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.1739	976	24.118	0.526	3.00E-04	6.64E-05	5.06E-03	8.54E-02	94.07
2	24.8582	991	23.455	0.512	3.14E-04	6.06E-05	5.56E-03	9.39E-02	94.35
3	24.9124	1025	22.727	0.496	3.18E-04	6.08E-05	6.18E-03	1.04E-01	94.85
4	24.8799	1092	21.304	0.465	3.22E-04	6.01E-05	6.95E-03	1.17E-01	95.36
5	24.9084	1205	19.329	0.422	3.17E-04	5.67E-05	7.94E-03	1.34E-01	96.01
6	24.8751	1296	17.947	0.392	3.11E-04	6.13E-05	9.25E-03	1.56E-01	96.64
7	24.8419	1461	15.899	0.347	3.01E-04	5.55E-05	1.11E-02	1.87E-01	97.28
8	24.8641	1747	13.308	0.290	2.76E-04	5.49E-05	1.38E-02	2.33E-01	98.00

Table A.9b Feed Specification : [Chromate] 6.73E-03 M Water Flux Rate = 58.151 L/m^2*hr

[Sulfate] 1.35E-02 M Filtration Area = 38.5 cm^2

[QUAT] 9.51E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.8806	1271	18.304	0.315	6.48E-04	4.74E-05	7.29E-03	1.04E-01	91.11
2	25.5977	1343	17.822	0.306	6.81E-04	4.99E-05	8.03E-03	1.14E-01	91.52
3	25.1038	1364	17.209	0.296	7.10E-04	4.47E-05	8.92E-03	1.27E-01	92.04
4	27.4862	1531	16.787	0.289	6.89E-04	3.48E-05	1.02E-02	1.45E-01	93.22
5	26.1271	1739	14.049	0.242	6.65E-04	4.09E-05	1.17E-02	1.67E-01	94.33
6	26.6682	1857	13.428	0.231	6.39E-04	3.60E-05	1.39E-02	1.98E-01	95.40
7	24.9355	2128	10.957	0.188	6.13E-04	4.01E-05	1.68E-02	2.39E-01	96.36
8	24.8296	2711	8.564	0.147	5.80E-04	4.50E-05	2.13E-02	3.02E-01	97.27

Table A.9c

Feed Specification :

[Chromate]	1.09E-02	M	Water Flux Rate =	77.151	L/m^2*hr
[Sulfate]	2.17E-02	M	Filtration Area =	38.5	cm^2
[QUAT]	1.31E-01	M			

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.9972	1587	14.728	0.191	1.10E-03	7.49E-05	1.18E-02	1.43E-01	90.61
2	24.8953	1629	14.290	0.185	1.21E-03	5.63E-05	1.29E-02	1.57E-01	90.62
3	24.8555	1746	13.311	0.173	1.17E-03	5.56E-05	1.43E-02	1.74E-01	91.86
4	25.1752	1878	12.535	0.162	1.21E-03	5.61E-05	1.61E-02	1.96E-01	92.52
5	24.8763	1953	11.910	0.154	1.14E-03	6.41E-05	1.84E-02	2.24E-01	93.84
6	24.8549	2250	10.329	0.134	1.07E-03	5.41E-05	2.15E-02	2.61E-01	95.04
7	24.8608	2809	8.276	0.107	1.07E-03	5.81E-05	2.58E-02	3.13E-01	95.84
8	25.0134	3803	6.150	0.080	1.04E-03	6.53E-05	3.22E-02	3.90E-01	96.77

Table A10 Experimental data of chromate rejection studies

[QUAT]:[Chromate]:[Sulfate] = 20:1:4

Solution Flux (L/m^2*hr) = (Volume of permeate(ml)*$100^2(cm^2)$*3600(s))/(Time interval(s)*38.5(cm^2)*100(ml))

Relative Flux = (Solution flux)/(Water flux)

Table A.10a Feed Specification : [Chromate] 4.48E-03 M Water Flux Rate = 45.480 L/m^2*hr

[Sulfate] 1.79E-02 M Filtration Area = 38.5 cm^2

[QUAT] 7.00E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.8746	1122	20.730	0.456	8.05E-04	5.54E-05	4.81E-03	7.63E-02	83.26
2	24.9084	1118	20.833	0.458	8.52E-04	6.08E-05	5.28E-03	8.39E-02	83.88
3	25.2467	1155	20.439	0.449	8.52E-04	5.00E-05	5.88E-03	9.33E-02	85.50
4	24.8989	1197	19.450	0.428	8.54E-04	4.99E-05	6.61E-03	1.05E-01	87.08
5	24.9466	1346	17.330	0.381	8.43E-04	5.69E-05	7.55E-03	1.20E-01	88.83
6	25.0764	1367	17.153	0.377	8.53E-04	4.75E-05	8.81E-03	1.40E-01	90.32
7	24.9123	1634	14.256	0.313	8.55E-04	4.78E-05	1.06E-02	1.68E-01	91.90
8	24.9050	1764	13.202	0.290	8.59E-04	4.74E-05	1.32E-02	2.09E-01	93.49

Table A.10b Feed Specification : [Chromate] 6.97E-03 M Water Flux Rate = 60.405 L/m^2*hr

[Sulfate] 2.79E-02 M Filtration Area = 38.5 cm^2

[QUAT] 9.30E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.1081	1435	16.361	0.271	1.14E-03	4.92E-05	7.50E-03	1.02E-01	84.86
2	24.9254	1445	16.129	0.267	1.26E-03	5.17E-05	8.24E-03	1.12E-01	84.68
3	24.8842	1504	15.471	0.256	1.31E-03	5.18E-05	9.15E-03	1.24E-01	85.65
4	24.8967	1592	14.623	0.242	1.26E-03	4.42E-05	1.03E-02	1.39E-01	87.72
5	24.9360	1766	13.203	0.219	1.25E-03	4.90E-05	1.18E-02	1.59E-01	89.40
6	24.8851	1970	11.812	0.196	1.22E-03	4.81E-05	1.37E-02	1.86E-01	91.08
7	24.9146	2251	10.350	0.171	1.26E-03	4.93E-05	1.64E-02	2.22E-01	92.30
8	24.9325	2675	8.715	0.144	1.25E-03	4.64E-05	2.05E-02	2.78E-01	93.91

Table A.10c Feed Specification : [Chromate] 1.08E-02 M Water Flux Rate = 73.977 L/m^2*hr

[Sulfate] 4.33E-02 M Filtration Area = 38.5 cm^2

[QUAT] 1.40E-01 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flu (L/m²*hr)	Relative Flu	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.9118	1895	12.292	0.166	1.63E-03	8.19E-05	1.17E-02	1.53E-01	85.97
2	24.9080	1959	11.889	0.161	1.92E-03	6.50E-05	1.28E-02	1.68E-01	84.99
3	25.0960	2045	11.475	0.155	1.88E-03	6.53E-05	1.42E-02	1.87E-01	86.75
4	25.1553	2260	10.408	0.141	1.89E-03	6.44E-05	1.60E-02	2.11E-01	88.16
5	24.3753	2493	9.143	0.124	1.84E-03	6.72E-05	1.82E-02	2.40E-01	89.90
6	26.3445	3002	8.206	0.111	1.86E-03	7.28E-05	2.14E-02	2.82E-01	91.34
7	24.8970	3739	6.226	0.084	1.78E-03	7.48E-05	2.58E-02	3.39E-01	93.10
8	25.2937	5247	4.508	0.061	1.75E-03	8.43E-05	3.23E-02	4.25E-01	94.59

Table A11 Experimental data of chromate rejection studies
[QUAT]:[Chromate]:[Sulfate] = 20:1:6

Solution Flux (L/m^2*hr) = (Volume of permeate(ml)*$100^2(cm^2)$*3600(s))/(Time interval(s)*$38.5(cm^2)$*100(ml))
Relative Flux = (Solution flux)/(Water flux)

Table A.11a Feed Specification : [Chromate] 4.59E-03 M Water Flux Rate = 45.480 L/m^2*hr
[Sulfate] 2.75E-02 M Filtration Area = 38.5 cm^2
[QUAT] 7.34E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.9759	1233	18.941	0.416	1.06E-03	6.07E-05	4.91E-03	8.00E-02	78.33
2	25.0742	1226	19.124	0.420	1.17E-03	5.63E-05	5.39E-03	8.80E-02	78.24
3	24.9918	1260	18.547	0.408	1.19E-03	6.06E-05	5.99E-03	9.78E-02	80.08
4	24.9769	1308	17.856	0.393	1.21E-03	6.02E-05	6.74E-03	1.10E-01	82.00
5	24.9547	1412	16.526	0.363	1.21E-03	6.27E-05	7.70E-03	1.26E-01	84.21
6	25.2478	1584	14.904	0.328	1.21E-03	5.78E-05	8.99E-03	1.47E-01	86.49
7	24.9297	1698	13.728	0.302	1.22E-03	5.86E-05	1.08E-02	1.76E-01	88.70
8	24.9265	1888	12.345	0.271	1.22E-03	5.73E-05	1.35E-02	2.20E-01	90.92

Table A.11b Feed Specification : [Chromate] 7.39E-03 M Water Flux Rate = 63.871 L/m^2*hr

[Sulfate] 4.43E-02 M Filtration Area = 38.5 cm^2

[QUAT] 1.26E-01 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.8955	1628	14.299	0.224	1.50E-03	6.43E-05	7.92E-03	1.37E-01	81.13
2	24.8703	1668	13.942	0.218	1.67E-03	6.06E-05	8.69E-03	1.50E-01	80.73
3	24.8705	1739	13.373	0.209	1.67E-03	5.73E-05	9.65E-03	1.67E-01	82.71
4	24.9465	1833	12.726	0.199	1.65E-03	6.14E-05	1.09E-02	1.88E-01	84.79
5	24.9602	2085	11.194	0.175	1.67E-03	6.09E-05	1.24E-02	2.15E-01	86.52
6	24.9039	2310	10.081	0.158	1.64E-03	6.47E-05	1.45E-02	2.50E-01	88.65
7	24.9141	2646	8.804	0.138	1.66E-03	8.58E-05	1.73E-02	3.00E-01	90.41
8	24.9295	3366	6.925	0.108	1.61E-03	7.25E-05	2.16E-02	3.74E-01	92.56

Table A.11c Feed Specification : [Chromate] 1.10E-02 M Water Flux Rate = 65.665 L/m^2*hr

[Sulfate] 6.61E-02 M Filtration Area = 38.5 cm^2

[QUAT] 1.62E-01 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.0184	2090	11.193	0.170	2.38E-03	8.02E-05	1.18E-02	1.77E-01	79.83
2	24.8963	2139	10.883	0.166	2.72E-03	8.31E-05	1.29E-02	1.94E-01	79.02
3	24.9609	2220	10.514	0.160	2.67E-03	7.72E-05	1.44E-02	2.16E-01	81.42
4	25.0595	2466	9.502	0.145	2.66E-03	6.98E-05	1.62E-02	2.43E-01	83.54
5	25.1622	2753	8.546	0.130	2.62E-03	7.33E-05	1.85E-02	2.78E-01	85.83
6	25.0182	3134	7.464	0.114	2.69E-03	7.67E-05	2.16E-02	3.24E-01	87.55
7	24.9903	3772	6.195	0.094	2.61E-03	8.08E-05	2.59E-02	3.89E-01	89.95
8	25.1300	5739	4.094	0.062	2.59E-03	9.56E-05	3.25E-02	4.87E-01	92.02

Table A12 Experimental data of chromate rejection studies
[QUAT]:[Chromate]:[Sulfate] = 20:1:8

Solution Flux (L/m^2*hr) = (Volume of permeate(ml)*$100^2(cm^2)$*3600(s))/(Time interval(s)*38.5(cm^2)*100(ml))
Relative Flux = (Solution flux)/(Water flux)

Table A.12a Feed Specification : [Chromate] 4.66E-03 M Water Flux Rate = 46.017 L/m^2*hr
[Sulfate] 3.73E-02 M Filtration Area = 38.5 cm^2
[QUAT] 7.53E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.2222	1293	18.240	0.396	1.23E-03	4.91E-05	4.97E-03	8.23E-02	75.33
2	24.9568	1277	18.274	0.397	1.37E-03	6.06E-05	5.46E-03	9.05E-02	74.96
3	25.3665	1319	17.983	0.391	1.36E-03	6.06E-05	6.07E-03	1.01E-01	77.57
4	24.8854	1386	16.789	0.365	1.36E-03	6.24E-05	6.83E-03	1.13E-01	80.05
5	24.9394	1494	15.609	0.339	1.39E-03	6.17E-05	7.81E-03	1.29E-01	82.23
6	26.7211	1703	14.672	0.319	1.41E-03	5.77E-05	9.20E-03	1.53E-01	84.63
7	24.9791	1775	13.159	0.286	1.43E-03	5.47E-05	1.11E-02	1.84E-01	87.12
8	24.9053	2012	11.575	0.252	1.43E-03	5.73E-05	1.39E-02	2.31E-01	89.68

Table A.12b Feed Specification : [Chromate] 7.36E-03 M Water Flux Rate = 63.697 L/m^2*hr

[Sulfate] 5.88E-02 M Filtration Area = 38.5 cm^2

[QUAT] 1.18E-01 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.2354	1825	12.930	0.203	2.09E-03	7.65E-05	7.84E-03	1.28E-01	73.34
2	25.0200	1939	12.066	0.189	2.19E-03	6.56E-05	8.62E-03	1.41E-01	74.57
3	25.1812	2060	11.430	0.179	2.20E-03	6.91E-05	9.58E-03	1.57E-01	76.98
4	25.0326	2149	10.892	0.171	2.20E-03	6.41E-05	1.08E-02	1.77E-01	79.61
5	25.2316	2516	9.377	0.147	2.21E-03	7.44E-05	1.23E-02	2.02E-01	82.12
6	25.2978	2687	8.804	0.138	2.21E-03	7.97E-05	1.44E-02	2.37E-01	84.67
7	25.2848	3087	7.659	0.120	2.20E-03	8.24E-05	1.74E-02	2.85E-01	87.36
8	25.3958	4017	5.912	0.093	2.16E-03	8.48E-05	2.19E-02	3.59E-01	90.12

Table A.12c Feed Specification : [Chromate] 1.06E-02 M Water Flux Rate = 63.697 L/m^2*hr

[Sulfate] 8.45E-02 M Filtration Area = 38.5 cm^2

[QUAT] 1.60E-01 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.1237	2095	11.214	0.176	2.82E-03	8.87E-05	1.13E-02	1.74E-01	74.98
2	25.0385	2135	10.966	0.172	3.21E-03	8.57E-05	1.24E-02	1.92E-01	74.03
3	25.0061	2223	10.518	0.165	3.22E-03	7.76E-05	1.37E-02	2.13E-01	76.51
4	24.9814	2458	9.503	0.149	3.24E-03	8.34E-05	1.54E-02	2.40E-01	79.02
5	25.0107	2682	8.720	0.137	3.20E-03	7.74E-05	1.77E-02	2.74E-01	81.88
6	27.1240	3469	7.311	0.115	3.20E-03	8.64E-05	2.09E-02	3.24E-01	84.65
7	25.2374	3928	6.008	0.094	3.17E-03	8.61E-05	2.52E-02	3.91E-01	87.43
8	25.3377	5873	4.034	0.063	3.12E-03	1.00E-04	3.18E-02	4.93E-01	90.20

Table A13 Experimental data of chromate rejection studies
[QUAT]:[Chromate]:[Sulfate] = 20:1:10

Solution Flux (L/m^2*hr) = (Volume of permeate(ml)*$100^2(cm^2)$*3600(s))/(Time interval(s)*38.5(cm^2)*100(ml))
Relative Flux = (Solution flux)/(Water flux)

Table A.13a Feed Specification : [Chromate] 4.98E-03 M Water Flux Rate = 45.747 L/m^2*hr
[Sulfate] 4.98E-02 M Filtration Area = 38.5 cm^2
[QUAT] 7.72E-02 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	24.9505	1303	17.905	0.391	1.32E-03	6.44E-05	5.31E-03	8.42E-02	75.07
2	24.9724	1300	17.962	0.393	1.42E-03	6.07E-05	5.83E-03	9.26E-02	75.67
3	25.0177	1330	17.589	0.384	1.41E-03	5.56E-05	6.48E-03	1.03E-01	78.18
4	24.9507	1455	16.035	0.351	1.43E-03	5.88E-05	7.29E-03	1.16E-01	80.44
5	25.0121	1500	15.592	0.341	1.44E-03	5.79E-05	8.32E-03	1.32E-01	82.69
6	24.9938	1626	14.373	0.314	1.46E-03	6.53E-05	9.71E-03	1.54E-01	84.98
7	25.0060	1762	13.270	0.290	1.49E-03	5.44E-05	1.16E-02	1.85E-01	87.24
8	24.9885	2021	11.562	0.253	1.50E-03	6.43E-05	1.45E-02	2.31E-01	89.69

Table A.13b Feed Specification : [Chromate] 5.87E-03 M Water Flux Rate = 45.747 L/m^2*hr

[Sulfate] 5.87E-02 M Filtration Area = 38.5 cm^2

[QUAT] 1.24E-01 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	25.0876	1731	13.552	0.296	1.72E-03	7.77E-05	6.25E-03	1.35E-01	72.51
2	25.0259	1812	12.914	0.282	1.85E-03	6.18E-05	6.87E-03	1.49E-01	72.99
3	25.0362	1896	12.347	0.270	1.88E-03	6.56E-05	7.63E-03	1.65E-01	75.34
4	25.0065	2013	11.616	0.254	1.86E-03	6.20E-05	8.59E-03	1.86E-01	78.28
5	25.0165	2241	10.438	0.228	1.87E-03	6.68E-05	9.81E-03	2.13E-01	80.94
6	25.0270	2385	9.812	0.214	1.86E-03	7.62E-05	1.15E-02	2.48E-01	83.74
7	24.9995	2806	8.331	0.182	1.86E-03	7.39E-05	1.37E-02	2.98E-01	86.45
8	25.1873	3516	6.698	0.146	1.87E-03	8.73E-05	1.72E-02	3.73E-01	89.16

Table A.13c Feed Specification : [Chromate] 8.30E-03 M Water Flux Rate = 59.634 L/m^2*hr

[Sulfate] 8.30E-02 M Filtration Area = 38.5 cm^2

[QUAT] 1.71E-01 M

Permeate No.	Permeate Weight (g	Time interva (sec)	Solution Flux (L/m^2*hr)	Relative Flux	Permeate (Molar)		Retentate (Molar)		$[CrO_4^{2-}]$ Rejection, %
					$[CrO_4^{2-}]$	[QUAT]	$[CrO_4^{2-}]$	[QUAT]	
1	26.0997	2281	10.699	0.179	2.77E-03	9.88E-05	8.82E-03	1.87E-01	68.55
2	25.1526	2297	10.239	0.172	2.81E-03	7.99E-05	9.72E-03	2.06E-01	71.05
3	25.1188	2414	9.730	0.163	2.85E-03	8.05E-05	1.08E-02	2.29E-01	73.63
4	25.0876	2640	8.886	0.149	2.83E-03	7.82E-05	1.22E-02	2.58E-01	76.75
5	25.0815	2997	7.825	0.131	2.81E-03	8.48E-05	1.39E-02	2.95E-01	79.82
6	25.1067	3486	6.734	0.113	2.80E-03	8.78E-05	1.63E-02	3.45E-01	82.85
7	25.0747	4336	5.407	0.091	2.82E-03	9.84E-05	1.96E-02	4.16E-01	85.61
8	25.2160	6492	3.632	0.061	2.75E-03	1.08E-04	2.47E-02	5.23E-01	88.86

Appendix B Experimental data for equilibrium precipitation studies

Table B1 Equilibrium precipitation studies of initial Ba^{2+} concentration at a [Chromate]:[Sulfate] of 1

Condition : $[CrO_4^{2-}]_{initial}$ 0.020 M
$[SO_4^{2-}]_{initial}$ 0.020 M
$[QUAT]_{initial}$ 0.1, 0.2 and 0.3 M

[Barium] (M)	$[Ba^{2+}]:[CrO_4^{2-}]:[SO_4^{2-}]$	$[Ba^{2+}]:[CrO_4^{2-}$ and $SO_4^{2-}]$	$[CrO_4^{2-}]_{supernatant}$ (M)			Fraction of chromate precipitated (%)		
			0.1 M QUAT	0.2 M QUAT	0.3 M QUAT	0.1 M QUAT	0.2 M QUAT	0.3 M QUAT
0.010	0.5 : 1 : 1	0.25	1.398E-02	1.440E-02	1.410E-02	30.08	28.02	29.50
0.016	0.8 : 1 : 1	0.40	1.250E-02	1.291E-02	1.268E-02	37.52	35.45	36.62
0.020	1 : 1 : 1	0.50	1.150E-02	1.205E-02	1.181E-02	42.48	39.77	40.96
0.024	1.2 : 1 : 1	0.60	7.739E-03	7.786E-03	6.886E-03	61.31	61.07	65.57
0.030	1.5 : 1 : 1	0.75	4.441E-03	5.284E-03	6.299E-03	77.79	73.58	68.50
0.040	2 : 1 : 1	1.00	3.393E-04	9.536E-04	1.379E-03	98.30	95.23	93.10
0.080	4 : 1 : 1	2.00	8.456E-06	8.659E-06	8.606E-06	99.96	99.96	99.96

Table B2 Equilibrium precipitation studies of initial chromate concentration at a [Barium]:[Sulfate] of 2

Condition : $[Ba^{2+}]_{initial}$ 0.040 M
$[SO_4^{2-}]_{initial}$ 0.020 M
$[QUAT]_{initial}$ 0.1, 0.2 and 0.3 M

Chromate (M)	$[Ba^{2+}]:[CrO_4^{2-}]:[SO_4^{2-}]$	$[Ba^{2+}]:[CrO_4^{2-}]$	$[CrO_4^{2-}]_{supernatant}$ (M)			Fraction of chromate precipitated (%)		
			0.1 M QUAT	0.2 M QUAT	0.3 M QUAT	0.1 M QUAT	0.2 M QUAT	0.3 M QUAT
0.010	2 : 0.5 : 1	4.00	8.882E-06	9.359E-06	1.161E-05	99.91	99.91	99.88
0.016	2 : 0.8 : 1	2.50	1.308E-05	1.725E-05	5.722E-05	99.92	99.89	99.64
0.020	2 : 1 : 1	2.00	3.393E-04	9.536E-04	1.379E-03	98.30	95.23	93.10
0.024	2 : 1.2 : 1	1.67	1.274E-03	2.914E-03	3.286E-03	94.69	87.86	86.31
0.030	2 : 1.5 : 1	1.33	5.670E-03	6.705E-03	1.015E-02	81.10	77.65	66.18

Table B3 Equilibrium precipitation studies of initial sulfate concentration at a [Barium]:[Chromate] of 2

Condition : $[Ba^{2+}]_{initial}$ 0.040 M
$[CrO_4^{2-}]_{initial}$ 0.020 M
$[QUAT]_{initial}$ 0.1, 0.2 and 0.3 M

[Sulfate] (M)	$[Ba^{2+}]:[CrO_4^{2-}]:[SO_4^{2-}]$	$[Ba^{2+}]:[CrO_4^{2-}]$	$[CrO_4^{2-}]_{supernatant}$ (M)			Fraction of chromate precipitated (%)		
			0.1 M QUAT	0.2 M QUAT	0.3 M QUAT	0.1 M QUAT	0.2 M QUAT	0.3 M QUAT
0.010	2 : 1 : 0.5	4.00	1.229E-05	1.191E-05	1.403E-05	99.94	99.94	99.93
0.016	2 : 1 : 0.8	2.50	1.311E-05	2.120E-05	4.774E-05	99.93	99.89	99.76
0.020	2 : 1 : 1	2.00	3.393E-04	9.536E-04	1.379E-03	98.30	95.23	93.10
0.024	2 : 1 : 1.2	1.67	1.847E-03	2.799E-03	2.997E-03	90.76	86.01	85.02
0.030	2 : 1 : 1.5	1.33	3.644E-03	4.173E-03	4.453E-03	81.78	79.14	77.73

CURRICURUM VITAE

Name:	Mr. Ekkarin Siripattananont
Date of Birth:	August 15, 1979
Nationality:	Thai
University Education:	
1997-2000	Bachelor Degree of Engineering in Chemical Engineering, Faculty of Engineering, King Mongkut's University of Technology Thonburi, Bangkok, Thailand.