

เอกสารอ้างอิง


ภาษาไทย

- จิระศักดิ์ รัตนไพฑูรย์ "ลักษณะของน้ำทิ้งจากโรงงานอุตสาหกรรมขนาดย่อมภายในเขต
ราชบุรีบูรณะ กรุงเทพมหานคร" วิทยานิพนธ์ภาควิชาวิศวกรรมสุขาภิบาล คณะ
วิศวกรรมศาสตร์ บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย, 2526.
- ชัยวัฒน์ เจนวานิชย์ "สารานุกรมธาตุ" O.S. PRINTING HOUSE CO., LTD., 2525
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วิศวกรรมศาสตร์ บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย, 2535.
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ภาคผนวก ก.
ตารางแสดงรวบรวมลักษณะน้ำทิ้งจากโรงงานอุตสาหกรรมบริเวณ
เขตบางกอกน้อย กรุงเทพมหานคร

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

สรุปข้อมูลการทำงานของโรงงานชุบโลหะ (จระศักดิ์, 2526)

โรงงาน	ลักษณะงานชุบ	ปริมาณงานชุบ (ชิ้น/วัน)	น้ำแข็ง (กก./วัน)	ฉีกรายน้ำแข็ง (กก./วัน)	ปริมาณโลหะหนักตกค้างการชุบ (mg/L)					ปริมาณโลหะหนักตกค้างการชุบ (mg/L)					ปริมาณโลหะหนัก-4 ชนิด					
					Cr					Ni					Cu		Zn		รวม	
					Cr	Ni	Cu	Zn	รวม	Cr	Ni	Cu	Zn	รวม	กมล. น้ำยชุบ	กมล. น้ำยชุบ	กมล. น้ำยชุบ	กมล. น้ำยชุบ		
Cr, Ni, Cu, Brass	35,000	26	0.74	3.5	252.0	166.9	10.9	433.3	1.9	41.2	34.0	3.4	80.5	0.12	0.02	11.27	2.09			
Cr, Ni	200	5.5	27.5	41.9	143.3	16.4	14.1	215.7	3.3	43.4	2.2	2.4	51.3	0.78	2.56	1.19	0.28			
Cr, Ni, Cu, Zn, Brass	22,500	20	0.89	48.8	15.0	0.8	44.7	109.3	22.9	14.7	1.2	19.4	58.2	0.05	0.03	2.19	1.16			
Cr, Ni, Zn	750	2.5	3.33	120.2	95.7	4.9	5.4	226.2	45.3	6.0	0.9	0.3	52.5	3.02	0.7	0.56	0.13			
Cr, Ni, Cu, Brass	130	0.2	1.54	212.3	161.0	22.1	14.4	409.8	73.9	0.2	0.5	0.3	74.9	1.52	5.76	0.08	0.01			
ค่าเฉลี่ย	11,716	10.8	6.8	85.3	133.4	42.2	17.9	270.8	29.5	21.2	7.0	5.1	63.5	9.1	1.81	3.06	0.73			

- หมายเหตุ 1. ค่าที่นำมาใช้เป็นการเฉลี่ยของแต่ละโรงงาน
 2. โรงงานชุบโลหะโรงที่ 6 มีงานชุบชิ้นงานขนาดเล็ก



ภาคผนวก ข.
ตารางแสดงรวบรวมลักษณะน้ำทิ้งจากโรงงานชุบโลหะบริเวณ
เขต กรุงเทพมหานคร

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

ตารางแสดงปริมาณและลักษณะน้ำเสียจำนวน 20 โรงงาน ในกรุงเทพฯ
(TISTR, 1982)

Factory Name	Plating Activity	Waste Volume m ³ /d.	Waste characteristics, mg/l.							
			Cr	Ni	Cu	Zn	Au	Al	CN ⁻	
1. Jintanasuan	Cr, Au	15	0.05	275	-	-	-	0.05	-	-
2. Sangjaroen	Cr	1	40.3	27.5	-	-	-	-	-	-
3. Golden Lamp Co.	Ni, Cu	6	-	1.4	-	-	-	-	-	100
4. Thai-vasco.Electro.Ltd.	Al	8	-	-	-	-	-	-	345- 1,520	-
5. Suthichai chromium	Cr	8	27.3	29.0	4.7	-	-	-	-	-
6. Sekmsarapad	Cr, Zn	3.5	22.5	-	-	-	91	-	-	5.0
7. Kimhuad	Cr	0.5	2.9	10.0	11.0	-	-	-	-	-
8. Sawmee	Cr	3	0.9	7.0	-	-	-	-	-	-
9. Theptip-chromium	Cr	3	96.6	21.3	2.3	-	-	-	-	-
10. Sahajerawat	Zn	4	-	-	-	-	0.20	-	-	-
11. Thaijaroenkarnchang	Cr, Zn	20	10.6	24.9	10	-	19.7	-	-	10
12. Ha-senghuad	Cr	4	0.5	2.0	105.5	-	-	-	-	667
13. Samchai-Ushakam	Zn	4	-	-	-	-	467	-	-	1,000
14. Yongwatanaplastic	Cr	2	6.3	5.5	0.2	-	-	-	-	-
15. Hong-senghuad	Cr	2	94.1	420.9	-	-	-	-	-	-
16. Watanakij	Cr	1	12.0	37.8	-	-	-	-	-	-
17. P.T.I. Battery	Cr	25-30	14.7	57.3	108.4	-	-	-	-	30
18. D.Bunnag	Cr	6.7	447.9	15.0	4.0	-	-	-	-	-
19. Sangboon	Cr	3-4	146	7.5	9.5	-	-	-	-	-
20. Sew-jeng	Au	1.5	-	18.6	-	-	-	0.1	-	-
Average		6.34	62	60.1	37.3	144.5	0.75	933	302	
Range		0.5- 30	0.05- 447.9	1.4- 420.9	0.2- 185.5	0.20- 467	0.05- 0.1	345- 1,520	5- 1,000	



ภาคผนวก ค.
แสดงปริมาณราคานิกเกิล

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

ราคาสารเคมี(นิกเกิลซัลเฟต)

Commercial grade	130 - 800	Baht/Kg.
Laboratory grade	2800 - 3200	Baht/Kg.

ที่มาจากบริษัท สยามเคมีวิทยาศาสตร์อุตสาหกรรม



ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย



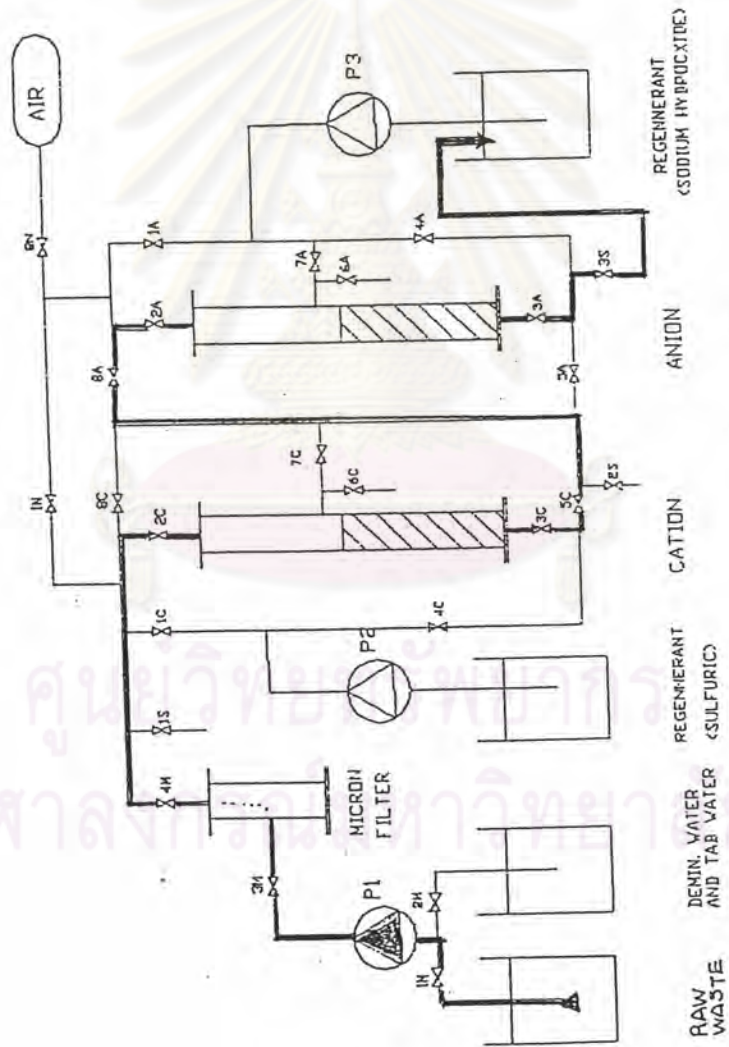
ภาคผนวก ง.

ตารางและรูปแสดงขั้นตอนการปฏิบัติงานในช่วงการแลกเปลี่ยนไอออน
และการรีเจนเนอเรชั่น

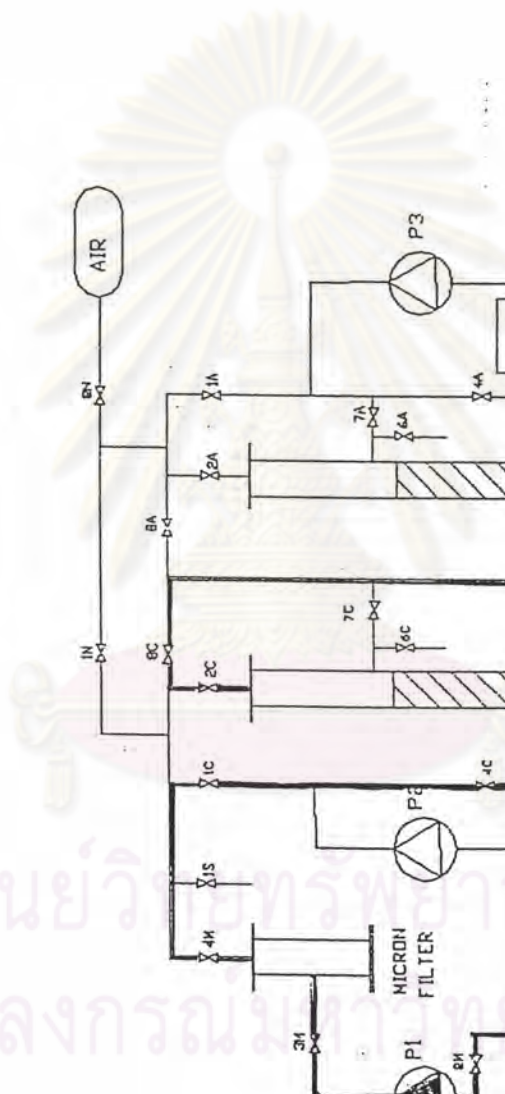
ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

ตารางแสดงขั้นตอนการปฏิบัติการต่างๆในการทดลอง

ขั้นตอนการทดลอง	ตำแหน่งรางวัลเปิด																							ปี			ข้อสังเกต				
	จังหวัดภาคเหนือตอนบน											จังหวัดภาคเหนือตอนล่าง											วอ.อื่นๆ								
	1C	2C	3C	4C	5C	6C	7C	8C	9C	2S	1A	2A	3A	4A	5A	6A	7A	8A	9A	3S	1S	1M	2M	3M	4M	1N		2N	P1	P2	P3
การลดปริมาณไฮดรอน		X	X		X							X	X					X	X		X		X	X				X			อัตราการไหล 30 BV/hr. ขนาดของชั้นหินเฉลี่ย 10 มม.
การเพิ่มอัตราการซึม																															ใช้หินกรวดขนาด 50 มม. ปริมาณ 50 ลิตร/ชั่วโมง
การล้างชั้น	SAC or WAC	X	X	X	X			X	X														X	X	X			X			น้ำล้างชั้นหิน
	SBA							X	X		X	X	X		X				X			X	X	X				X			
การล้างผิว	SAC or WAC		X	X	X		X	X																				X	X		
	SBA											X	X	X		X			X								X	X			
การล้างน้ำ	SAC or WAC	X	X	X	X		X	X										X					X	X	X		X	X			น้ำล้างน้ำประปาไฮดรอน-
	SBA							X	X		X	X		X	X								X	X	X			X			(DEMINERALIZED WATER) จำนวน 12 ลิตร มีอัตราการไหล 1 ลิตร/ชม.
การล้างเร็ว	SAC or WAC		X	X		X					X	X					X	X			X	X					X			น้ำล้างน้ำประปาไฮดรอน-	
	SBA																														(DEMINERALIZED WATER) จำนวน 12 ลิตร มีอัตราการไหล 1 ลิตร/ชม.

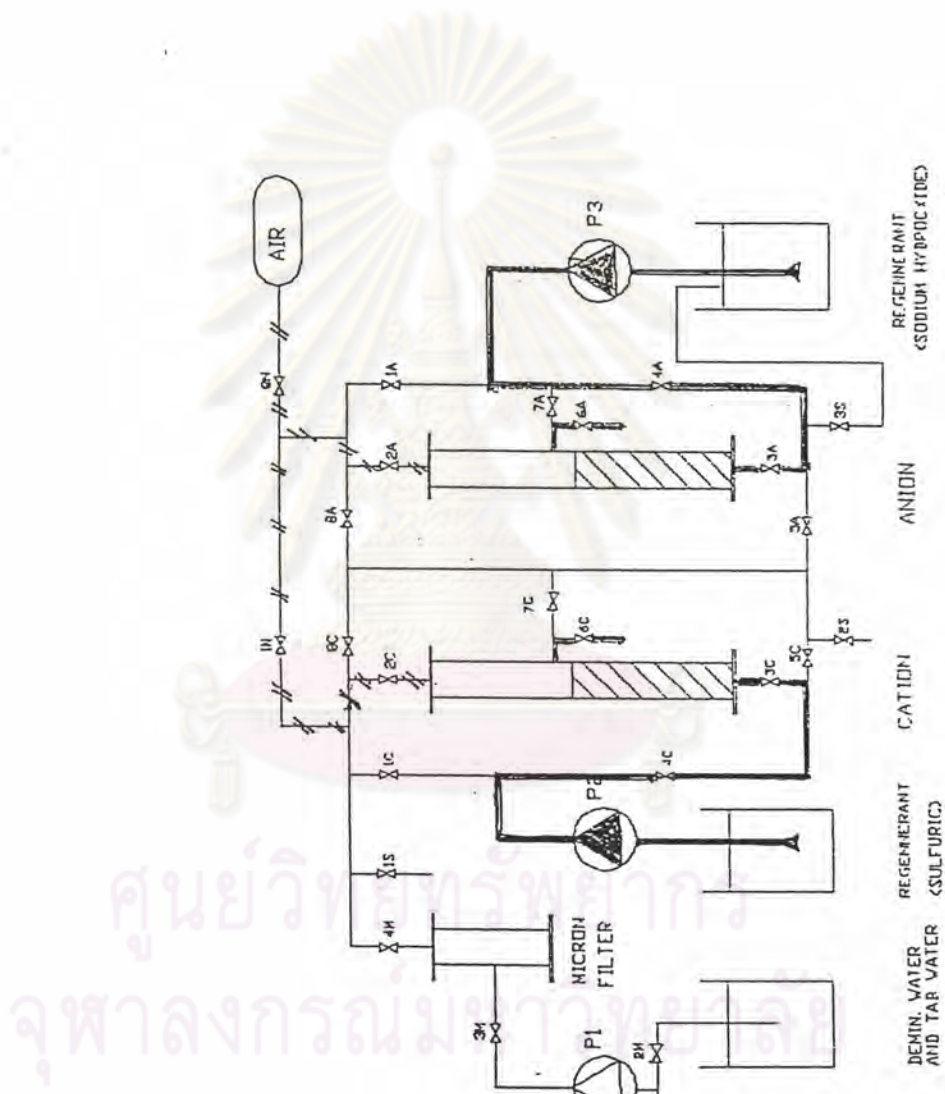


รูปที่ 1 แสดงขั้นตอนการแลกเปลี่ยนไอออน



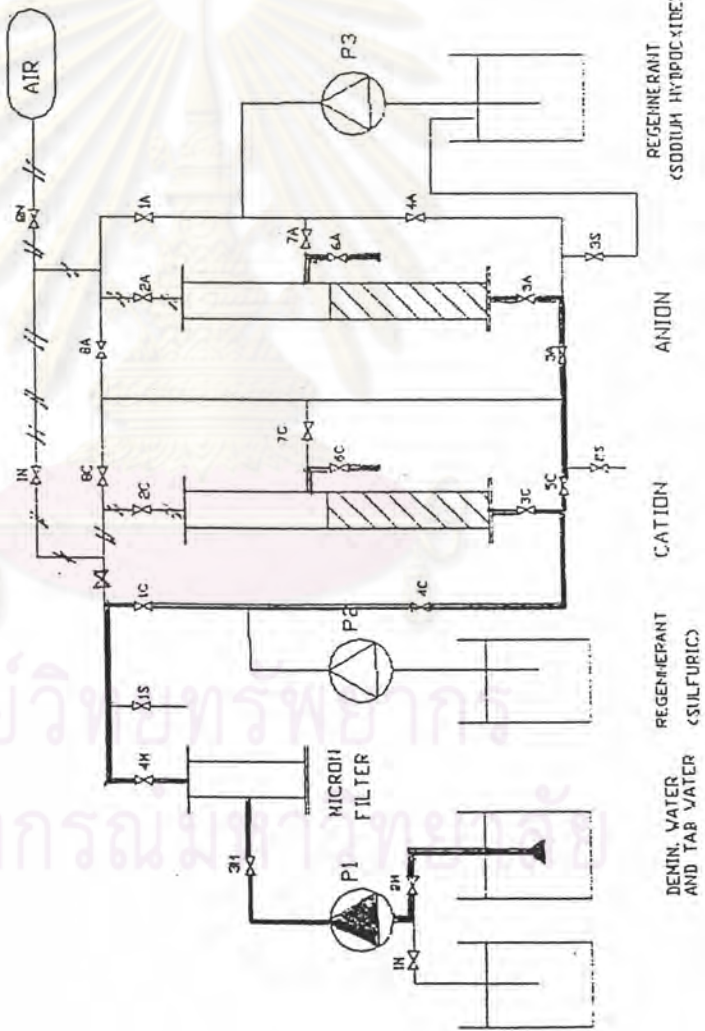
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จุฬาลงกรณ์มหาวิทยาลัย

รูปที่ 2 แสดงขั้นตอนการล้างย้อน



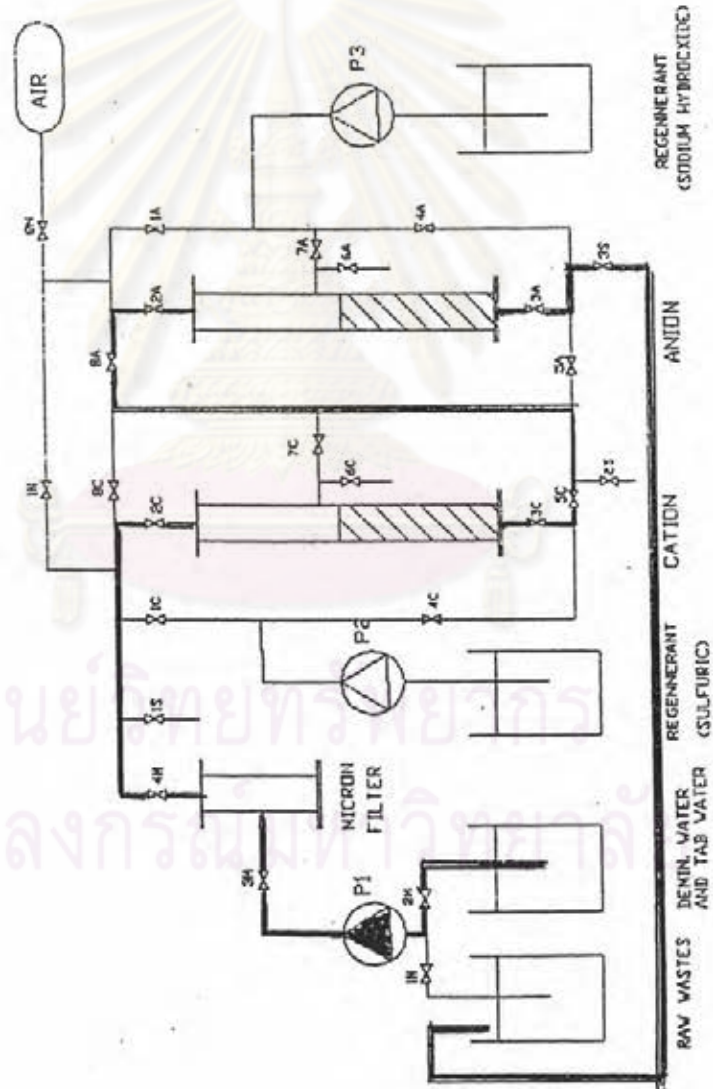
รูปที่ 3 แสดงขั้นตอนการล้างด้วยกรด

ศูนย์วิจัยและพัฒนาการ
จุฬาลงกรณ์มหาวิทยาลัย



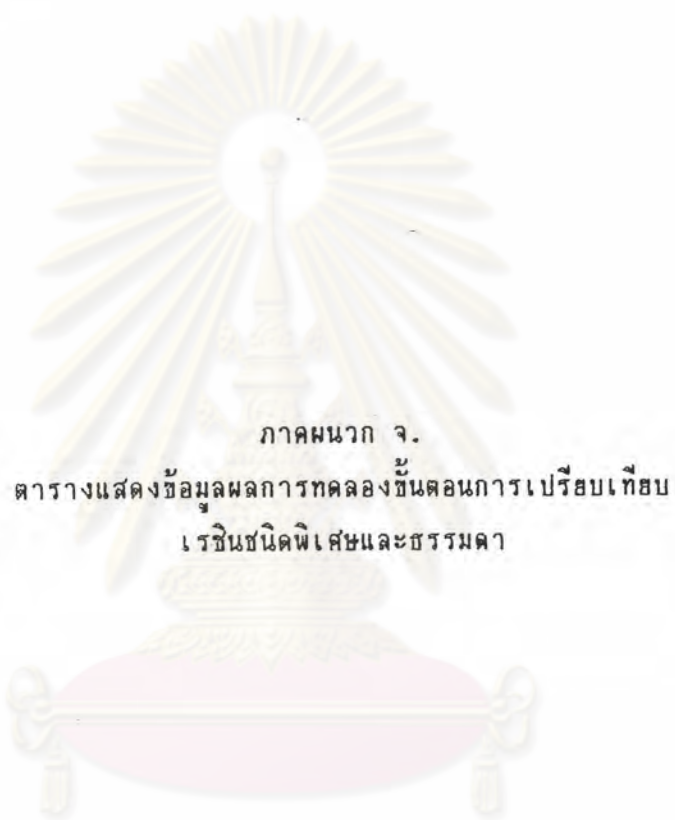
ศูนย์วิศวกรรมบำบัดน้ำ
จุฬาลงกรณ์มหาวิทยาลัย

รูปที่ 4 แสดงขั้นตอนการล้างน้ำ



รูปที่ 6 แสดงขั้นตอนการแลกเปลี่ยนไอออนโดยอัตโนมัติ

ศูนย์วิจัยทรัพยากรน้ำ
จุฬาลงกรณ์มหาวิทยาลัย



ภาคผนวก จ.

ตารางแสดงข้อมูลผลการทดลองขั้นตอนการเปรียบเทียบ
เรซินชนิดพิเศษและธรรมดา

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

รูปแบบแสดงข้อมูลในตารางผลการทดลอง ผลการเปรียบเทียบเรซินชนิดพิเศษและ
ธรรมดาขั้นตอนการแลกเปลี่ยนไอออน

SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO Ni. IN/Ni. OUT		
		CONDUCT. (ms/cm.)	pH	NICKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
1	2	3	4	5	6	7	8	9	10	11	12
SUM (RATIO OF Ni. IN TO Ni. OUT TOTAL)											13
TOTAL EXCHANGE NICKEL (mg / l.resin)											14

1. SAMPLE NO. แสดงอันดับการเก็บตัวอย่าง
2. BED VOLUME (BV) แสดงปริมาณน้ำเสียใด ๆ ผ่านถึงปฏิกรณ์แคตไอออนหรือ ถึงปฏิกรณ์แอนไอออนใด ๆ ที่ทำการเก็บตัวอย่าง หน่วย BV.
3. CATION CONDUCT แสดงค่าการนำไฟฟ้าออกจากถึงปฏิกรณ์แคตไอออนหน่วยคือ มิลลิซีเมนต่อเซนติเมตร
4. CATION pH แสดง ค่า pH ที่ผ่านถึงปฏิกรณ์แคตไอออน
5. CATION NICKEL (C_n) แสดงค่าความเข้มข้น निकเกิลที่ออกจากถึงปฏิกรณ์แคตไอออนหน่วย มก./ล.
6. CATION TDS แสดงค่าของแข็งละลายที่ออกจากถึงปฏิกรณ์แคตไอออนหน่วย มก./ล.
7. ANION CONDUCT. แสดงค่าการนำไฟฟ้าที่ออกจากถึงแอนไอออนเรซิน
8. ANION pH แสดงค่า pH ที่ออกจากถึงแอนไอออนเรซิน
9. ANION TDS. แสดงค่าของแข็งละลายที่ออกจากถึงแอนไอออนเรซิน
10. RATIO Ni. IN/Ni. OUT VALUE (X_n) แสดงอัตราส่วนค่าความเข้มข้นโลหะ निकเกิลที่ออกจากถึงแคตไอออนเรซินต่อความเข้มข้นโลหะ निकเกิลในน้ำเสียสังเคราะห์, ที่ป้อนเข้าระบบ

$$X_n = (C_n / C_i)$$

โดย C_i = ความเข้มข้นของโลหะ निकเกิลที่ป้อนเข้าระบบ

11. RATIO Ni.IN/Ni.OUT AVERAGE (\bar{X}_n) แสดงค่าเฉลี่ยอัตราส่วน RATIO Ni. IN/ NI. OUT VALUE ของตัวอย่างในแถวที่แสดงค่า (X_n) และแถวถัดมา (X_{n+1})

$$\bar{X}_n = \frac{\sum_{x=n}^{x=n+1} X_n}{2}$$

12. RATIO Ni.IN/Ni. OUT TOTAL (Z_n) แสดงการรวมค่า RATIO Ni.IN/Ni. OUT ช่วงปริมาตรน้ำเสียใด ๆ หรือพื้นที่ใต้กราฟ RATIO Ni./Ni OUT บริเวณความแตกต่าง ปริมาตรระหว่างปริมาตรน้ำเสียใด ๆ BV_n กับปริมาตรน้ำเสียก่อนหน้า BV_{n-1}

$$Z_n = \bar{X}_n * (BV_n - BV_{n-1})$$

13. ผลรวมค่า RATIO Ni.IN/Ni.OUT รวมจนถึงจุดอ้อมตัว แสดงค่า

$$\sum_{n=1}^{n=n_b} Z_n$$

โดย nt = จุดที่ความเข้มข้นเข้าระบบเท่ากับความเข้มข้นออกจากระบบ

14. ปริมาณนิเกิลที่เรซินแลกเปลี่ยนได้จนถึงจุดอ้อมตัว

$$\text{แสดงค่า} = (C_i * BV_{n_b}) - C_i * \sum_{n=1}^{n=n_b} Z_n \quad \text{หน่วย มก./ล. เรซิน}$$

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

รูปแบบแสดงข้อมูลในตารางผลการทดลอง ผลการเปรียบเทียบเรซินชนิดพิเศษและธรรมดา
ขั้นตอนการการล้างด้วยกรด

SAMPLE No.	BED VOLUME (BV)	CATION CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	Ni CONC. (mg/l)	Ni. CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE Ni CONC. (mg/l)
1	2	3	4	5	6	7	8

1. SAMPLE No. แสดงอันดับการเก็บตัวอย่างที่ปริมาตรน้ำเสียใด ๆ
2. BED VOLUME (BV_n) แสดง ปริมาตรน้ำเสียใด ๆ ผ่านถึงปฏิกรณ์แคทไอออน หรือถึงปฏิกรณ์แอนไอออนใด ๆ ที่ทำการเก็บตัวอย่าง หน่วย BV.
3. CATION CONDUCT แสดงค่าการนำไฟฟ้าหลังจากล้างด้วยกรดที่ออกจากถังแคทไอออนเรซิน
4. CATION pH แสดง ค่า pH หลังจากล้างด้วยกรดที่ออกจากถังแคทไอออนเรซิน
5. CATION Ni CONC. (C_n) แสดงค่าความเข้มข้นหลังจากล้างด้วยกรดที่ออกจากถังแคทไอออนเรซิน
6. Ni. CONC. * BEDVOLUME (N_n) แสดงค่า ปริมาณนิกเกิลที่ปริมาตรกรดล้างใด ๆ

$$N_n = C_n * (BV_n - BV_{n-1})$$
 หน่วย มก./ล. เรซิน
7. CUMULATIVE NICKEL (Y_n) แสดง ค่าผลรวมปริมาณนิกเกิลจนถึงปริมาตรกรดล้างใด ๆ

โดย
$$Y_n = \sum_{a=1}^{n} C_n$$
 หน่วย มก./ล.เรซิน

8. CUMULATIVE NICKEL CONC. (G_n) แสดงค่าความเข้มข้นรวมนิกเกิลจนถึงจุดปริมาตรกรดล้างใด ๆ

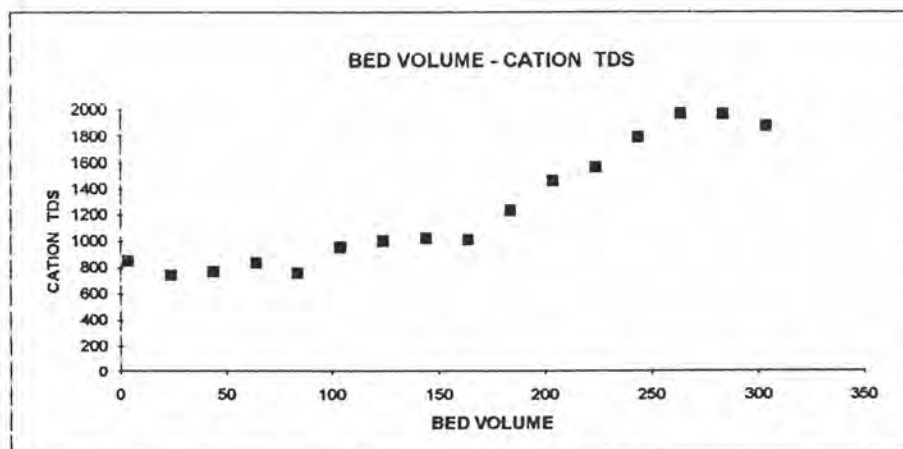
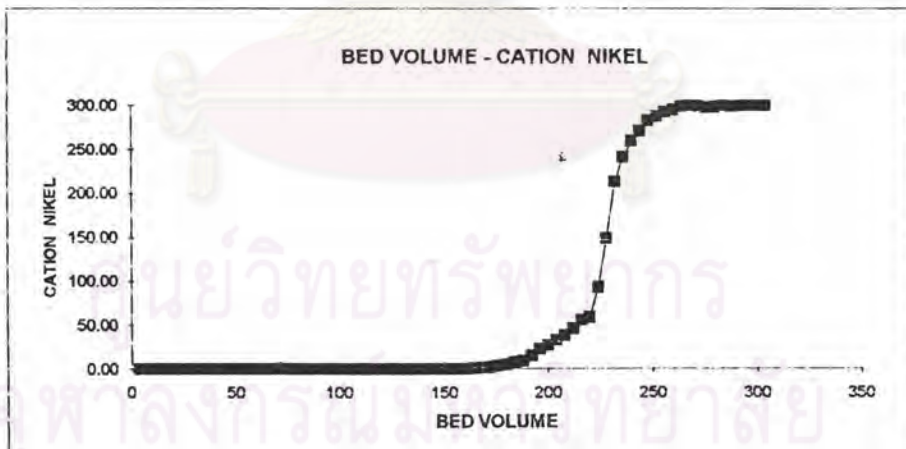
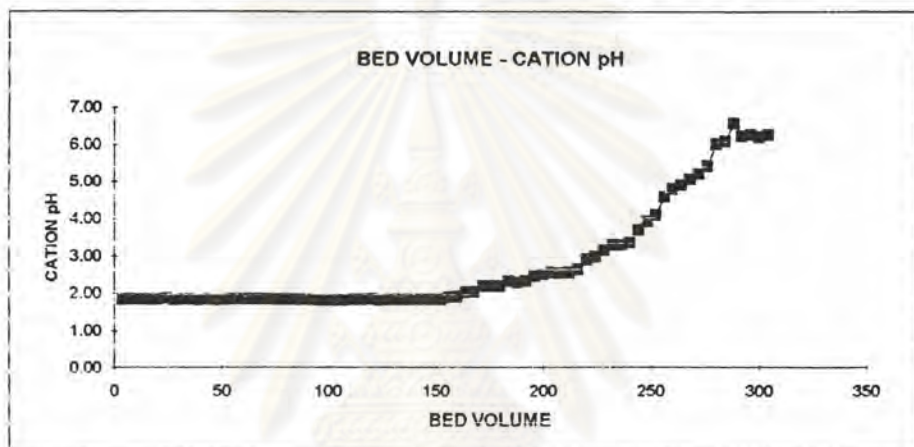
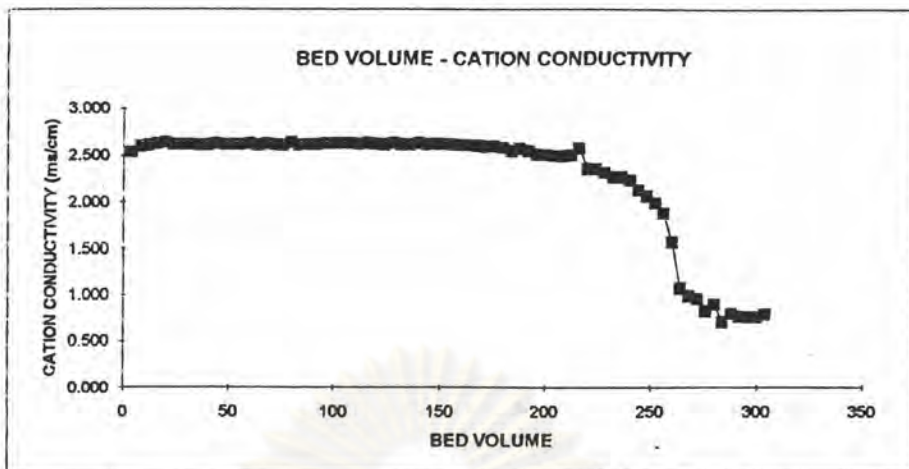
โดย
$$G_n = Y_n / BV_n$$
 หน่วย มก./ล.เรซิน

RAW WATER: INFLUENT NI = 300 mg/l ONLY SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : SULFONIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO NI. IN/ NI. OUT		
		CONDUCT. (ms/cm.)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
1	4	2.540	1.83	0.36	850	0.290	10.68	129	0.0012	0.0012	0.0047
2	8	2.600	1.85	0.35		0.280	10.72		0.0012	0.0012	0.0047
3	12	2.610	1.84	0.35		0.240	10.05		0.0012	0.0012	0.0047
4	16	2.630	1.84	0.36		0.150	9.83		0.0012	0.0012	0.0047
5	20	2.640	1.84	0.35		0.080	9.07		0.0012	0.0012	0.0047
6	24	2.620	1.86	0.35	740	0.050	8.24	110	0.0012	0.0012	0.0046
7	28	2.620	1.82	0.34		0.004	7.06		0.0011	0.0011	0.0045
8	32	2.620	1.84	0.34		0.003	7.01		0.0011	0.0011	0.0045
9	36	2.610	1.83	0.34		0.003	7.09		0.0011	0.0013	0.0050
10	40	2.610	1.82	0.41		0.004	7.43		0.0014	0.0012	0.0049
11	44	2.630	1.83	0.33		0.002	6.94	105	0.0011	0.0011	0.0043
12	48	2.620	1.82	0.32		0.003	7.10		0.0011	0.0012	0.0049
13	52	2.620	1.83	0.41		0.002	6.90		0.0014	0.0012	0.0048
14	56	2.620	1.85	0.31		0.003	6.84		0.0010	0.0011	0.0043
15	60	2.630	1.85	0.34		0.009	6.94		0.0011	0.0011	0.0045
16	64	2.610	1.85	0.33	640	0.010	6.97	95	0.0011	0.0012	0.0047
17	68	2.630	1.85	0.38		0.021	6.95		0.0013	0.0021	0.0084
18	72	2.620	1.85	0.88		0.087	6.51		0.0029	0.0020	0.0080
19	76	2.610	1.84	0.32		0.123	6.43		0.0011	0.0010	0.0041
20	80	2.640	1.84	0.30		0.136	6.19		0.0010	0.0011	0.0042
21	84	2.610	1.84	0.33	756	0.159	5.80	345	0.0011	0.0010	0.0041
22	88	2.620	1.84	0.28		0.143	5.97		0.0009	0.0009	0.0037
23	92	2.620	1.84	0.28		0.374	3.50		0.0009	0.0009	0.0035
24	96	2.630	1.82	0.25		0.450	3.47		0.0008	0.0008	0.0033
25	100	2.630	1.82	0.25		0.605	3.08		0.0008	0.0008	0.0033
26	104	2.630	1.82	0.25	950	0.987	2.97	856	0.0008	0.0008	0.0032
27	108	2.630	1.82	0.23		1.920	2.84		0.0008	0.0008	0.0033
28	112	2.620	1.83	0.26		2.480	2.81		0.0009	0.0009	0.0035
29	116	2.630	1.84	0.27		2.270	2.79		0.0009	0.0009	0.0035
30	120	2.620	1.85	0.26		2.320	2.72		0.0009	0.0009	0.0035
31	124	2.610	1.82	0.26	999	2.350	2.17	789	0.0009	0.0009	0.0034
32	128	2.630	1.83	0.25		2.370	2.06		0.0008	0.0008	0.0033
33	132	2.610	1.83	0.25		2.660	2.04		0.0008	0.0008	0.0032
34	136	2.610	1.83	0.23		2.390	2.09		0.0008	0.0008	0.0030
35	140	2.630	1.83	0.22		2.760	2.03		0.0007	0.0007	0.0027
36	144	2.610	1.83	0.19	1023	2.900	1.99	987	0.0006	0.0007	0.0027
37	148	2.620	1.83	0.21		2.990	2.00		0.0007	0.0010	0.0039
38	152	2.615	1.83	0.38		2.640	2.00		0.0013	0.0014	0.0057
39	156	2.610	1.90	0.48		2.890	2.01		0.0016	0.0018	0.0071
40	160	2.608	1.91	0.59		2.600	2.01		0.0020	0.0026	0.0103
41	164	2.604	2.02	0.95	1011	2.910	1.99	1023	0.0032	0.0037	0.0147
42	168	2.600	2.03	1.25		2.620	2.01		0.0042	0.0060	0.0238
43	172	2.591	2.19	2.32		2.650	2.04		0.0077	0.0104	0.0415
44	176	2.592	2.19	3.90		2.550	2.06		0.0130	0.0147	0.0589
45	180	2.581	2.20	4.94		2.350	2.14		0.0165	0.0209	0.0835
46	184	2.542	2.33	7.58	1230	2.190	2.20	1240	0.0253	0.0285	0.1141
47	188	2.574	2.29	9.54		2.230	2.07		0.0318	0.0413	0.1653
48	192	2.542	2.33	15.26		2.130	2.09		0.0509	0.0643	0.2571
49	196	2.510	2.48	23.30		1.970	2.20		0.0777	0.0848	0.3393
50	200	2.503	2.52	27.60		1.970	2.31		0.0920	0.1012	0.4047
51	204	2.490	2.57	33.10	1456	1.820	2.43	1420	0.1103	0.1195	0.4780
52	208	2.486	2.55	38.60		1.630	2.07		0.1287	0.1415	0.5660
53	212	2.498	2.57	46.30		1.520	2.05		0.1543	0.1702	0.6807
54	216	2.574	2.65	55.80		1.490	2.09		0.1860	0.1910	0.7640
55	220	2.351	2.91	58.80		1.476	2.10		0.1960	0.2522	1.0087
56	224	2.341	2.99	92.50	1560	1.425	2.01	1587	0.3083	0.4023	1.6093
57	228	2.309	3.17	148.90		1.396	2.19		0.4963	0.6025	2.4100
58	232	2.258	3.29	212.60		1.358	2.21		0.7087	0.7553	3.0213
59	236	2.258	3.29	240.60		1.307	2.25		0.8020	0.8340	3.3360

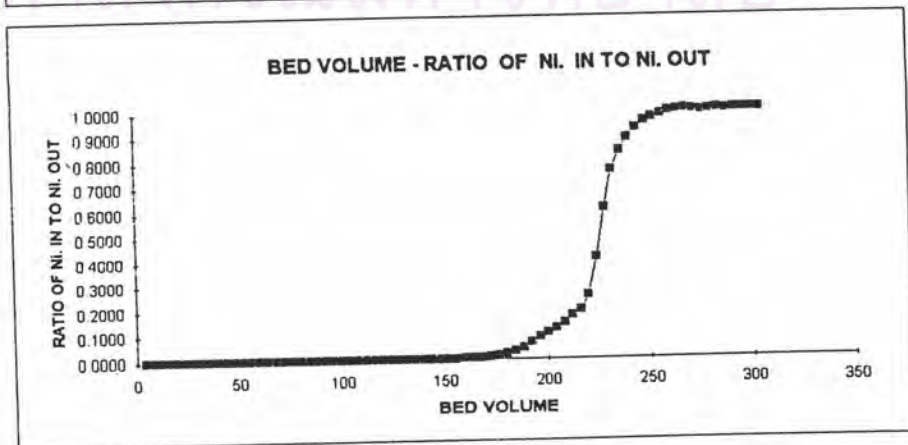
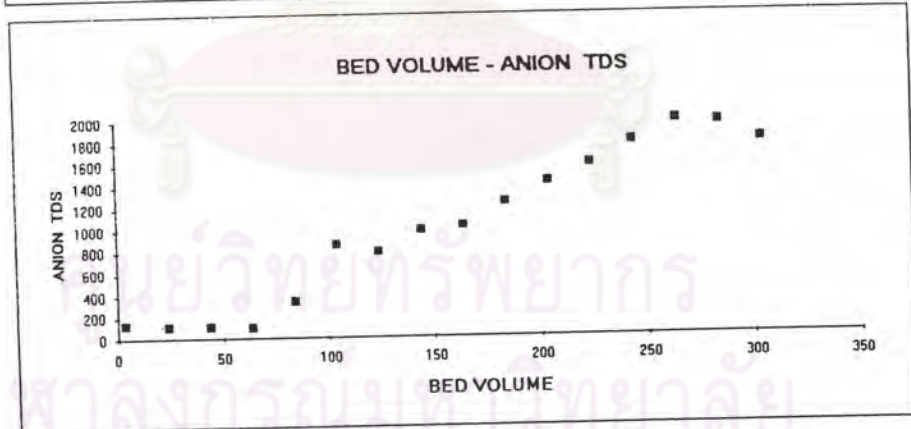
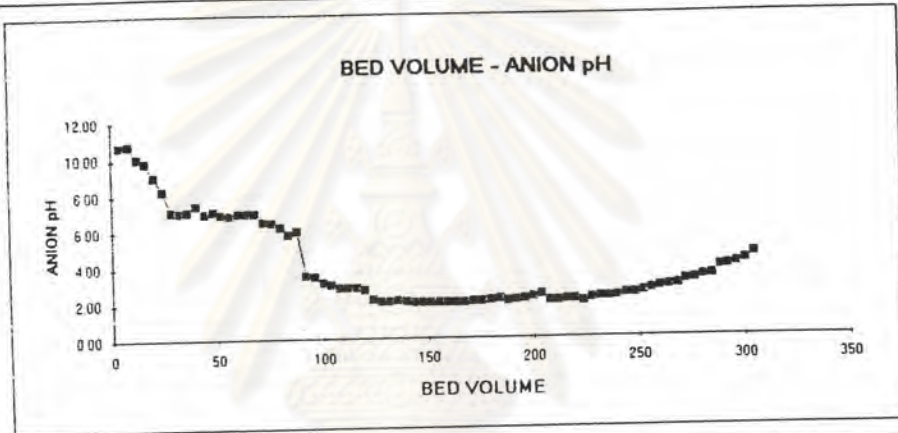
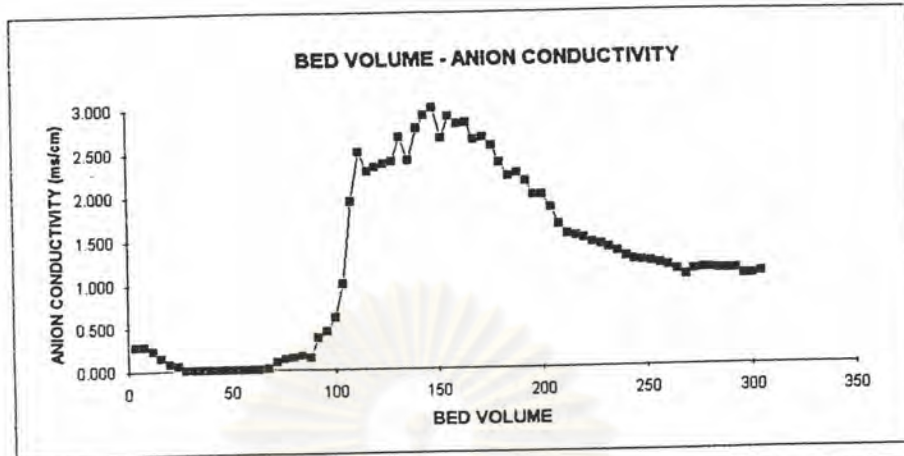
RAW WATER: INFLUENT NI. = 300 mg/l ONLY SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : SULFONIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO NI. IN/ NI. OUT		
		CONDUCT. (ms/cm.)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
60	240	2.224	3.35	259.80		1.250	2.28		0.8660	0.8838	3.5353
61	244	2.112	3.70	270.50	1789	1.214	2.41	1789	0.9017	0.9220	3.6880
62	248	2.051	3.92	282.70		1.201	2.43		0.9423	0.9502	3.8007
63	252	1.975	4.10	287.40		1.195	2.54		0.9580	0.9667	3.8667
64	256	1.862	4.60	292.60		1.169	2.63		0.9753	0.9793	3.9173
65	260	1.563	4.80	295.00		1.136	2.74		0.9833	0.9887	3.9547
66	264	1.058	4.91	298.20	1963	1.087	2.81	1966	0.9940	0.9960	3.9840
67	268	0.980	5.07	299.40		1.032	2.90		0.9980	0.9968	3.9873
68	272	0.950	5.23	298.70		1.094	3.08		0.9957	0.9933	3.9733
69	276	0.821	5.42	297.30		1.110	3.17		0.9910	0.9915	3.9660
70	280	0.891	6.02	297.60		1.109	3.34		0.9920	0.9953	3.9813
71	284	0.702	6.10	299.60	1962	1.096	3.39	1963	0.9987	0.9968	3.9873
72	288	0.789	6.58	298.50		1.094	3.87		0.9950	0.9957	3.9827
73	292	0.763	6.23	298.90		1.094	3.90		0.9963	0.9970	3.9880
74	296	0.756	6.27	299.30		1.036	4.01		0.9977	0.9985	3.9940
75	300	0.755	6.19	299.80		1.029	4.20		0.9993	0.9992	3.9967
76	304	0.785	6.27	299.70	1869	1.054	4.56	1796	0.9990	0.9990	3.9960
SUM(RATIO OF NI. IN TO NI. OUT TOTAL)											82.16
TOTAL EXCHANGE NICKEL (mg / l resin)											66553.20

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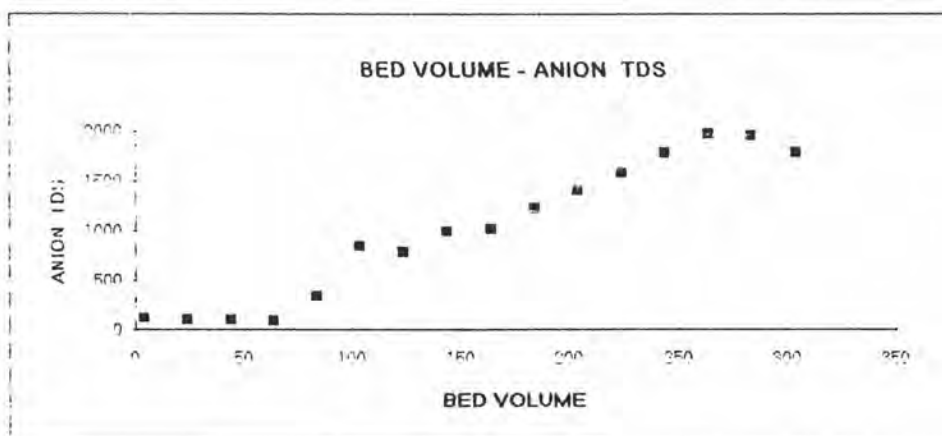
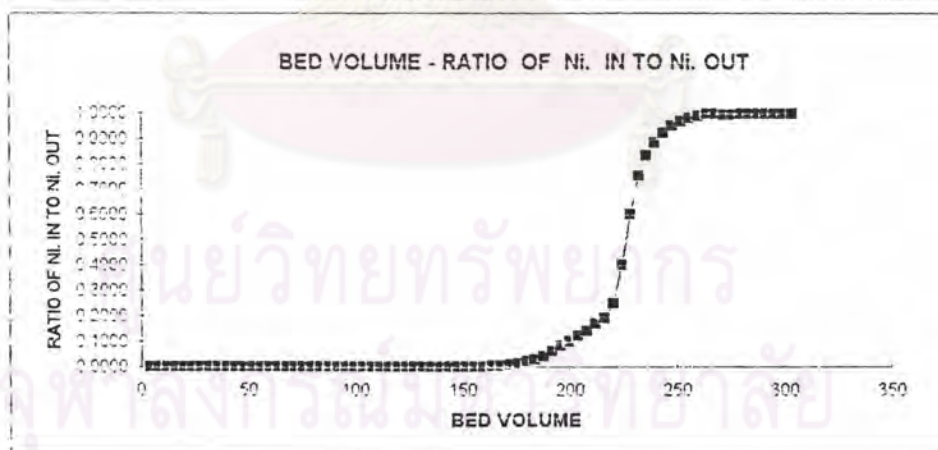
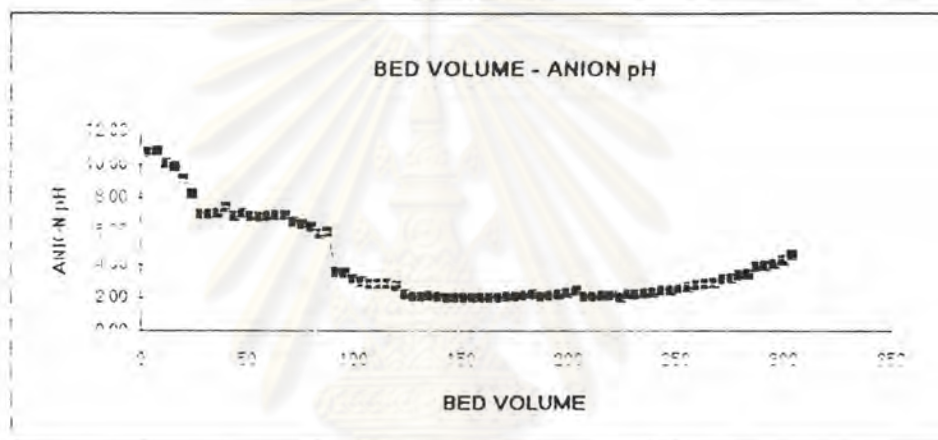
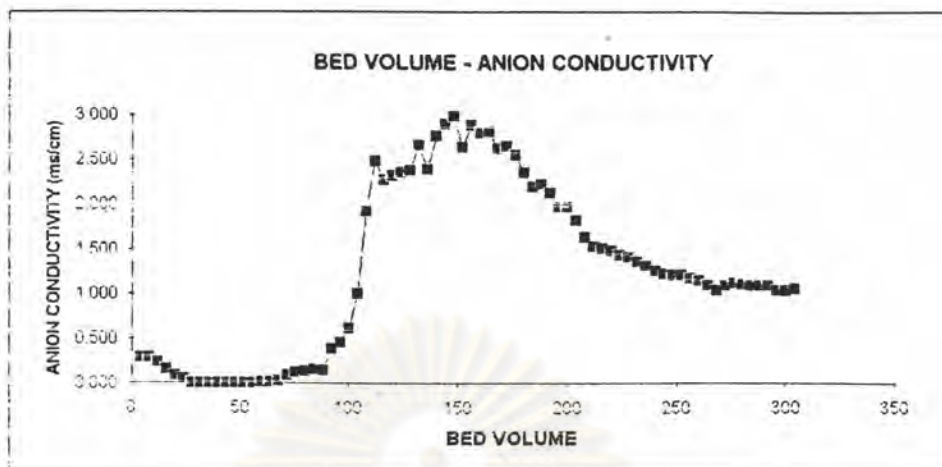
1-R1.XLS



1-R1.XLS



1-R1.XLS

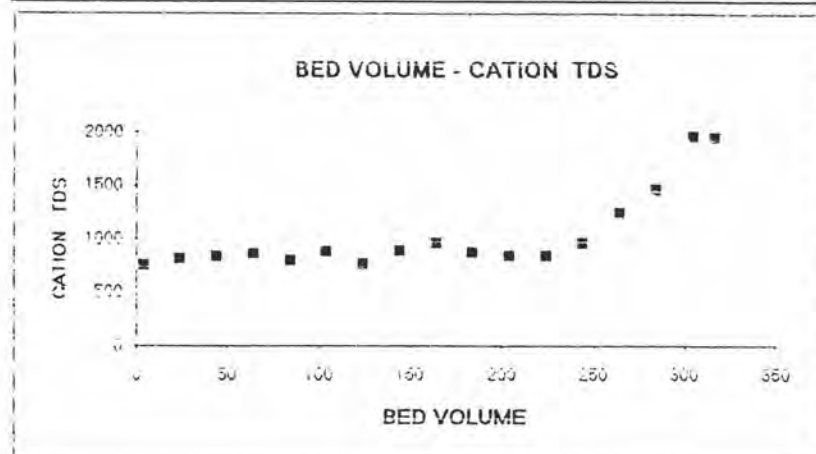
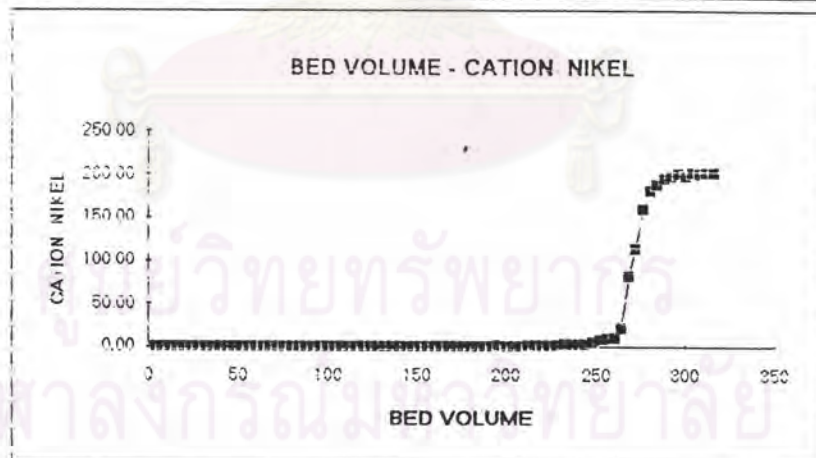
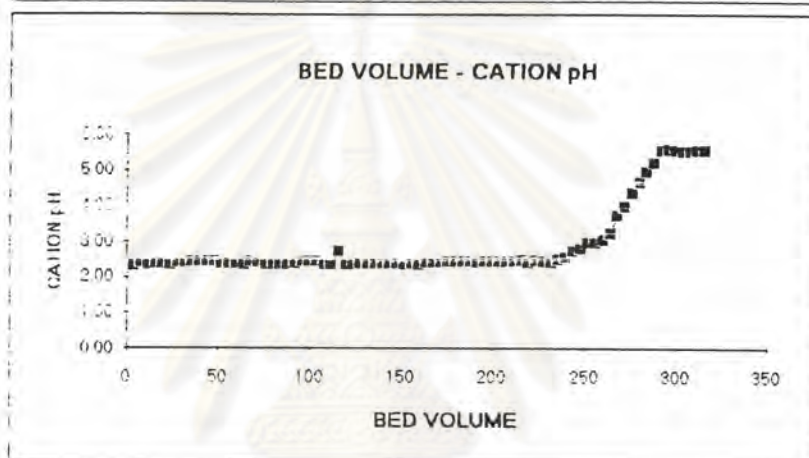
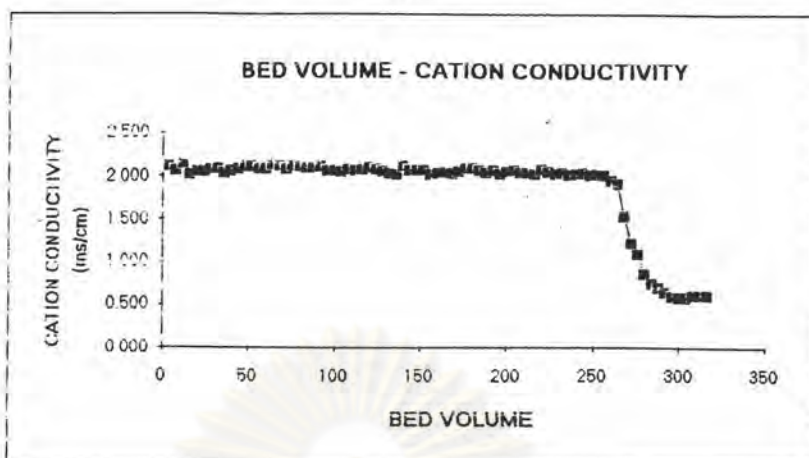


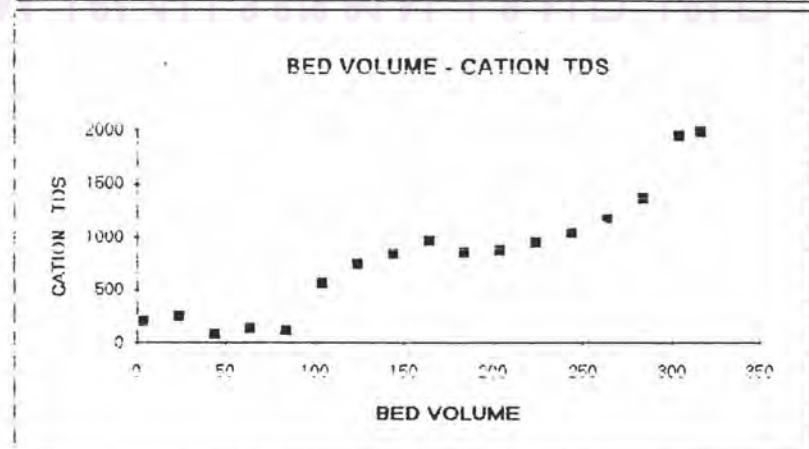
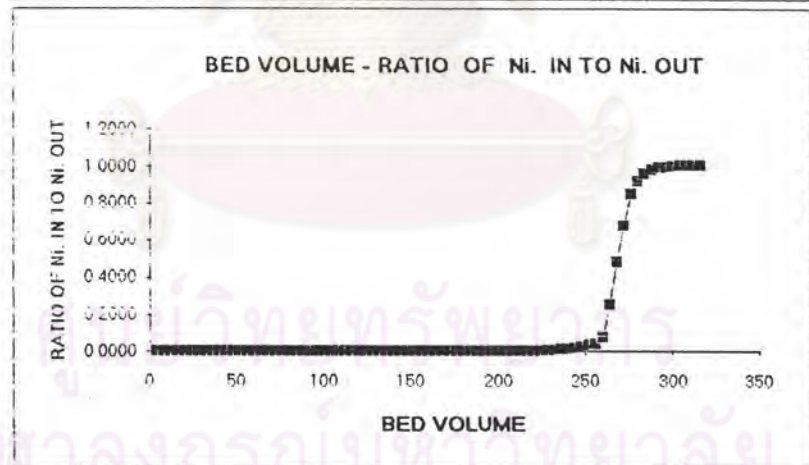
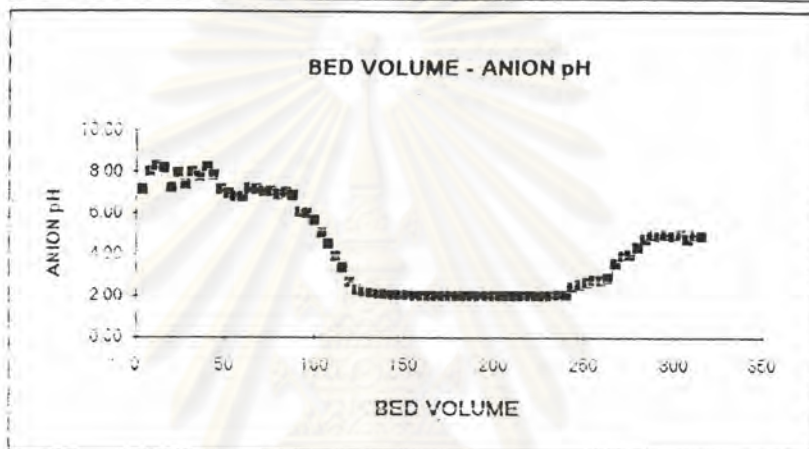
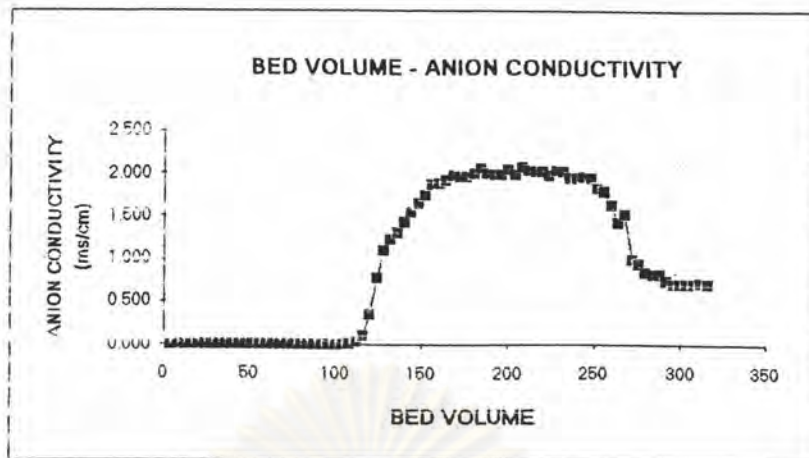
RAW WATER: INFLUENT NI = 200 mg/l ONLY SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : SULFONIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO NI IN/ NI OUT		
		CONDUCT. (ms/cm.)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
1	4	2.120	2.33	0.04	750	0.007	7.11	195	0.0002	0.0002	0.0006
2	8	2.070	2.40	0.04		0.008	8.00		0.0002	0.0003	0.0013
3	12	2.140	2.35	0.09		0.004	8.27		0.0005	0.0007	0.0026
4	16	2.020	2.39	0.17		0.004	8.14		0.0009	0.0007	0.0026
5	20	2.050	2.37	0.09		0.004	7.24		0.0005	0.0004	0.0017
6	24	2.050	2.36	0.08	812	0.004	7.90	245	0.0004	0.0004	0.0014
7	28	2.080	2.41	0.06		0.003	7.40		0.0003	0.0003	0.0012
8	32	2.090	2.42	0.06		0.003	7.93		0.0003	0.0004	0.0015
9	36	2.040	2.44	0.09		0.003	7.72		0.0005	0.0005	0.0021
10	40	2.070	2.43	0.12		0.003	8.23		0.0006	0.0010	0.0040
11	44	2.090	2.45	0.28	830	0.003	7.78	85	0.0014	0.0010	0.0038
12	48	2.120	2.44	0.10		0.004	7.12		0.0005	0.0005	0.0020
13	52	2.120	2.38	0.10		0.003	6.93		0.0005	0.0005	0.0018
14	56	2.090	2.39	0.08		0.003	6.76		0.0004	0.0004	0.0016
15	60	2.090	2.38	0.08		0.002	6.76		0.0004	0.0004	0.0017
16	64	2.140	2.36	0.09	860	0.003	7.20	139	0.0005	0.0005	0.0019
17	68	2.130	2.44	0.10		0.002	7.11		0.0005	0.0005	0.0021
18	72	2.090	2.41	0.11		0.002	7.05		0.0006	0.0006	0.0030
19	76	2.130	2.35	0.19		0.002	7.05		0.0010	0.0008	0.0031
20	80	2.110	2.34	0.12		0.002	6.88		0.0006	0.0007	0.0026
21	84	2.098	2.36	0.14	798	0.002	7.00	123	0.0007	0.0008	0.0031
22	88	2.100	2.35	0.17		0.002	6.84		0.0009	0.0008	0.0031
23	92	2.110	2.37	0.14		0.002	6.04		0.0007	0.0007	0.0027
24	96	2.060	2.45	0.13		0.002	6.00		0.0007	0.0006	0.0025
25	100	2.060	2.43	0.12		0.004	5.62		0.0006	0.0007	0.0026
26	104	2.050	2.44	0.14	885	0.001	5.02	563	0.0007	0.0007	0.0028
27	108	2.080	2.36	0.14		0.017	4.51		0.0007	0.0007	0.0027
28	112	2.070	2.35	0.13		0.039	3.90		0.0007	0.0007	0.0029
29	116	2.080	2.72	0.16		0.107	3.36		0.0008	0.0007	0.0028
30	120	2.100	2.35	0.12		0.354	2.68		0.0006	0.0006	0.0023
31	124	2.080	2.36	0.11	762	0.776	2.31	743	0.0006	0.0007	0.0026
32	128	2.050	2.39	0.15		1.095	2.18		0.0008	0.0007	0.0029
33	132	2.030	2.39	0.14		1.230	2.15		0.0007	0.0009	0.0035
34	136	2.020	2.37	0.21		1.310	2.10		0.0011	0.0010	0.0040
35	140	2.110	2.37	0.19		1.430	2.08		0.0010	0.0009	0.0037
36	144	2.060	2.38	0.18	893	1.543	2.04	845	0.0009	0.0009	0.0036
37	148	2.070	2.38	0.18		1.643	2.03		0.0009	0.0010	0.0041
38	152	2.070	2.35	0.23		1.743	2.02		0.0012	0.0011	0.0042
39	156	2.010	2.39	0.19		1.872	2.00		0.0010	0.0010	0.0038
40	160	2.030	2.35	0.19		1.885	2.00		0.0010	0.0009	0.0036
41	164	2.040	2.41	0.17	965	1.920	2.00	963	0.0009	0.0009	0.0034
42	168	2.030	2.41	0.17		1.971	1.98		0.0009	0.0009	0.0035
43	172	2.050	2.42	0.18		1.948	1.99		0.0009	0.0009	0.0036
44	176	2.090	2.45	0.18		1.948	1.99		0.0009	0.0010	0.0038
45	180	2.090	2.45	0.20		1.988	1.98		0.0010	0.0010	0.0040
46	184	2.070	2.43	0.20	872	2.050	1.98	850	0.0010	0.0010	0.0041
47	188	2.040	2.43	0.21		1.965	1.98		0.0011	0.0012	0.0049
48	192	2.070	2.41	0.28		1.982	1.98		0.0014	0.0028	0.0113
49	196	2.030	2.44	0.85		1.984	1.97		0.0043	0.0027	0.0109
50	200	2.050	2.45	0.24		2.040	1.97		0.0012	0.0015	0.0059
51	204	2.060	2.45	0.35	839	1.980	1.97	869	0.0018	0.0015	0.0061
52	208	2.040	2.44	0.26		2.060	1.98		0.0013	0.0020	0.0081
53	212	2.040	2.43	0.55		2.030	1.98		0.0028	0.0038	0.0150
54	216	2.030	2.46	0.95		2.010	1.98		0.0048	0.0047	0.0186
55	220	2.080	2.42	0.91		2.020	1.99		0.0046	0.0050	0.0198
56	224	2.050	2.46	1.07	840	1.968	2.01	945	0.0054	0.0050	0.0199
57	228	2.030	2.43	0.92		2.030	1.99		0.0046	0.0074	0.0294
58	232	2.040	2.41	2.02		2.010	1.98		0.0101	0.0110	0.0441
59	236	2.010	2.51	2.39		1.938	2.05		0.0120	0.0120	0.0480

RAW WATER: INFLUENT NI. = 200 mg/l ONLY SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : SULFONIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO NI. IN/ NI. OUT		
		CONDUCT. (ms/cm.)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
60	240	2.030	2.56	2.41		1.941	2.05		0.0121	0.0124	0.0495
61	244	2.040	2.74	2.54	963	1.952	2.43	1045	0.0127	0.0175	0.0700
62	248	2.020	2.81	4.46		1.937	2.58		0.0223	0.0283	0.1132
63	252	2.030	2.96	6.86		1.825	2.64		0.0343	0.0368	0.1472
64	256	2.010	2.97	7.86		1.796	2.74		0.0393	0.0448	0.1791
65	260	1.950	3.05	10.05		1.625	2.75		0.0503	0.0764	0.3055
66	264	1.910	3.25	20.50	1250	1.435	2.85	1159	0.1025	0.2835	1.0140
67	268	1.543	3.75	80.90		1.528	3.60		0.4045	0.4833	1.9330
68	272	1.230	3.99	112.40		0.998	3.95		0.5620	0.6805	2.7220
69	276	1.102	4.37	159.90		0.950	4.02		0.7990	0.8513	3.4050
70	280	0.863	4.66	180.70		0.852	4.35		0.9035	0.9208	3.6830
71	284	0.754	4.95	187.60	1465	0.822	4.76	1359	0.9380	0.9573	3.8290
72	288	0.699	5.23	195.30		0.821	4.97		0.9765	0.9820	3.9280
73	292	0.654	5.56	197.50		0.75	4.92		0.9875	0.9933	3.9730
74	296	0.597	5.58	199.80		0.71	4.95		0.9990	0.9950	3.9800
75	300	0.590	5.57	198.20		0.715	4.93		0.9910	0.9983	3.9930
76	304	0.589	5.54	201.10	1963	0.710	4.95	1942	1.0055	1.0040	4.0160
77	308	0.610	5.54	200.50		0.709	4.76		1.0025	1.0043	4.0170
78	312	0.612	5.55	201.20		0.720	4.98		1.0060	1.0053	4.0210
79	316	0.610	5.55	200.90	1952	0.71	4.90	1985	1.0045	1.0045	4.0180
SUM(RATIO OF NI. IN TO NI. OUT TOTAL											37.71120
TOTAL EXCHANGE NICKEL (mg / i resin)											55657.76

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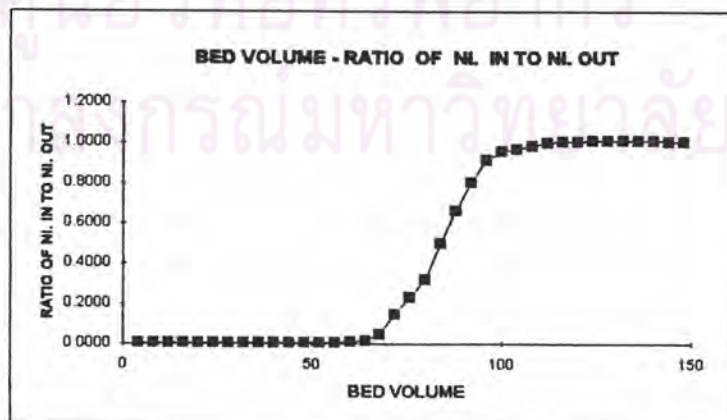
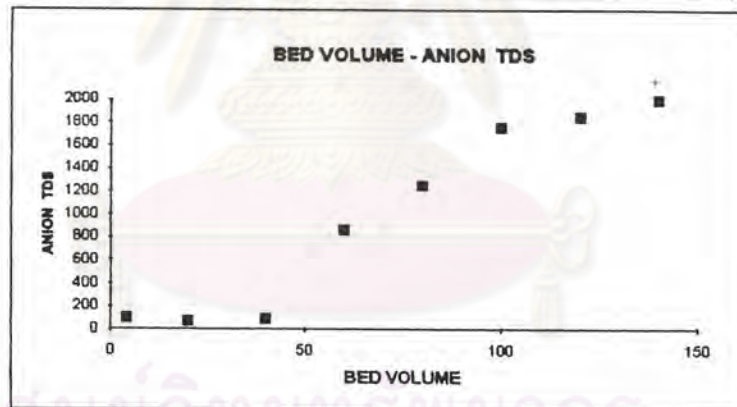
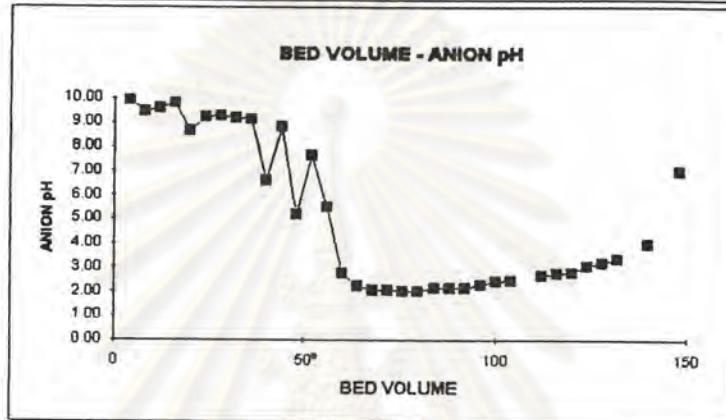
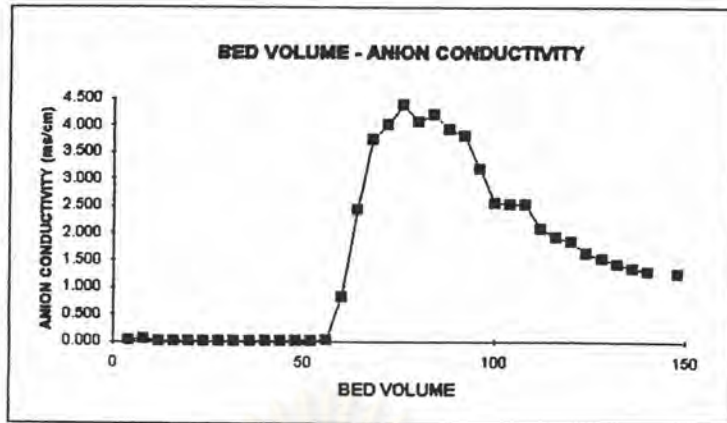
2-R1.XLS

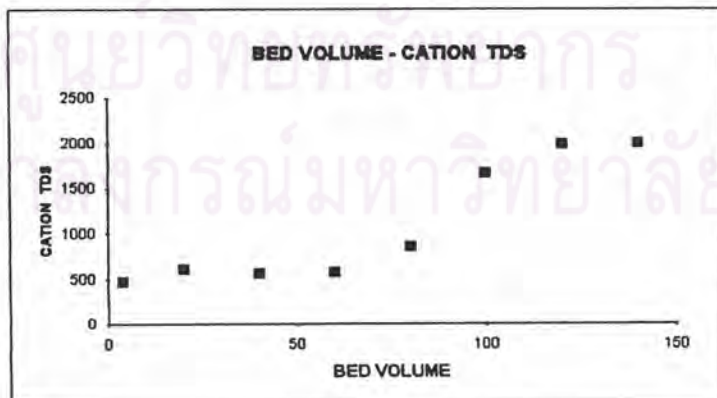
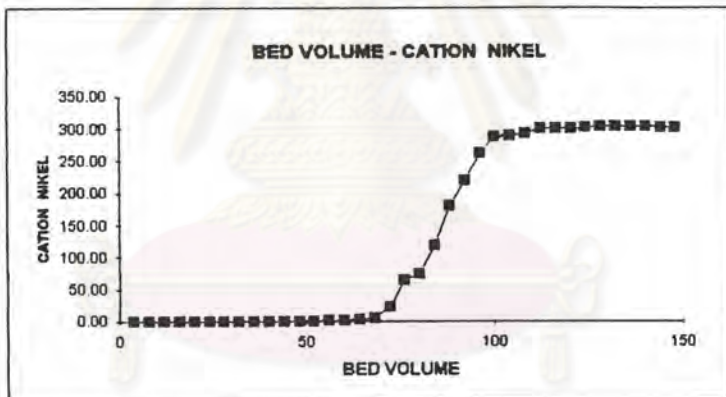
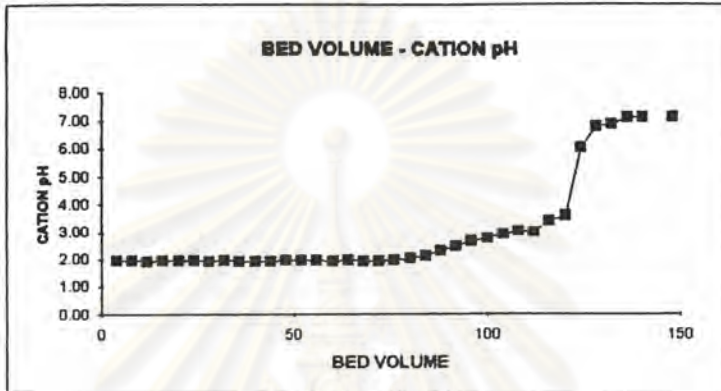
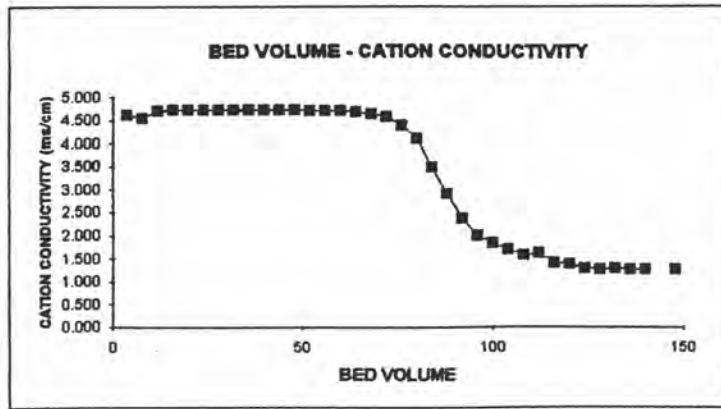




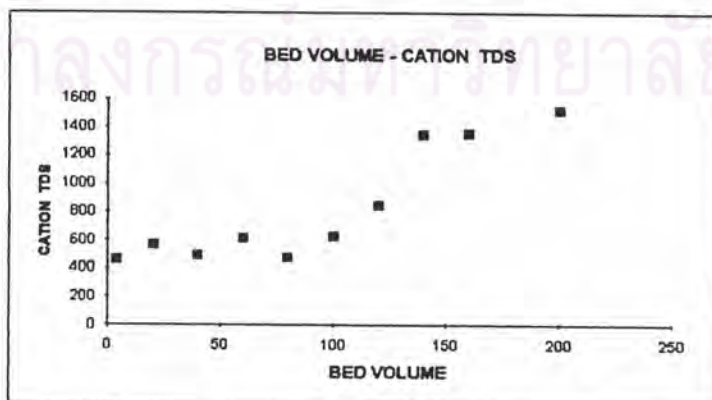
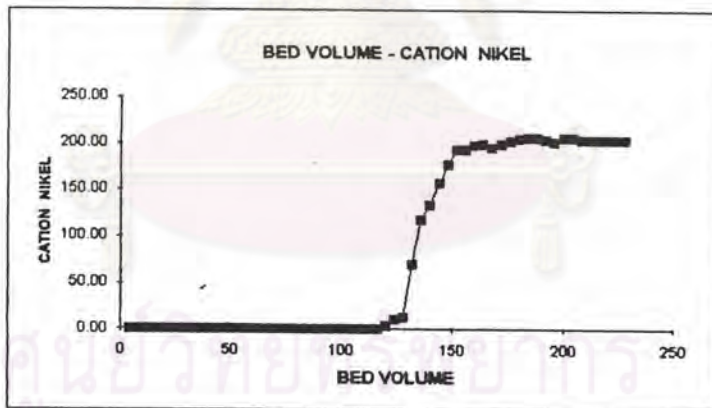
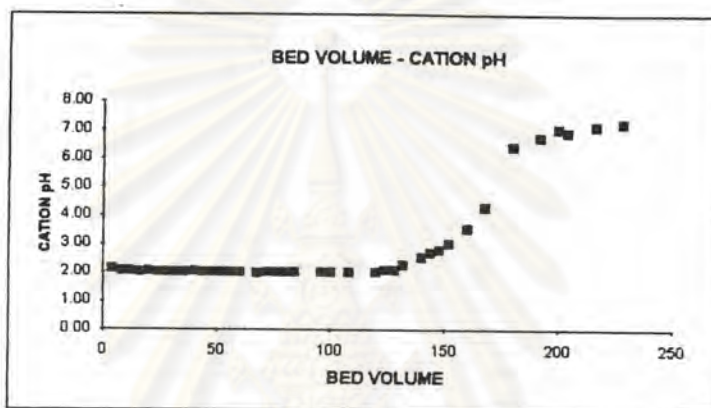
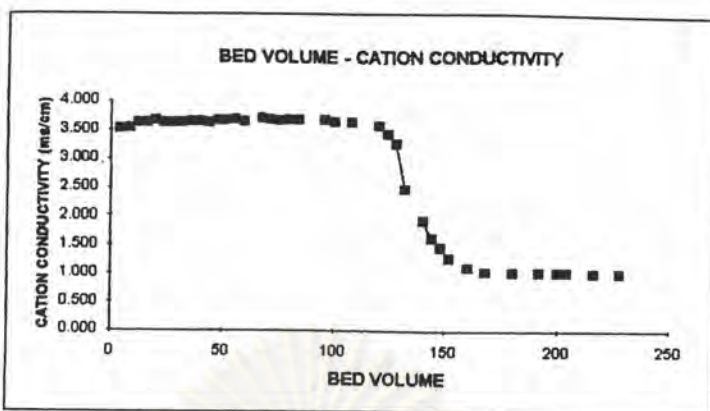
RAW WATER: INFLUENT NI = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : SULFONIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV)	CATION				ANION			RATIO NI IN/NI OUT		
		CONDUCT (mc/cm)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (mc/cm)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
1	4	4.6	1.940	0.60	468.00	0.043	9.900	98.00	0.0020	0.0020	0.0080
2	8	4.53	1.950	0.60		0.048	9.410		0.0020	0.0020	0.0080
3	12	4.71	1.930	0.60		0.016	9.580		0.0020	0.0020	0.0080
4	16	4.72	1.950	0.60		0.013	9.750		0.0020	0.0020	0.0080
5	20	4.73	1.940	0.60	602.00	0.012	8.640	7306.00	0.0020	0.0020	0.0080
6	24	4.72	1.940	0.60		0.01	9.200		0.0020	0.0020	0.0080
7	28	4.73	1.930	0.60		0.008	9.250		0.0020	0.0020	0.0080
8	32	4.73	1.940	0.60		0.008	9.150		0.0020	0.0020	0.0080
9	36	4.73	1.930	0.60		0.009	9.110		0.0020	0.0020	0.0080
10	40	4.73	1.930	0.60	555.00	0.017	6.560	84.20	0.0020	0.0020	0.0080
11	44	4.72	1.930	0.60		0.01	8.830		0.0020	0.0020	0.0080
12	48	4.73	1.940	0.60		0.018	5.170		0.0020	0.0020	0.0080
13	52	4.71	1.940	0.60		0.015	7.620		0.0020	0.0025	0.0100
14	56	4.71	1.940	0.90		0.03	5.490		0.0030	0.0033	0.0133
15	60	4.7	1.910	1.10	574.00	0.83	2.740	860.00	0.0037	0.0072	0.0289
16	64	4.69	1.950	3.24		2.43	2.230		0.0108	0.0147	0.0588
17	68	4.64	1.920	5.59		3.76	2.050		0.0186	0.0485	0.1939
18	72	4.57	1.930	23.50		4.03	2.040		0.0783	0.1462	0.5847
19	76	4.37	1.960	64.20		4.4	2.030		0.2140	0.2315	0.9260
20	80	4.09	2.010	74.71	852.00	4.08	2.020	1247.00	0.2490	0.3225	1.2902
21	84	3.47	2.120	118.82		4.22	2.150		0.3961	0.4971	1.9882
22	88	2.9	2.290	179.41		3.95	2.150		0.5980	0.6652	2.6608
23	92	2.36	2.430	219.71		3.84	2.160		0.7324	0.8025	3.2098
24	96	1.98	2.620	261.76		3.22	2.280		0.8725	0.9147	3.6598
25	100	1.82	2.750	287.06	1662.00	2.57	2.410	1754.00	0.9569	0.9601	3.8404
26	104	1.68	2.890	289.00		2.55	2.460		0.9633	0.9679	3.8718
27	108	1.58	3.020	291.76		2.55			0.9725	0.9858	3.9431
28	112	1.63	2.980	299.71		2.1	2.650		0.9990	1.0005	4.0020
29	116	1.4	3.400	300.59		1.95	2.770		1.0020	1.0026	4.0106
30	120	1.39	3.600	301.00	1981.00	1.86	2.810	1846.00	1.0033	1.0058	4.0233
31	124	1.3	6.050	302.50		1.64	3.060		1.0083	1.0095	4.0378
32	128	1.28	6.780	303.17		1.54	3.210		1.0106	1.0103	4.0410
33	132	1.29	6.890	302.98		1.46	3.390		1.0099	1.0100	4.0399
34	136	1.28	7.110	303.01		1.38			1.0100	1.0104	4.0417
36	140	1.28	7.100	303.24	2001.00	1.31	4.000	1997.00	1.0108	1.0081	4.0323
36	144			301.60					1.0053	1.0048	4.0190
37	148	1.27	7.090	301.25		1.28	6.960		1.0042	1.0042	4.0167
SUM (TOTAL RATIO OF NI. IN TO NI. OUT)											34.3874
TOTAL EXCHANGE NICKEL (mg/l.resin)											34083.79

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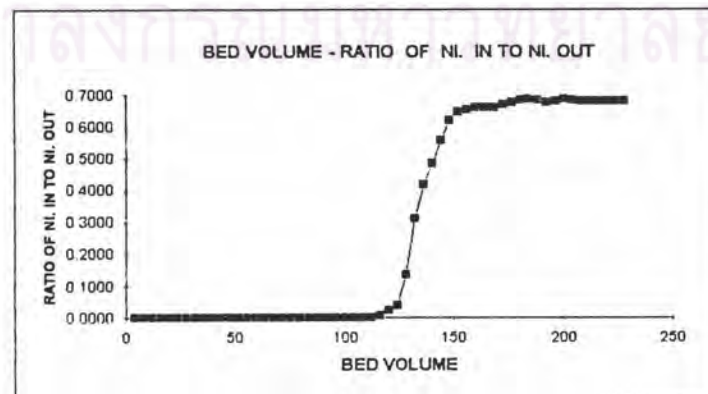
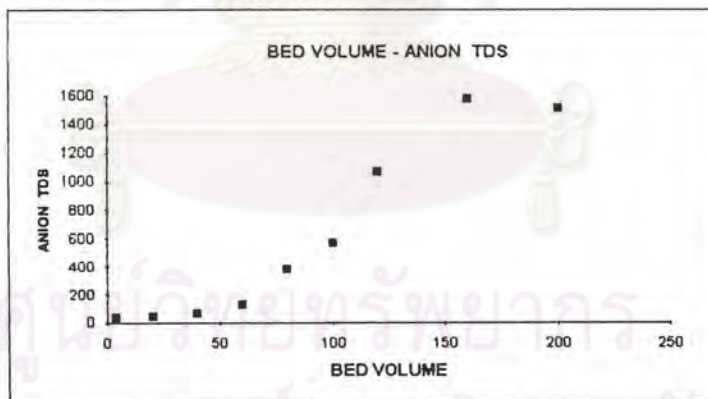
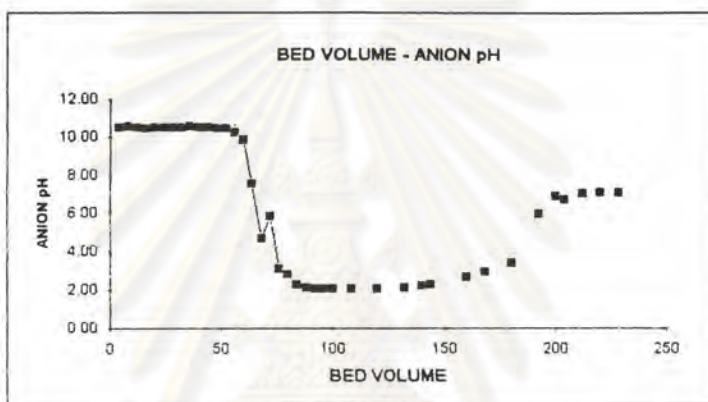
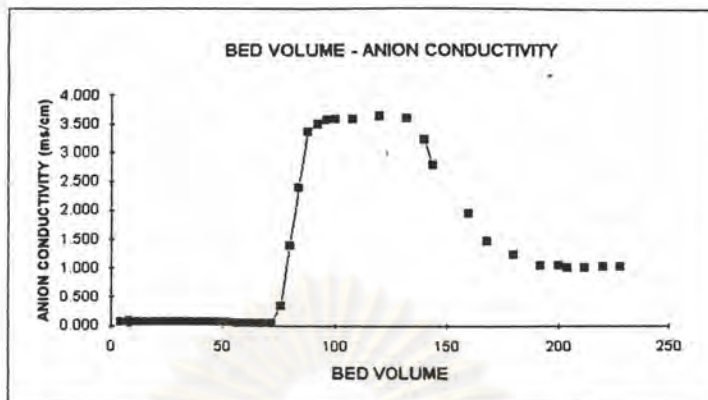




4-R1 XLS



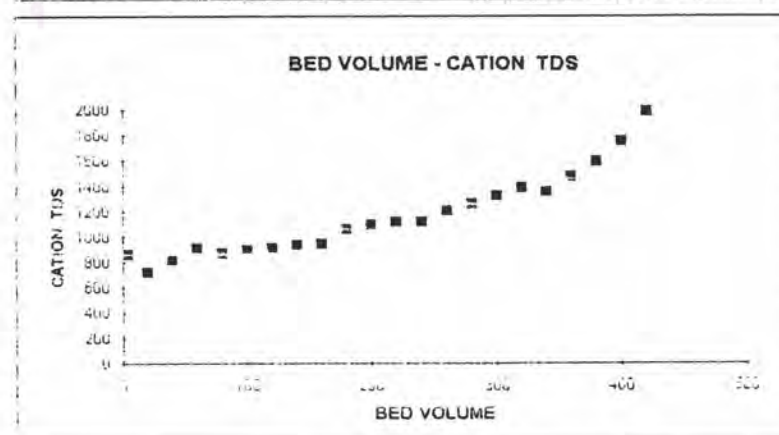
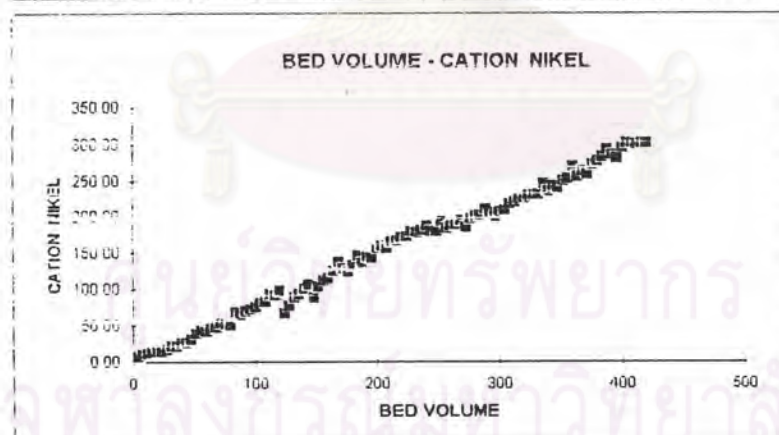
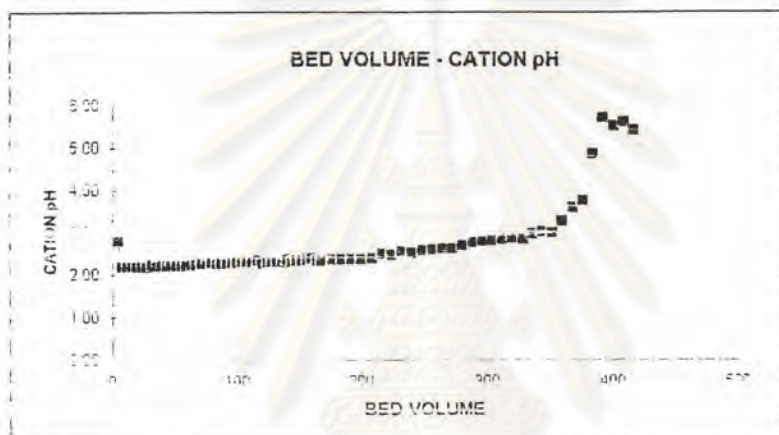
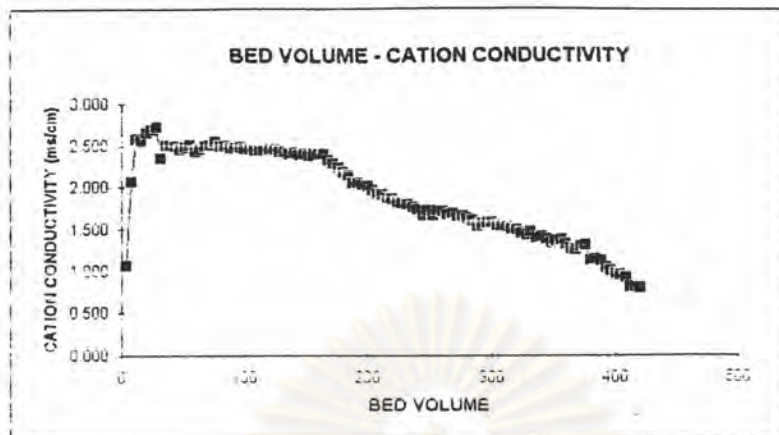
4-R1.XLS



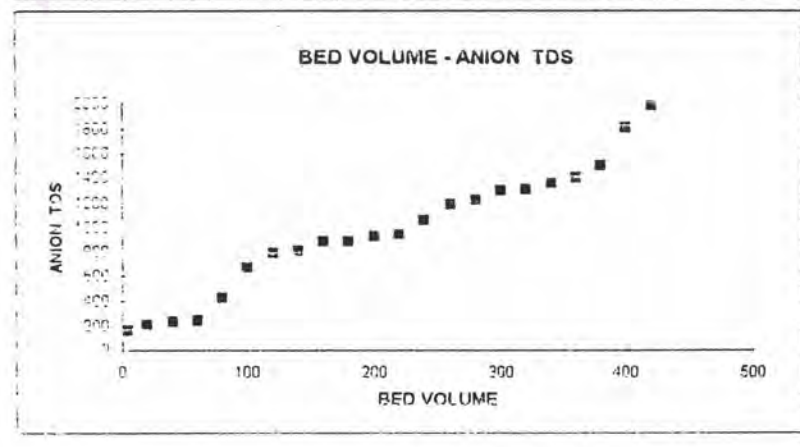
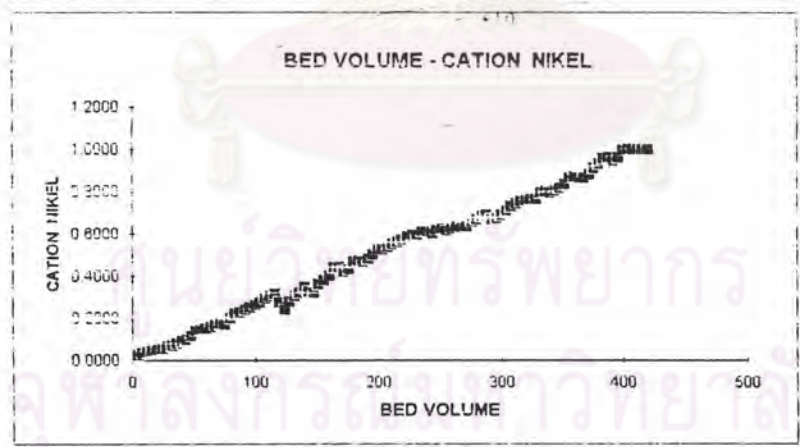
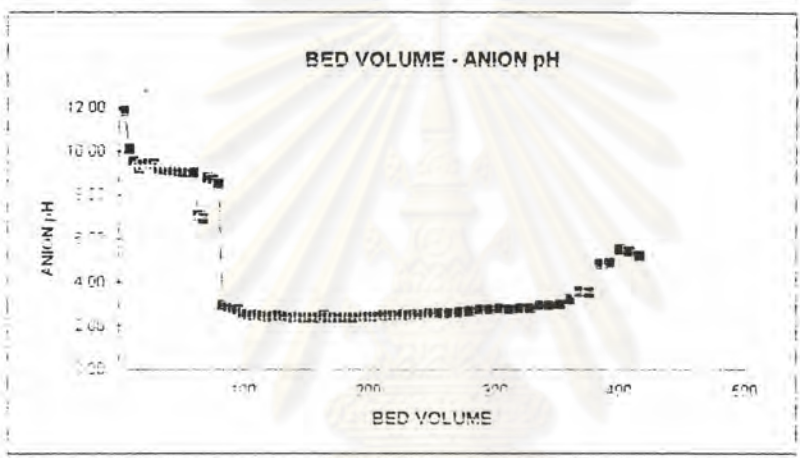
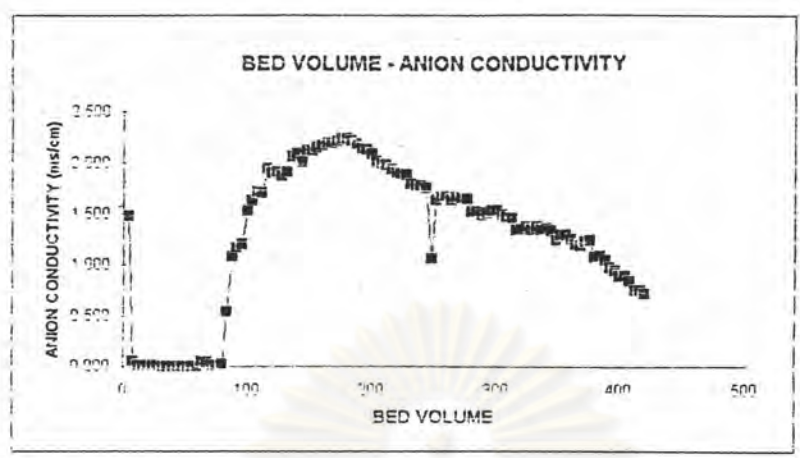
RAW WATER: INFLUENT NI = 300 mg/l ONLY											
SERVICE FLOWRATE = 20 BV/hr											
RESIN TYPE : IMMINODIACETIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO NI IN/ NI OUT		
		CONDUCT. (mg/cm.)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (mg/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
1	4	1.060	2.79	6.30	856	1.481	11.82	167	0.0210	0.0257	0.1026
2	8	2.070	2.17	9.09		0.059	10.09		0.0303	0.0342	0.1366
3	12	2.570	2.18	11.40		0.020	9.52		0.0380	0.0394	0.1574
4	16	2.550	2.17	12.21		0.020	9.26		0.0407	0.0429	0.1714
5	20	2.650	2.16	13.50	712	0.018	9.38	210	0.0450	0.0462	0.1847
6	24	2.690	2.17	14.20		0.017	9.42		0.0473	0.0516	0.2065
7	28	2.720	2.18	16.77		0.011	9.45		0.0559	0.0626	0.2504
8	32	2.340	2.23	20.79		0.004	9.25		0.0693	0.0707	0.2826
9	36	2.500	2.21	21.60		0.008	9.18		0.0720	0.0788	0.3153
10	40	2.490	2.20	25.70	816	0.009	9.16	229	0.0857	0.0867	0.3467
11	44	2.480	2.19	26.30		0.010	9.12		0.0877	0.0938	0.3753
12	48	2.440	2.21	30.00		0.007	9.11		0.1000	0.1150	0.4600
13	52	2.470	2.21	39.00		0.008	9.03		0.1300	0.1375	0.5500
14	56	2.490	2.21	43.50		0.009	9.03		0.1450	0.1435	0.5740
15	60	2.420	2.21	42.60	910	0.010	9.05	246	0.1420	0.1492	0.5967
16	64	2.450	2.22	46.90		0.058	7.05		0.1563	0.1587	0.6347
17	68	2.480	2.23	48.30		0.048	6.93		0.1610	0.1695	0.6780
18	72	2.490	2.25	53.40		0.011	8.81		0.1780	0.1760	0.7040
19	76	2.530	2.24	52.20		0.019	8.70		0.1740	0.1710	0.6840
20	80	2.480	2.27	50.40	868	0.031	8.52	420	0.1680	0.1980	0.7920
21	84	2.480	2.25	68.40		0.547	2.94		0.2280	0.2203	0.8813
22	88	2.460	2.26	63.80		1.080	2.85		0.2127	0.2228	0.8913
23	92	2.456	2.25	69.90		1.180	2.80		0.2330	0.2365	0.9460
24	96	2.470	2.27	72.00		1.210	2.71		0.2400	0.2470	0.9880
25	100	2.450	2.28	76.20	890	1.530	2.54	668	0.2540	0.2620	1.0480
26	104	2.440	2.29	81.00		1.630	2.49		0.2700	0.2740	1.0960
27	108	2.430	2.30	83.40		1.720	2.45		0.2780	0.2930	1.1720
28	112	2.430	2.3	92.40		1.705	2.49		0.3080	0.3055	1.2220
29	116	2.430	2.32	90.90		1.950	2.45		0.3030	0.3145	1.2580
30	120	2.440	2.26	97.80	912	1.902	2.38	789	0.3260	0.2740	1.0960
31	124	2.450	2.27	66.60		1.912	2.40		0.2220	0.2405	0.9620
32	128	2.420	2.29	77.70		1.871	2.42		0.2590	0.2780	1.1120
33	132	2.420	2.30	89.10		1.910	2.42		0.2970	0.3035	1.2140
34	136	2.400	2.31	93.00		2.060	2.39		0.3100	0.3215	1.2860
35	140	2.410	2.34	99.90	935	2.090	2.34	810	0.3330	0.3435	1.3740
36	144	2.380	2.29	106.20		2.010	2.39		0.3540	0.3255	1.3020
37	148	2.390	2.33	89.10		2.120	2.34		0.2970	0.3200	1.2800
38	152	2.370	2.33	102.90		2.120	2.34		0.3430	0.3585	1.4340
39	156	2.400	2.35	112.20		2.150	2.33		0.3740	0.3785	1.5140
40	160	2.390	2.37	114.90	940	2.170	2.33	889	0.3830	0.3995	1.5980
41	164	2.390	2.32	124.60		2.200	2.42		0.4160	0.4370	1.7480
42	168	2.320	2.32	137.40		2.200	2.34		0.4580	0.4420	1.7680
43	172	2.280		127.80		2.220	2.35		0.4260	0.4185	1.6740
44	176	2.230	2.34	123.30		2.240	2.33		0.4110	0.4270	1.7080
45	180	2.180		132.90	1056	2.240	2.32	890	0.4430	0.4640	1.8560
46	184	2.140	2.35	145.50		2.220	2.34		0.4850	0.4690	1.8760
47	188	2.060		135.90		2.180	2.35		0.4530	0.4665	1.8660
48	192	2.050	2.36	144.00		2.140	2.35		0.4800	0.4785	1.9140
49	196	2.030		143.10		2.130	2.37		0.4770	0.4990	1.9960
50	200	2.020	2.35	156.30	1089	2.090	2.38	930	0.5210	0.5255	2.1020
51	204	1.960		159.00		2.020	2.39		0.5300	0.5240	2.0960
52	208	1.930	2.37	155.40		2.000	2.40		0.5180	0.5335	2.1340
53	212	1.910		164.70		1.990	2.42		0.5490	0.5515	2.2060
54	216	1.880	2.48	166.20		1.950	2.43		0.5540	0.5620	2.2480
55	220	1.860		171.00	1114	1.920	2.44	946	0.5700	0.5710	2.2840
56	224	1.830	2.46	171.60		1.900	2.45		0.5720	0.5845	2.3380
57	228	1.810		179.10		1.890	2.47		0.5970	0.5950	2.3800
58	232	1.800	2.53	177.90		1.800	2.46		0.5930	0.5970	2.3880
59	236	1.760		180.30		1.780	2.49		0.6010	0.6125	2.4500

RAW WATER: INFLUENT NI = 300 mg/l ONLY SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV)	CATION				ANION			RATIO NI IN/ NI OUT		
		CONDUCT. (ms/cm.)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
60	240	1.740	2.49	187.20	1120	1.780	2.49	1056	0.6240	0.6115	2.4460
61	244	1.660		179.70		1.760	2.51		0.5990	0.5985	2.3940
62	248	1.730	2.56	179.40		1.072	2.52		0.5980	0.6195	2.4780
63	252	1.660		192.30		1.640	2.52		0.6410	0.6270	2.5080
64	256	1.730	2.57	183.90		1.68	2.52		0.6130	0.6165	2.4660
65	260	1.710		186.00	1210	1.69		1189	0.6200	0.6230	2.4920
66	264	1.672	2.59	187.80		1.650	2.56		0.6260	0.6355	2.5420
67	268	1.684		193.50		1.68			0.6450	0.6312	2.5247
68	272	1.652	2.61	185.20		1.67	2.58		0.6173	0.6365	2.5460
69	276	1.645		196.70		1.656			0.6557	0.6600	2.6400
70	280	1.623	2.68	199.30	1256	1.526	2.64	1222	0.6643	0.6683	2.6733
71	284	1.599		201.70		1.53			0.6723	0.6862	2.7447
72	288	1.539	2.75	210.00		1.500	2.73		0.7000	0.6897	2.7587
73	292	1.563		203.90		1.523			0.6793	0.6723	2.6893
74	296	1.579	2.78	199.60		1.543	2.75		0.6653	0.6762	2.7047
75	300	1.578		206.10	1328	1.545		1302	0.6870	0.6922	2.7687
76	304	1.543	2.79	209.20		1.496	2.80		0.6973	0.7098	2.8393
77	308	1.537		216.70		1.483			0.7223	0.7295	2.9180
78	312	1.524	2.82	221.00		1.472	2.74		0.7367	0.7438	2.9753
79	316	1.499		225.30		1.350			0.7510	0.7533	3.0133
80	320	1.490	2.96	226.70	1390	1.364	2.80	1309	0.7557	0.7588	3.0353
81	324	1.454		228.60		1.390			0.7620	0.7637	3.0547
82	328	1.423	2.83	229.60		1.354	2.79		0.7653	0.7677	3.0707
83	332	1.463		231.00		1.381			0.7700	0.7933	3.1733
84	336	1.385	2.95	245.00		1.350	2.94		0.8167	0.8000	3.2000
85	340	1.395		235.00	1356	1.361		1363	0.7833	0.7967	3.1867
86	344	1.378	2.99	243.00		1.346	2.94		0.8100	0.8047	3.2187
87	348	1.327		239.80		1.252			0.7993	0.8147	3.2587
88	352	1.348	2.98	249.00		1.305	2.95		0.8300	0.8363	3.3453
89	356	1.356		252.80		1.305			0.8427	0.8680	3.4720
90	360	1.316	3.25	268.00	1480	1.264	3.21	1400	0.8933	0.8717	3.4867
91	364	1.259		255.00		1.208			0.8500	0.8633	3.4533
92	368	1.245	3.58	263.00		1.198	3.54		0.8767	0.8683	3.4733
93	372	1.287		258.00		1.242			0.8600	0.8817	3.5267
94	376	1.299	3.72	271.00		1.255	3.50		0.9033	0.9117	3.6467
95	380	1.124		276.00	1593	1.089		1493	0.9200	0.9292	3.7167
96	384	1.136	4.86	281.50		1.096	4.82		0.9383	0.9563	3.8253
97	388	1.112		292.30		1.055			0.9743	0.9605	3.8420
98	392	1.032	5.70	284.00		0.985	4.89		0.9467	0.9417	3.7667
99	396	0.998		281.00		0.952			0.9367	0.9610	3.8440
100	400	0.957	5.52	295.60	1756	0.902	5.50	1809	0.9853	0.9947	3.9787
101	404	0.943		301.20		0.894			1.0040	1.0035	4.0140
102	408	0.920	5.60	300.90		0.842	5.40		1.0030	1.0012	4.0047
103	412	0.803		299.80		0.750			0.9993	1.0005	4.0020
104	416	0.805	5.4	300.50		0.750	5.20		1.0017	1.0017	4.0067
105	420	0.795		300.50	1987	0.725		1987	1.0017	1.0017	2.0033
TOTAL RATIO OF NI IN TO NI OUT											173.6335
TOTAL EXCHANGE NICKEL (mg/l. resin)											73909.96

1-R2.XLS

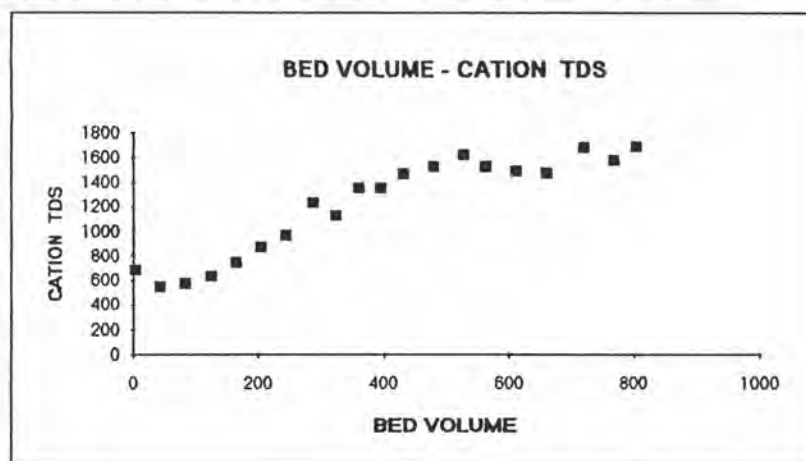
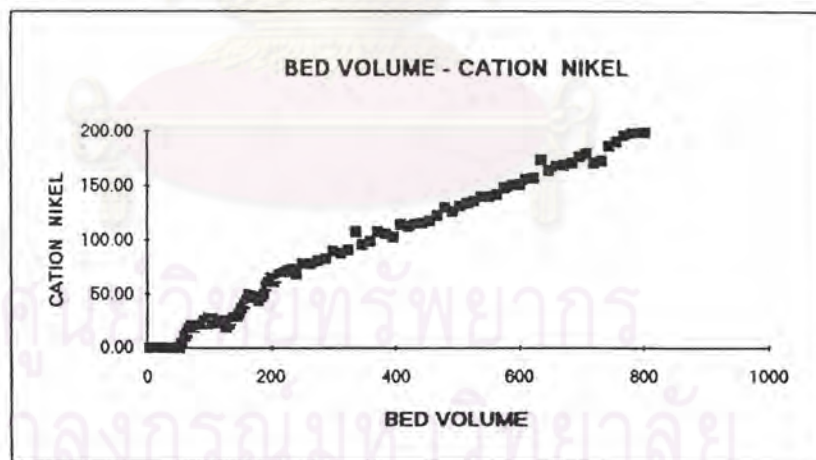
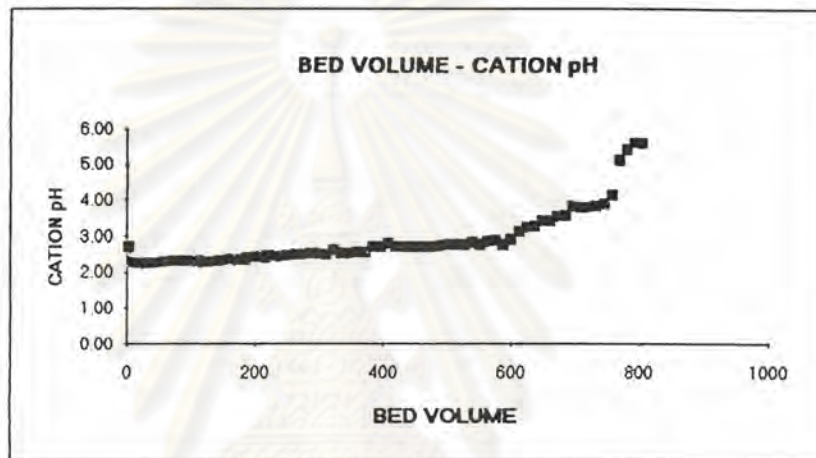
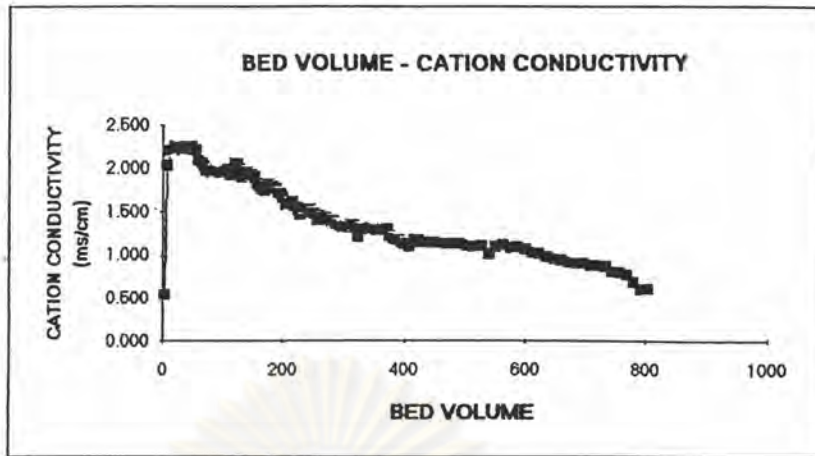


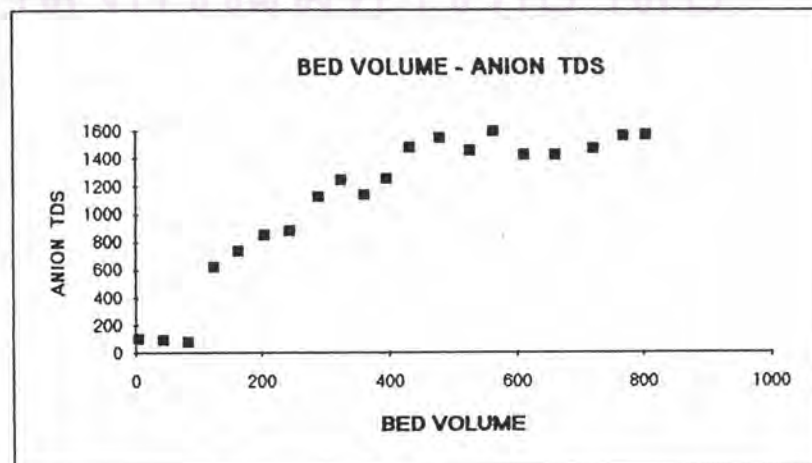
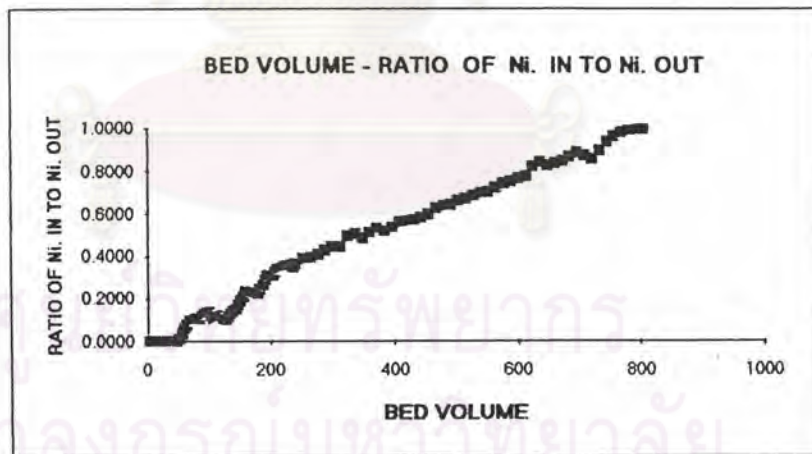
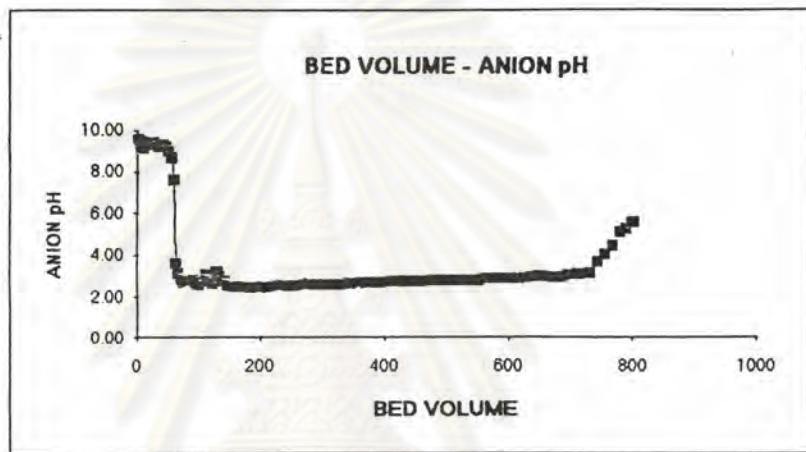
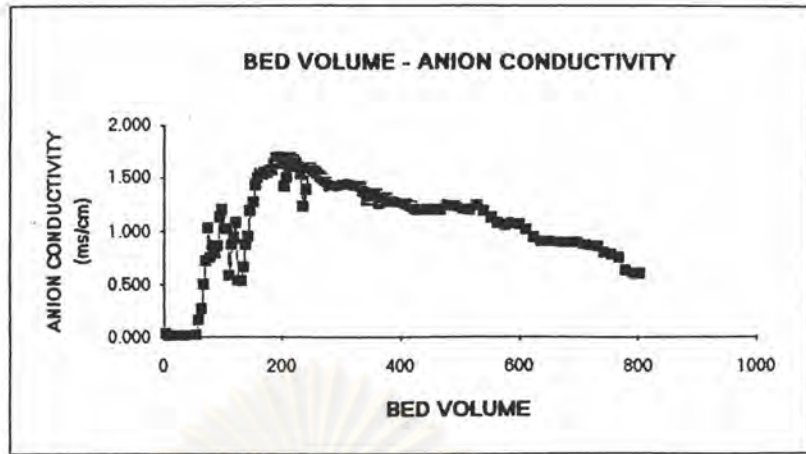
1-R2.XLS



RAW WATER: INFLUENT NI. = 200 mg/l ONLY SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO NI. IN/ NI. OUT		
		CONDUCT. (ms/cm.)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
1	4	0.540	2.70	0.16	687	0.032	9.50	105	0.0008	0.0006	0.0022
2	8	2.030	2.31	0.06		0.019	9.10		0.0003	0.0003	0.0011
3	12	2.200	2.28	0.05		0.011	9.11		0.0003	0.0002	0.0009
4	16	2.220	2.27	0.04		0.011	9.26		0.0002	0.0002	0.0008
5	20	2.250	2.26	0.04		0.011	9.44		0.0002	0.0003	0.0010
6	24	2.230	2.25	0.06		0.012	9.26		0.0003	0.0003	0.0010
7	28	2.240	2.26	0.04		0.012	9.37		0.0002	0.0003	0.0010
8	32	2.220	2.24	0.06		0.013	9.25		0.0003	0.0003	0.0012
9	36	2.250	2.26	0.06		0.014	9.17		0.0003	0.0004	0.0014
10	40	2.230	2.25	0.08		0.013	9.15		0.0004	0.0004	0.0016
11	44	2.230	2.25	0.08	543	0.013	9.25	98	0.0004	0.0005	0.0018
12	48	2.250	2.25	0.10		0.014	9.17		0.0005	0.0011	0.0044
13	52	2.220	2.26	0.34		0.014	8.95		0.0017	0.0092	0.0366
14	56	2.220	2.26	3.32		0.020	8.64		0.0166	0.0340	0.1360
15	60	2.090	2.28	10.28		0.159	7.59		0.0514	0.0607	0.2428
16	64	2.070	2.29	14.00		0.270	3.59		0.0700	0.0783	0.3130
17	68	2.030	2.30	17.30		0.501	3.06		0.0865	0.0935	0.3740
18	72	1.990	2.32	20.10		0.720	2.82		0.1005	0.0975	0.3898
19	76	1.980	2.31	18.88		1.027	2.68		0.0944	0.0990	0.3960
20	80	1.960	2.32	20.72		0.750	2.78		0.1036	0.1041	0.4162
21	84	1.970	2.31	20.90	569	0.875	2.69	79	0.1045	0.1069	0.4274
22	88	1.980	2.31	21.84		0.790	2.72		0.1092	0.1171	0.4684
23	92	1.970	2.31	25.00		0.860	2.76		0.1250	0.1240	0.4960
24	96	1.960	2.31	24.60		1.130	2.64		0.1230	0.1295	0.5180
25	100	1.960	2.31	27.20		1.204	2.56		0.1360	0.1335	0.5340
26	104	1.970	2.31	26.20		1.023	2.67		0.1310	0.1165	0.4740
27	108	2.000	2.31	21.20		1.024	2.68		0.1060	0.1070	0.4280
28	112	1.930	2.3	21.60		0.578	3.03		0.1080	0.1095	0.4380
29	116	1.960	2.31	22.20		0.869	2.74		0.1110	0.1155	0.4620
30	120	2.070	2.27	24.00		0.944	2.70		0.1200	0.1205	0.4820
31	124	2.060	2.26	24.20	630	1.078	2.60	625	0.1210	0.1080	0.4320
32	128	2.000	2.29	19.00		0.534	3.15		0.0950	0.1025	0.4100
33	132	1.910	2.30	22.00		0.527	3.15		0.1100	0.1175	0.4700
34	136	1.970	2.3	25.00		0.663	2.94		0.1250	0.1300	0.5200
35	140	1.960	2.3	27.00		0.666	2.71		0.1350	0.1390	0.5560
36	144	1.940	2.31	28.60		0.950	2.70		0.1430	0.1510	0.6040
37	148	1.940	2.32	31.80		1.189	2.58		0.1590	0.1710	0.6840
38	152	1.910	2.31	36.60		1.270	2.53		0.1830	0.1910	0.7640
39	156	1.840	2.33	39.80		1.428	2.49		0.1990	0.2110	0.8440
40	160	1.800	2.35	44.60		1.502	2.46		0.2230	0.2330	0.9320
41	164	1.780	2.36	46.60	745	1.538	2.46	736	0.2430	0.2355	0.9420
42	168	1.750	2.38	45.60		1.534	2.45		0.2280	0.2303	0.9210
43	172	1.780	2.36	46.50		1.548	2.44		0.2325	0.2370	0.9480
44	176	1.830	2.33	48.30		1.546	2.45		0.2415	0.2293	0.9170
45	180	1.800	2.34	43.40		1.570	2.44		0.2170	0.2270	0.9080
46	184	1.800	2.35	47.40		1.570	2.41		0.2370	0.2425	0.9700
47	188	1.780	2.42	49.60		1.629	2.41		0.2480	0.2665	1.0660
48	192	1.720	2.40	57.00		1.694	2.41		0.2850	0.2915	1.1660
49	196	1.710	2.40	59.60		1.697	2.41		0.2980	0.3115	1.2460
50	200	1.670	2.41	65.00		1.632	2.42		0.3250	0.3145	1.2580
51	204	1.580	2.43	60.80	872	1.419	2.48	854	0.3040	0.3110	1.2440
52	208	1.600	2.42	63.60		1.502	2.45		0.3180	0.3270	1.3080
53	212	1.590	2.43	67.20		1.595	2.43		0.3360	0.3380	1.3520
54	216	1.610	2.41	68.00		1.687	2.42		0.3400	0.3425	1.3700
55	220	1.570	2.46	69.00		1.673	2.44		0.3450	0.3478	1.3910
56	224	1.520	2.47	70.10		1.639	2.45		0.3505	0.3548	1.4190
57	228	1.470	2.48	71.80		1.597	2.47		0.3590	0.3595	1.4380
58	232	1.540	2.46	72.00		1.530	2.49		0.3600	0.3610	1.4440
59	236	1.550	2.46	72.40		1.230	2.56		0.3620	0.3495	1.3980

RAW WATER: INFLUENT NI = 200 mg/l ONLY SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO NI IN/ NI OUT		
		CONDUCT. (ms/cm.)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
119	476										
120	480	1.140	2.72	129.20	1528	1.237	2.74	1546	0.6460	0.6365	7.6380
121	484										
122	488										
123	492	1.135	2.74	125.40		1.234	2.75		0.6270	0.6405	7.6860
124	496										
125	500										
126	504	1.110	2.77	130.80		1.210	2.74		0.6540	0.6608	7.9290
127	508										
128	512										
129	516	1.095	2.78	133.50		1.200	2.77		0.6675	0.6733	8.0790
130	520										
131	524										
132	528	1.110	2.77	135.80	1623	1.237	2.75	1453	0.6790	0.6885	8.2620
133	532										
134	536										
135	540	1.010	2.82	139.60		1.195	2.77		0.6980	0.6985	8.3820
136	544										
137	548										
138	552	1.100	2.77	139.80		1.128	2.78		0.6990	0.7033	8.4390
139	556										
140	560										
141	564	1.120	2.85	141.50	1523	1.080	2.85	1596	0.7075	0.7218	8.6610
142	568										
143	572										
144	576	1.080	2.89	147.20		1.060	2.84		0.7360	0.7413	8.8950
145	580										
146	584										
147	588	1.100	2.77	149.30		1.080	2.86		0.7465	0.7493	8.9910
148	592										
149	596										
150	600	1.070	2.90	150.40		1.070	2.86		0.7520	0.7640	9.1680
151	604										
152	608										
153	612	1.040	3.12	155.20	1489	1.020	2.88	1425	0.7760	0.7775	9.3300
154	616										
155	620										
156	624	1.020	3.23	155.80		0.948	2.88		0.7790	0.8208	9.8490
157	628										
158	632										
159	636	0.987	3.28	172.50		0.915	2.90		0.8625	0.8393	10.0710
160	640										
161	644										
162	648	0.957	3.41	163.20		0.910	2.96		0.8160	0.8248	9.8970
163	652										
164	656										
165	660	0.945	3.42	166.70	1472	0.908	2.97	1422	0.8335	0.8373	10.0470
166	664										
167	668										
168	672	0.923	3.55	168.20		0.905	2.94		0.8410	0.8450	10.1400
169	676										
170	680										
171	684	0.916	3.58	169.80		0.904	2.93		0.8490	0.8635	10.3620
172	688										
173	692										
174	696	0.910	3.84	175.60		0.904	3.01		0.8780	0.8850	10.6200
175	700										
176	704										
177	708	0.883	3.81	178.40		0.883	3.07		0.8920	0.8708	10.4490

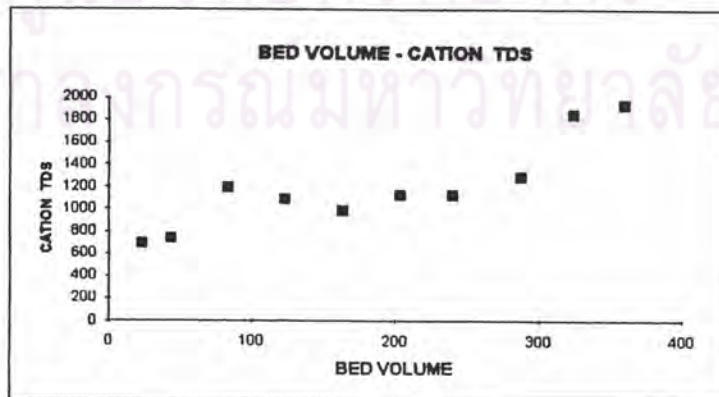
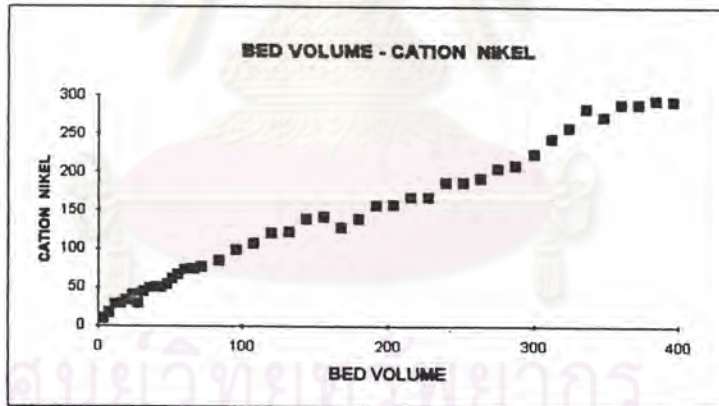
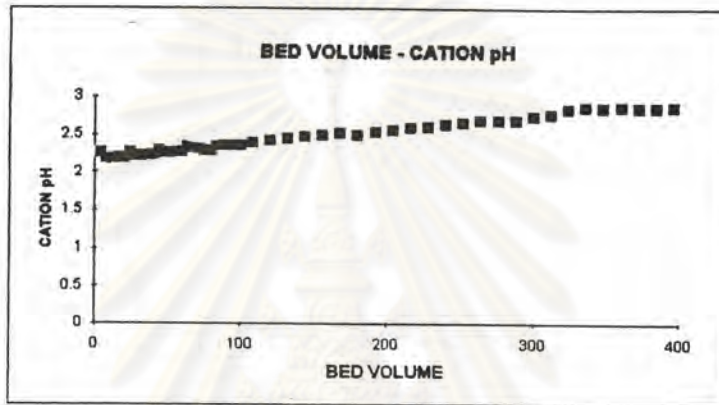
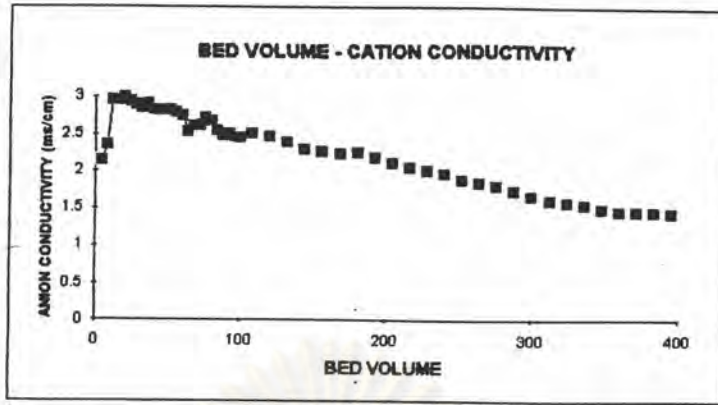


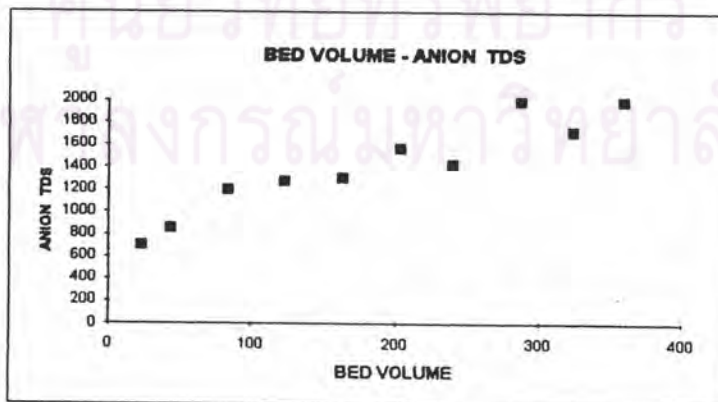
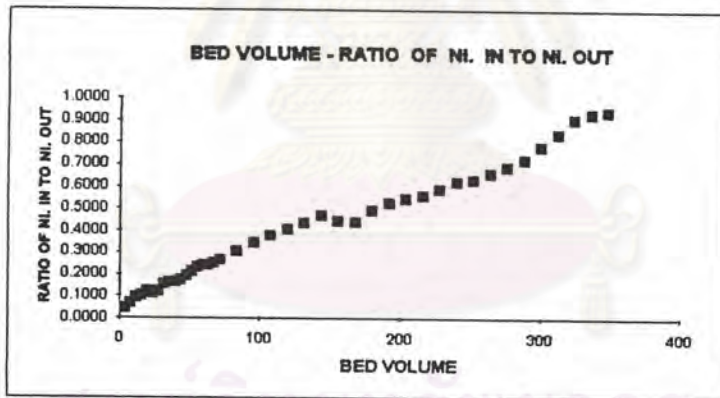
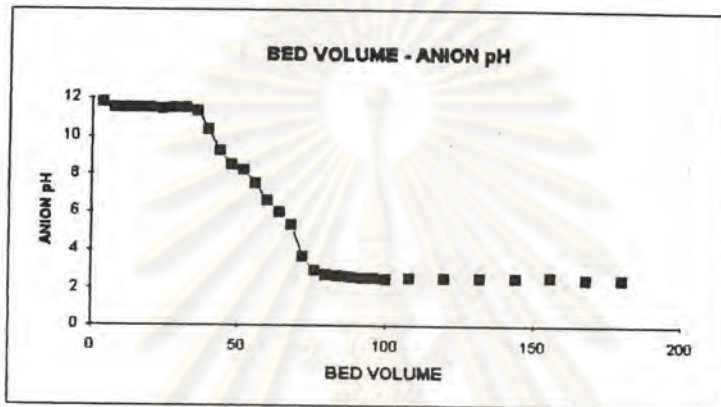
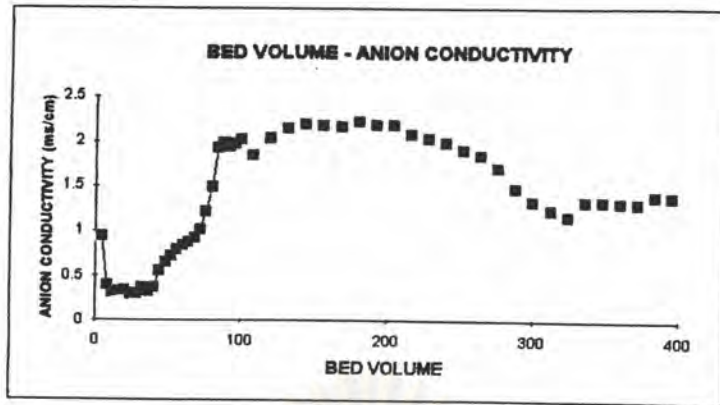


RAW WATER: INFLUENT NI = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO NI. IN/ NI. OUT		
		CONDUCT. (ms/cm.)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
83	332										
84	336	1.542	3.52	254.16		1.347	2.98		0.8472	0.8618	10.3420
85	340										
86	344										
87	348	1.479	4.16	262.94		1.344	2.94		0.8765	0.8873	10.6470
88	352										
89	356										
90	360	1.458	4.75	269.41	1932	1.337	2.91	1985	0.8980	0.9323	11.1870
91	364										
92	368										
93	372	1.455	4.85	289.94		1.314	2.95		0.9665	0.9759	11.7106
94	376										
95	380										
96	384	1.462	5.12	295.59		1.403	2.94		0.9853	0.9824	11.7882
97	388										
98	392										
99	396	1.447	5.11	293.82		1.39	2.91		0.9794	0.4897	5.8764
100	400										
SUM(RATIO OF NI. IN TO NI. OUT)											193.78
TOTAL EXCHANGE NICKEL (mg/l. resin)											60664.74

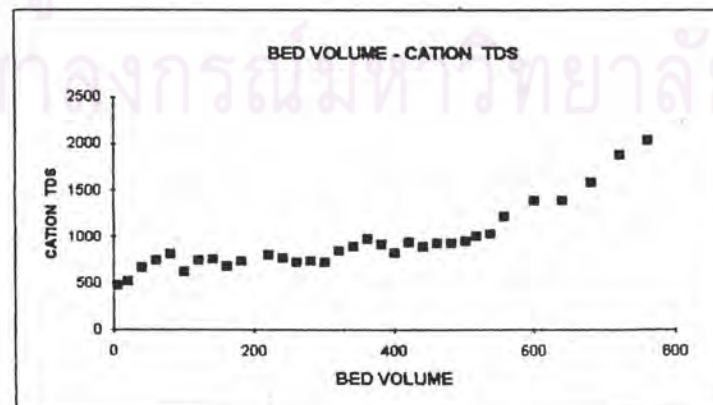
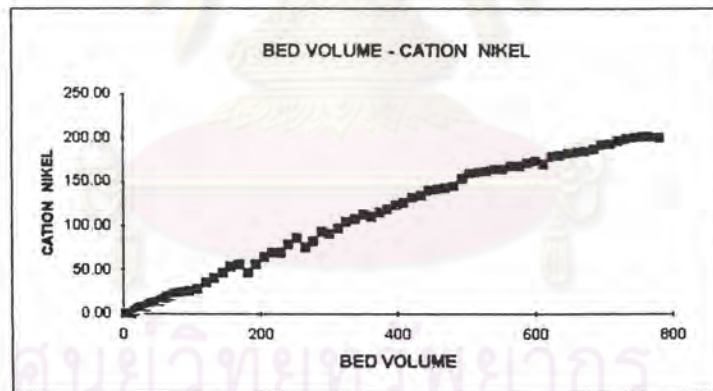
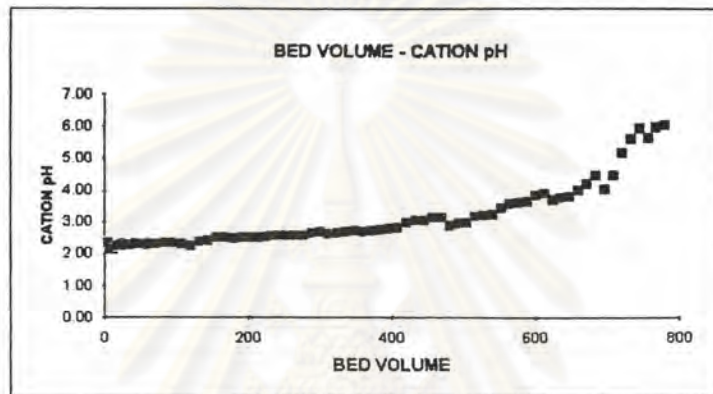
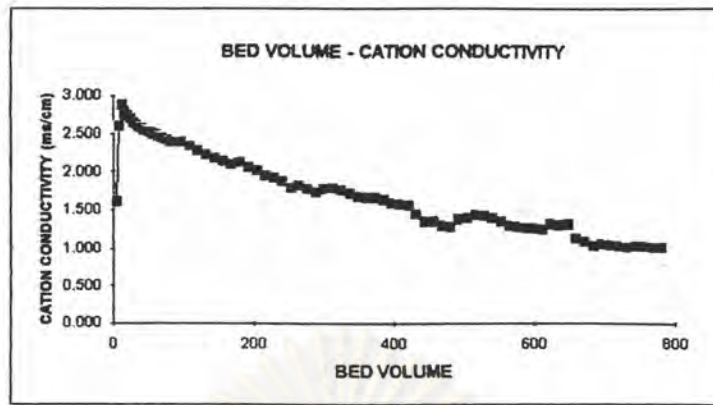


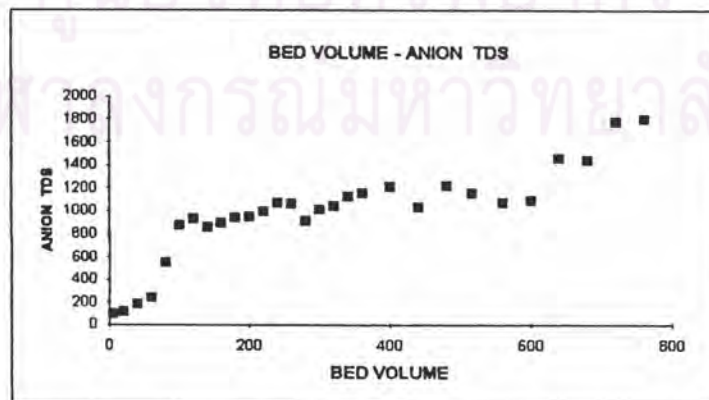
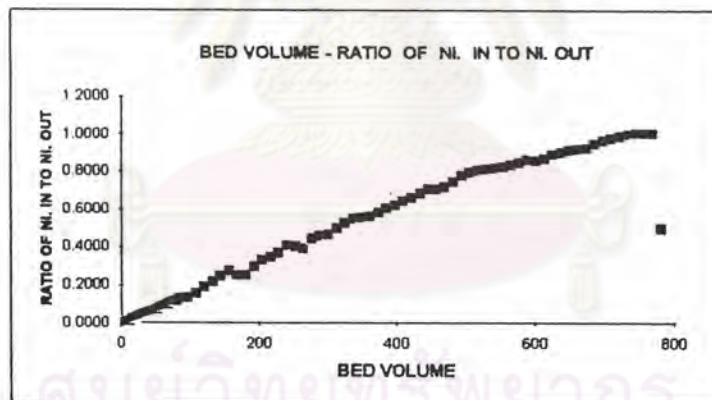
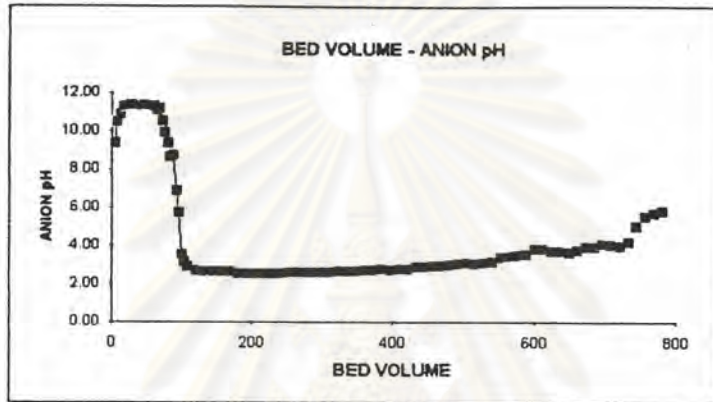
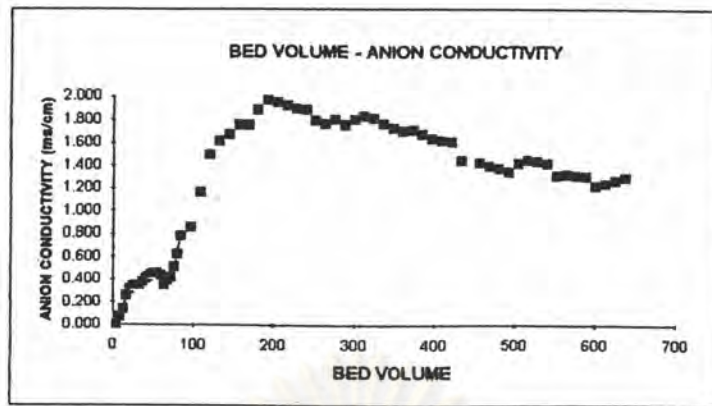
 ศูนย์วิทยทรัพยากร
 จุฬาลงกรณ์มหาวิทยาลัย





RAW WATER: INFLUENT NI = 200 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO NI IN/NI OUT		
		CONDUCT. (ms/cm.)	pH	NIKEI (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
119	476										
120	480	1.275	2.91	145.20	930	1.376	3.01	1220	0.7260	0.7455	8.9460
121	484										
122	488										
123	492	1.369	2.97	153.00		1.344	3.04		0.7650	0.7815	9.3780
124	496										
125	500				958						
126	504	1.390	2.98	159.60		1.423	3.11		0.7960	0.8010	9.6120
127	508										
128	512										
129	516	1.433	3.19	160.80	1016	1.454	3.07	1158	0.8040	0.8080	9.6960
130	520										
131	524										
132	528	1.411	3.22	162.40		1.443	3.11		0.8120	0.8165	9.7980
133	532										
134	536				1038						
136	540	1.386	3.26	164.20		1.427	3.16		0.8210	0.8210	9.8520
136	544										
137	548										
138	552	1.347	3.47	164.20		1.321	3.37		0.8210	0.8295	9.9540
139	556				1224						
140	560							1078			
141	564	1.293	3.59	167.60		1.332	3.47		0.8380	0.8400	10.0800
142	568										
143	572										
144	576	1.280	3.61	168.40		1.324	3.51		0.8420	0.8495	10.1940
146	580										
146	584										
147	588	1.266	3.67	171.40		1.309	3.58		0.8570	0.8635	10.3620
148	592										
149	596										
150	600	1.256	3.85	174.00	1398	1.226	3.81	1092	0.8700	0.8625	10.3500
151	604										
152	608										
153	612	1.241	3.92	171.00		1.242	3.82		0.8550	0.8740	10.4880
154	616										
155	620										
156	624	1.312	3.72	178.60		1.272	3.72		0.8930	0.8965	10.7580
157	628										
158	632										
159	636	1.306	3.79	180.00		1.306	3.74		0.9000	0.9065	10.8780
160	640				1402			1460			
161	644										
162	648	1.313	3.84	182.60		1.310	3.87		0.9130	0.9165	10.9980
163	652										
164	656										
166	660	1.128	4.01	184.00		1.157	3.75		0.9200	0.9220	11.0640
168	664										
167	668										
168	672	1.089	4.21	184.80		1.148	3.94		0.9240	0.9295	11.1540
169	676										
170	680				1588			1448			
171	684	1.043	4.48	187.00		1.102	3.96		0.9350	0.9488	11.3850
172	688										
173	692										
174	696	1.060	4.07	192.50		1.075	4.10		0.9625	0.9658	11.5890
176	700										
176	704										
177	708	1.045	4.49	193.80		1.05	4.06		0.9690	0.9763	11.7150





RAW WATER: INFLUENT NI = 100 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV)	CATION				ANION			RATIO NI IN/NI OUT		
		CONDUCT. (ms/cm.)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
1	4	1.111	4.14	0.20	568	2.070	12.09	130	0.0020	0.0025	0.0100
2	8	1.150	4.21	0.30		2.010	12.00		0.0030	0.0035	0.0140
3	12	1.193	3.64	0.40		2.150	11.94		0.0040	0.0040	0.0160
4	16	1.128	4.21	0.40		2.100	11.96		0.0040	0.0040	0.0160
5	20	1.294	3.64	0.40	620	1.830	11.83	370	0.0040	0.0055	0.0220
6	24	1.353	2.87	0.70		0.615	11.75		0.0070	0.0075	0.0300
7	28	1.413	2.83	0.80		0.650	11.51		0.0080	0.0090	0.0360
8	32	1.480	2.76	1.00		0.643	11.55		0.0100	0.0110	0.0440
9	36	1.550	2.71	1.20		0.640	11.54		0.0120	0.0125	0.0500
10	40	1.617	2.65	1.30	512	0.634	11.55	148	0.0130	0.0140	0.0560
11	44	1.687	2.62	1.50		0.563	11.49		0.0150	0.0155	0.0620
12	48	1.740	2.57	1.60		0.542	11.50		0.0160	0.0195	0.3120
13	52	1.784	2.55			0.510	11.45		0.0000		
14	56	1.813	2.53			0.425	11.30		0.0000		
15	60	1.833	2.51			0.354	11.07		0.0000		
16	64	1.833	2.53	2.30		0.338	10.65		0.0230	0.0265	0.4240
17	68	1.831	2.50			0.410	10.51		0.0000		
18	72	1.823	2.51			0.501	10.40		0.0000		
19	76	1.862	2.49			0.611	10.25		0.0000		
20	80	1.745		3.00	436	0.672	9.00	584	0.0300	0.0335	0.5360
21	84	1.797	2.52			0.692	9.58		0.0000		
22	88	1.780	2.52			0.721	9.45		0.0000		
23	92	1.789	2.52			0.757	9.15		0.0000		
24	96	1.764	2.54	3.70		0.774	8.90		0.0370	0.0410	0.6560
25	100	1.808	2.52			0.813	6.00		0.0000		
26	104	1.627	2.63			0.814	5.50		0.0000		
27	108	1.730	2.58			0.820	3.24		0.0000		
28	112			4.50					0.0450	0.0495	0.7920
29	116								0.0000		
30	120	1.495	2.59		530	1.137	3.03	670	0.0000		
31	124								0.0000		
32	128	1.475	2.53	5.40		1.299	2.89		0.0540	0.0585	0.9360
33	132								0.0000		
34	136	1.680	2.52			1.603	2.72		0.0000		
35	140								0.0000		
36	144	1.694		6.30		1.492	2.78		0.0630	0.0690	1.1040
37	148								0.0000		
38	152	1.678	2.54			1.493	2.75		0.0000		
39	156								0.0000		
40	160	1.660	2.55	7.50	596	1.501	2.75	492	0.0750	0.0805	1.2880
41	164								0.0000		
42	168	1.668	2.53			1.509	2.75		0.0000		
43	172								0.0000		
44	176	1.665		8.60		1.527	2.73		0.0860	0.0920	1.4720
45	180								0.0000		
46	184	1.660	2.56			1.539	2.73		0.0000		
47	188								0.0000		
48	192	1.630		9.80		1.548	2.70		0.0980	0.1115	1.7840
49	196								0.0000		
50	200	1.619	2.58		720	1.524	2.72	586	0.0000		
51	204								0.0000		
52	208	1.594		12.50		1.610	2.67		0.1250	0.0965	1.5440
53	212								0.0000		
54	216	1.761	2.52			1.574	2.65		0.0000		
55	220								0.0000		
56	224	1.643		6.80		1.636	2.64		0.0680	0.0810	1.2960
57	228								0.0000		
58	232	1.651	2.56			1.661	2.63		0.0000		
59	236								0.0000		

RAW WATER: INFLUENT NI. = 100 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO NI. IN/NI. OUT		
		CONDUCT. (ms/cm.)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
80	240	1.628		9.40	732	1.603	2.65	598	0.0940	0.0760	1.2160
81	244								0.0000		
82	248	1.622	2.64			1.627	2.63		0.0000		
83	252								0.0000		
84	256	1.474		5.80		1.572	2.60		0.0580	0.0640	0.5120
85	260								0.0000		
86	264	1.413	2.66	7.00		1.459	2.66		0.0700	0.0675	1.6200
87	268								0.0000		
88	272	1.401				1.432	2.66		0.0000		
89	276								0.0000		
90	280	1.400	2.67		504	1.583	2.58	624	0.0000		
91	284								0.0000		
92	288	1.391		6.50		1.382	2.68		0.0650	0.0810	1.2960
93	292								0.0000		
94	296	1.374	2.67			1.384	2.69		0.0000		
95	300								0.0000		
96	304	1.358		9.70		1.383	2.68		0.0970	0.1135	1.8160
97	308								0.0000		
98	312	1.356	2.69			1.384	2.68		0.0000		
99	316								0.0000		
100	320	1.349		13.00	542	1.369	2.68	602	0.1300	0.1410	2.2560
101	324								0.0000		
102	328	1.344	2.70			1.377	2.67		0.0000		
103	332								0.0000		
104	336	1.337		15.20		1.361	2.68		0.1520	0.1640	2.6240
105	340								0.0000		
106	344	1.398	2.67			1.368	2.68		0.0000		
107	348								0.0000		
108	352	1.336		17.60		1.351	2.69		0.1760	0.1885	3.0160
109	356								0.0000		
110	360	1.318	2.72		649	1.338	2.70	662	0.0000		
111	364								0.0000		
112	368	1.310		20.10		1.333	2.71		0.2010	0.1625	2.6000
113	372								0.0000		
114	376	1.299	2.34			1.320	2.70		0.0000		
115	380								0.0000		
116	384	1.346		12.40		1.316	2.73		0.1240	0.1530	2.4480
117	388								0.0000		
118	392	1.315	2.74			1.311	2.71		0.0000		
119	396								0.0000		
120	400	1.301		18.20	576	1.301	2.70	558	0.1820	0.1990	3.1840
121	404								0.0000		
122	408	1.330	2.79			1.351	2.72		0.0000		
123	412								0.0000		
124	416			21.60					0.2160	0.2315	3.7040
125	420								0.0000		
126	424	1.322	2.80			1.346	2.72		0.0000		
127	428								0.0000		
128	432			24.70					0.2470	0.2605	4.1680
129	436								0.0000		
130	440	1.304	2.80		620	1.327	2.75	310	0.0000		
131	444								0.0000		
132	448			27.40					0.2740	0.2820	4.5120
133	452								0.0000		
134	456	1.282	2.81			1.307	2.76		0.0000		
135	460								0.0000		
136	464			29.00					0.2900	0.2995	4.7920
137	468								0.0000		
138	472	1.272	2.82			1.285	2.79		0.0000		

RAW WATER: INFLUENT NI = 100 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No	BED VOLUME (BV)	CATION				ANION			RATIO NI: IN/ NI: OUT		
		CONDUCT. (ms/cm)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
119	476								0.0000		
120	480			30.90	722			536	0.3090	0.3155	5.0480
121	484								0.0000		
122	488	1.250	2.84			1.287	2.80		0.0000		
123	492								0.0000		
124	496			32.20					0.3220	0.3305	5.2880
125	500								0.0000		
126	504	1.234	2.84			1.267	2.81		0.0000		
127	508								0.0000		
128	512			33.90					0.3390	0.3375	5.4000
129	516								0.0000		
130	520	1.210	2.86		736	1.237	2.84	556	0.0000		
131	524								0.0000		
132	528			33.60					0.3360	0.3470	5.5520
133	532								0.0000		
134	536	1.192	2.87			1.244	2.83		0.0000		
135	540								0.0000		
136	544			35.80					0.3580	0.3620	14.4800
137	548								0.0000		
138	552	1.179	2.90			1.202	2.88		0.0000		
139	556								0.0000		
140	560				758			590	0.0000		
141	564								0.0000		
142	568	1.189	2.88			1.192	2.89		0.0000		
143	572								0.0000		
144	576								0.0000		
145	580								0.0000		
146	584	1.170	2.92	36.60		1.215	2.86		0.3660	0.3845	9.2280
147	588								0.0000		
148	592								0.0000		
149	596								0.0000		
150	600	1.159	2.93		706	1.185	2.92	636	0.0000		
151	604								0.0000		
152	608			40.30					0.4030	0.4140	9.9360
153	612								0.0000		
154	616	1.135	2.96			1.156	2.94		0.0000		
155	620								0.0000		
156	624								0.0000		
157	628								0.0000		
158	632	1.115	2.99	42.50		1.150	2.95		0.4250	0.4330	10.3920
159	636								0.0000		
160	640				848			702	0.0000		
161	644								0.0000		
162	648	1.085	3.02			1.128	3.04		0.0000		
163	652								0.0000		
164	656			44.10					0.4410	0.4515	10.8360
165	660								0.0000		
166	664	1.106	3.04			1.112	3.07		0.0000		
167	668								0.0000		
168	672								0.0000		
169	676								0.0000		
170	680	1.093	3.06	46.20	810	1.11	3.11	610	0.4620	0.4710	11.3040
171	684								0.0000		
172	688								0.0000		
173	692								0.0000		
174	696	1.077	3.08			1.101	3.13		0.0000		
175	700								0.0000		
176	704			48.00					0.4800	0.4885	11.7240
177	708								0.0000		

RAW WATER: INFLUENT NI = 100 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO NO. IN/NI. OUT		
		CONDUCT (ms/cm.)	pH	NIKEI (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
178	712	1.087	3.08			1.084	3.14		0.0000		
179	716								0.0000		
180	720				920			735	0.0000		
181	724								0.0000		
182	728	1.048	3.12	49.70		1.066	3.15		0.4970	0.5050	12.1200
183	732								0.0000		
184	736								0.0000		
185	740								0.0000		
186	744	1.039	3.16			1.078	3.14		0.0000		
187	748								0.0000		
188	752			51.30					0.5130	0.4895	11.7480
189	756								0.0000		
190	760	1.031	3.19		970	1.048	3.18	792	0.0000		
191	764								0.0000		
192	768								0.0000		
193	772								0.0000		
194	776	1.056	3.15	46.60		1.040	3.20		0.4660	0.4930	11.8320
195	780								0.0000		
196	784								0.0000		
197	788								0.0000		
198	792	1.045	3.17			1.061	3.19		0.0000		
199	796								0.0000		
200	800			52.00	1030			860	0.5200	0.5190	12.4560
201	804								0.0000		
202	808	1.035	3.22			1.054	3.18		0.0000		
203	812								0.0000		
204	816								0.0000		
205	820								0.0000		
206	824	1.022	3.25	51.80		1.038	3.24		0.5180	0.5530	22.1200
207	828								0.0000		
208	832								0.0000		
209	836								0.0000		
210	840	1.009	3.30		980	1.028	3.27	820	0.0000		
211	844								0.0000		
212	848								0.0000		
213	852								0.0000		
214	856	1.002	3.33			1.018	3.29		0.0000		
215	860								0.0000		
216	864			58.80					0.5880	0.5930	14.2320
217	868								0.0000		
218	872	0.988	3.40			0.998	3.34		0.0000		
219	876								0.0000		
220	880				1040			890	0.0000		
221	884								0.0000		
222	888	0.966	3.44	59.80		0.990	3.37		0.5980	0.6040	14.4960
223	892								0.0000		
224	896								0.0000		
225	900								0.0000		
226	904	0.957	3.49			0.973	3.43		0.0000		
227	908								0.0000		
228	912			61.00					0.6100	0.6155	14.7720
229	916								0.0000		
230	920	0.944	3.56		1202	0.959	3.48	1062	0.0000		
231	924								0.0000		
232	928								0.0000		
233	932								0.0000		
234	936	0.933	3.63	62.10		0.954	3.51		0.6210	0.6360	15.2640
235	940								0.0000		
236	944								0.0000		

RAW WATER: INFLUENT NI = 100 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO NI IN/ NI OUT		
		CONDUCT. (mc/cm.)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (mc/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
237	948								0.0000		
238	952	0.887	3.88			0.950	3.61		0.0000		
239	956								0.0000		
240	960			65.10	1070			941	0.6510	0.6545	15.7080
241	964								0.0000		
242	968	0.869	4.16			0.913	3.74		0.0000		
243	972								0.0000		
244	976								0.0000		
245	980								0.0000		
246	984	0.910	3.80	65.80		0.913	3.74		0.6580	0.6570	15.7680
247	988								0.0000		
248	992								0.0000		
249	996								0.0000		
250	1000	0.892	3.85		1284	0.892	3.86	1184	0.0000		
251	1004								0.0000		
252	1008			65.60					0.6560	0.6705	16.0920
253	1012								0.0000		
254	1016	0.892	4.00			0.892	3.86		0.0000		
255	1020								0.0000		
256	1024								0.0000		
257	1028								0.0000		
258	1032	0.886	4.21	68.50		0.894	3.83		0.6850	0.6930	16.6320
259	1036								0.0000		
260	1040				1347			1227	0.0000		
261	1044								0.0000		
262	1048	0.897	3.98			0.899	3.99		0.0000		
263	1052								0.0000		
264	1056			70.10					0.7010	0.7130	17.1120
265	1060								0.0000		
266	1064	0.874	4.30			0.875	4.50		0.0000		
267	1068								0.0000		
268	1072								0.0000		
269	1076								0.0000		
270	1080	0.870	4.60	72.50	1345	0.871	4.70	1235	0.7250	0.7420	17.8080
271	1084								0.0000		
272	1088								0.0000		
273	1092								0.0000		
274	1096	0.860	4.90			0.860	5.10		0.0000		
275	1100								0.0000		
276	1104			75.90					0.7590	0.7710	18.5040
277	1108								0.0000		
278	1112	0.857	5.10			0.860	5.12		0.0000		
279	1116								0.0000		
280	1120				1212			1118	0.0000		
281	1124								0.0000		
282	1128	0.859	4.80	78.30		0.861	4.72		0.7830	0.7975	19.1400
283	1132								0.0000		
284	1136								0.0000		
285	1140								0.0000		
286	1144	0.865	4.95			0.865	4.87		0.0000		
287	1148								0.0000		
288	1152			81.20					0.8120	0.8330	19.9920
289	1156								0.0000		
290	1160	0.853	5.11		1256	0.856	5.10	1173	0.0000		
291	1164								0.0000		
292	1168								0.0000		
293	1172								0.0000		
294	1176	0.869	5.09	85.40		0.871	4.95		0.8540	0.8675	20.8200
295	1180								0.0000		

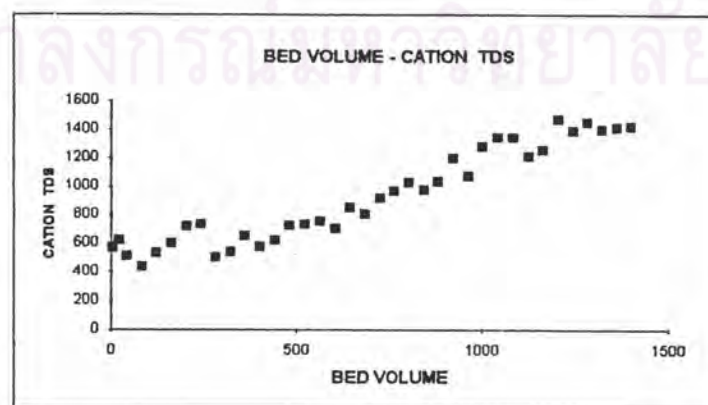
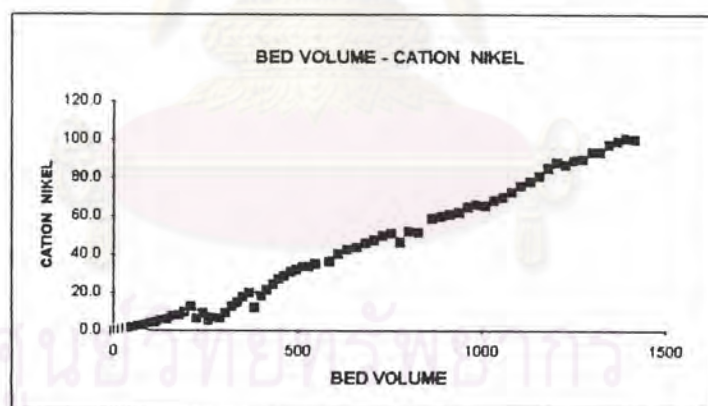
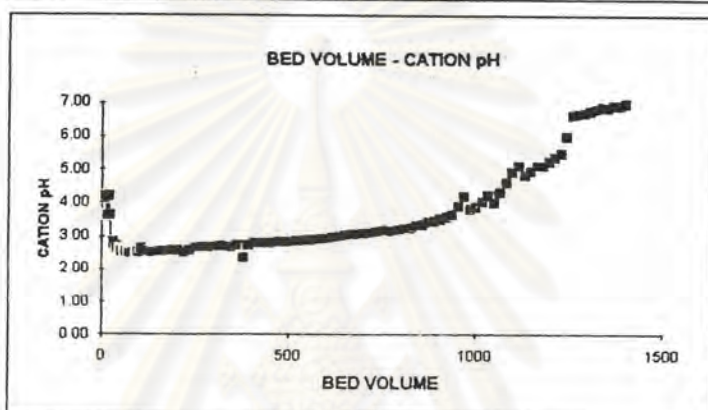
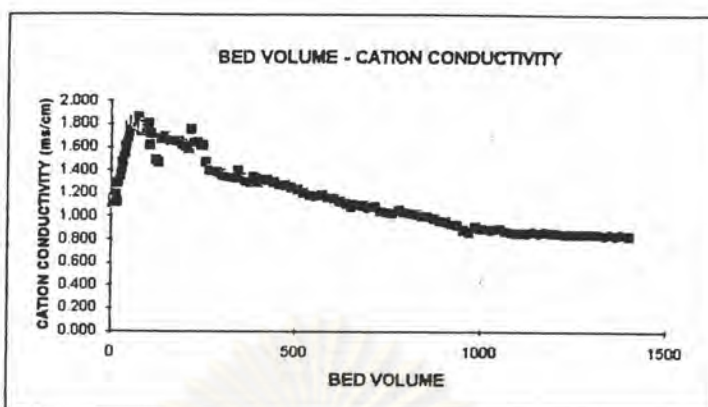
RAW WATER: INFLUENT NI = 100 mg/l & OTHER											
SERVICE FLOWRATE = 20 BV/hr											
RESIN TYPE : IMMINODIACETIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO NI:IN/NL:OUT		
		CONDUCT. (ms/cm.)	pH	NIKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
296	1184								0.0000		
297	1188								0.0000		
298	1192	0.857	5.23			0.859	4.80		0.0000		
299	1196								0.0000		
300	1200			88.10	1474			1424	0.8810	0.9770	21.0480
301	1204								0.0000		
302	1208	0.855	5.37			0.857	5.12		0.0000		
303	1212								0.0000		
304	1216								0.0000		
305	1220								0.0000		
306	1224	0.851	5.49	87.30		0.85	5.27		0.8730	0.8825	21.1800
307	1228								0.0000		
308	1232								0.0000		
309	1236								0.0000		
310	1240	0.850	6.01		1394	0.854	5.24	1366	0.0000		
311	1244								0.0000		
312	1248			89.20					0.8920	0.8965	21.5160
313	1252								0.0000		
314	1256	0.849	6.63			0.851	5.49		0.0000		
315	1260								0.0000		
316	1264								0.0000		
317	1268								0.0000		
318	1272	0.848	6.68	90.10		0.852	5.78		0.9010	0.9210	22.1040
319	1276								0.0000		
320	1280				1453			1428	0.0000		
321	1284								0.0000		
322	1288	0.847	6.71			0.850	5.93		0.0000		
323	1292								0.0000		
324	1296			94.10					0.9410	0.9390	22.5360
325	1300								0.0000		
326	1304	0.843	6.77			0.846	5.98		0.0000		
327	1308								0.0000		
328	1312								0.0000		
329	1316								0.0000		
330	1320	0.845	6.84	93.70	1399	0.85	6.04	1411	0.9370	0.9575	22.9800
331	1324								0.0000		
332	1328								0.0000		
333	1332								0.0000		
334	1336	0.840	6.90			0.842	6.12		0.0000		
335	1340								0.0000		
336	1344			97.80					0.9780	0.9855	23.6520
337	1348								0.0000		
338	1352	0.846	6.87			0.849	6.22		0.0000		
339	1356								0.0000		
340	1360				1412			1408	0.0000		
341	1364								0.0000		
342	1368	0.837	6.94	99.30		0.840	6.18		0.9930	1.0025	24.0600
343	1372								0.0000		
344	1376								0.0000		
345	1380								0.0000		
346	1384	0.849	6.92			0.852	6.14		0.0000		
347	1388								0.0000		
348	1392			101.20					1.0120	1.0085	24.2040
349	1396								0.0000		
350	1400	0.842	6.98		1420	0.845	6.15	1425	0.0000		
351	1404								0.0000		
352	1408								0.0000		
353	1412								0.0000		
354	1416			100.50					1.0050	1.0050	24.1200

RAW WATER: INFLUENT NI = 100 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC ACID FUNCTIONAL GROUP: Service after regen with sulfuric acid 3% flowrate 4.5 BV/hr											
SAMPLE No.	BED VOLUME (BV.)	CATION				ANION			RATIO NI. IN/NI. OUT		
		CONDUCT. (ms/cm.)	pH	NICKEL (mg/l)	TDS (mg/l)	CONDUCTIVITY (ms/cm.)	pH	TDS (mg/l)	VALUE	AVERAGE	TOTAL
										SUM(RATIO OF NI. IN TO NI. OUT TOTAL)	685.47
										TOTAL EXCHANGE NICKEL (mg /l.resin)	73053.20

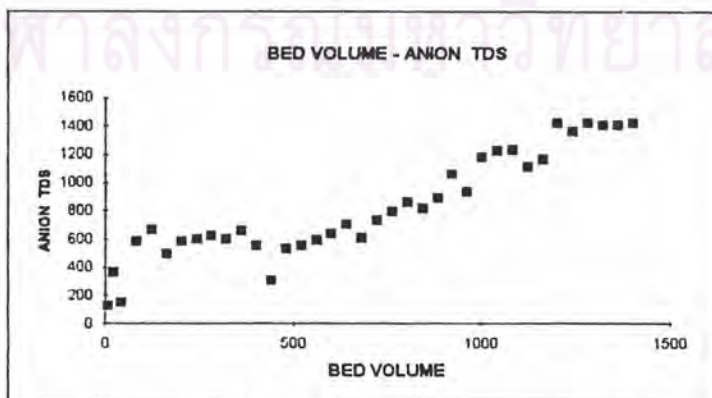
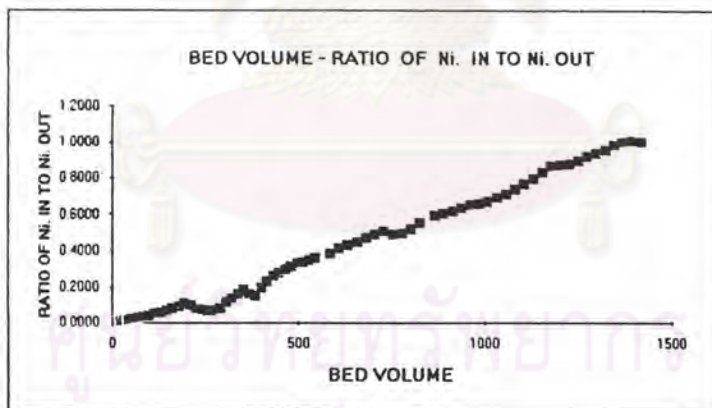
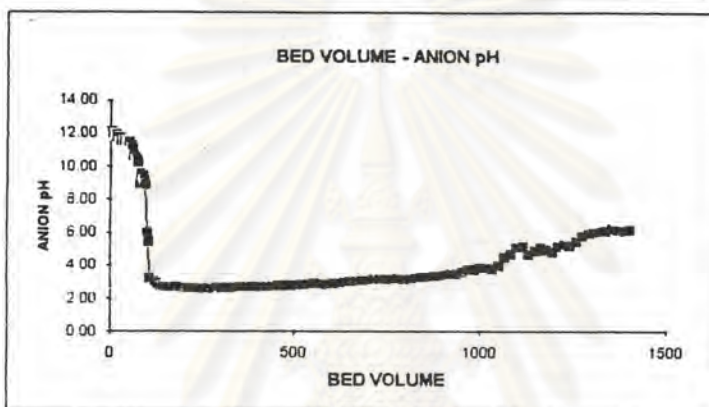
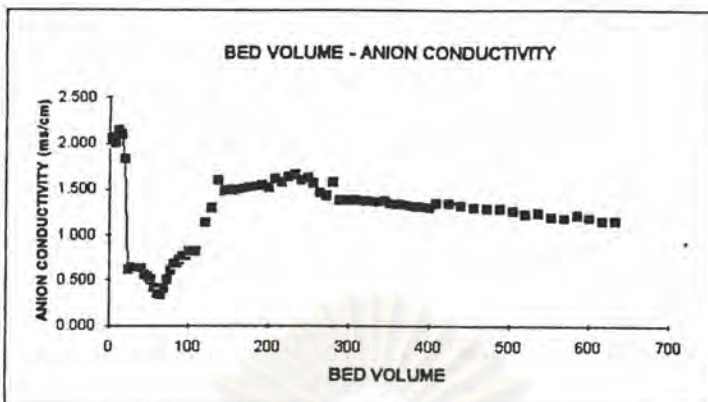


ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

5-R2.XLS



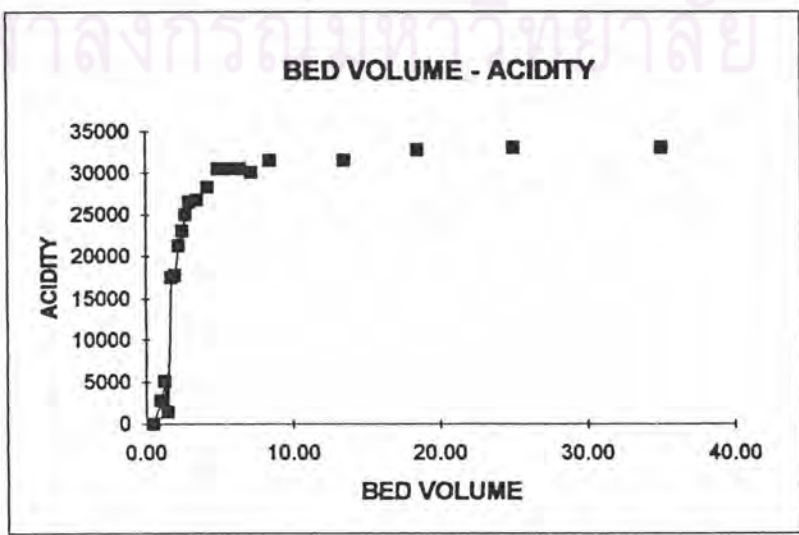
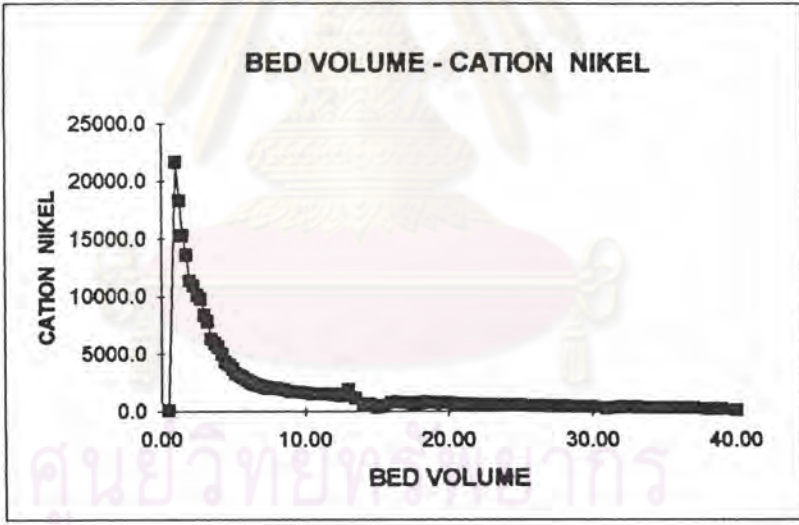
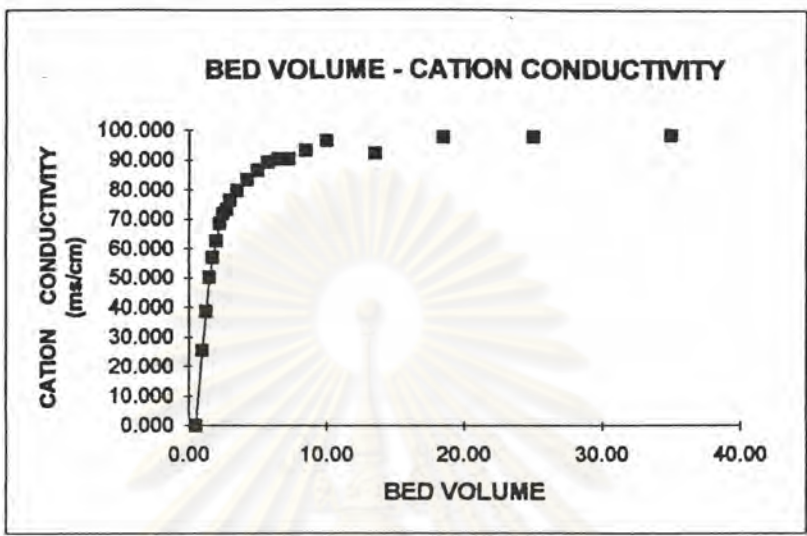
5-R2.XLS



REGENERATION WITH SULFURIC ACID 3%							
ACID INTRODUCE FLOWRATE 4.5 BV./hr							
SERVICE INFLUENT NI .300 mg/l ONLY ; RESIN TYPE : SULFONIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.50	0.004	0	87.1	21.78	21.78	43.55
2	1.00	25.500	2750	21640.0	8115.00	8136.78	8136.78
3	1.25	38.500	5125	18360.0	4590.00	12726.78	10181.42
4	1.50	50.100	1420	15290.0	3822.50	16549.28	11032.85
5	1.75	57.000	17500	13640.0	3410.00	18549.28	9456.73
6	2.00	62.600	17750	11360.0	2845.00	19959.28	9979.64
7	2.25	68.500	21250	10920.0	2730.00	19394.28	8619.68
8	2.50	72.000	23000	10080.0	2520.00	21914.28	8765.71
9	2.75	73.400	25000	9750.0	2437.50	24351.78	8855.19
10	3.00	76.400	26530	8390.0	2097.50	26449.28	8816.43
11	3.25			7820.0	1955.00	28404.28	8739.78
12	3.50	79.600	26750	6320.0	1580.00	29984.28	8566.94
13	3.75			5910.0	1477.50	31461.78	8389.81
14	4.00			5590.0	1397.50	32859.28	8214.82
15	4.25	83.300	28250	4975.0	1243.75	34103.03	8024.24
16	4.50			4270.0	1067.50	35170.53	7815.67
17	4.75			4055.0	1013.75	36184.28	7617.74
18	5.00	86.600	30500	3695.0	923.75	37108.03	7421.61
19	5.25			3275.0	818.75	37926.78	7224.15
20	5.50			3105.0	776.25	38703.03	7036.91
21	5.75	89.200	30500	2930.0	732.50	39435.53	6856.35
22	6.00			2700.0	675.00	40110.53	6685.09
23	6.25			2552.0	638.00	40748.53	6519.76
24	6.50	90.300	30500	2376.0	594.00	41342.53	6360.39
25	6.75			2296.0	574.00	41916.53	6208.86
26	7.00			2200.0	550.00	42466.53	6066.65
27	7.25	90.400	30000	2112.0	528.00	42994.53	5930.28
28	7.50			2048.0	512.00	43506.53	5800.87
29	8.00			2048.0	512.00	44018.53	5502.32
30	8.50	93.200	31500	1908.0	477.00	44495.53	5234.77
31	9.00			1768.0	484.00	45379.53	5042.17
32	9.50			1688.0	444.00	46223.53	4865.63
33	10.00	96.500		1604.0	402.00	47025.53	4702.55
34	10.50			1528.0	384.00	47789.53	4551.38
36	11.00			1540.0	370.00	48559.53	4414.50
36	11.50			1500.0	350.00	49309.53	4287.78
37	12.00			1480.0	340.00	50049.53	4170.79
38	12.50			1396.0	328.00	50747.53	4059.80
38	13.00			1910.0	320.00	51702.53	3977.12
40	13.50	92.200	31500	1144.0	320.00	52274.53	3872.19
41	14.00			654.0	320.00	52801.53	3757.25
42	14.50			690.0	345.00	52946.53	3651.48

REGENERATION WITH SULFURIC ACID 3%							
ACID INTRODUCE FLOWRATE 4.5 BV./hr							
SERVICE INFLUENT NI .300 mg/l ONLY ; RESIN TYPE : SULFONIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME	CONDUCT. (mc/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
43	15.00			358.0	179.00	53125.53	3541.70
44	15.50			444.0	222.00	53347.53	3441.78
45	16.00			790.0	395.00	53742.53	3358.91
46	16.50			817.0	408.50	54151.03	3281.88
47	17.00			786.0	393.00	54544.03	3208.47
48	17.50			755.0	377.50	54921.53	3138.37
49	18.00			724.0	362.00	55283.53	3071.31
50	18.50	97.500	32750	817.0	408.50	55692.03	3010.38
51	19.00			775.0	387.50	56079.53	2951.55
52	19.50			728.0	364.00	56443.53	2894.54
53	20.00			783.0	391.50	56835.03	2841.75
54	20.50			695.0	347.50	57182.53	2789.39
55	21.00			676.0	338.00	57520.53	2739.07
56	21.50			701.0	350.50	57871.03	2691.68
57	22.00			610.0	305.00	58176.03	2644.36
58	23.00			581.0	290.50	58466.53	2542.02
59	24.00			567.0	283.50	58750.03	2447.92
60	25.00	97.600	33000	551.0	275.50	59025.53	2361.02
61	26.00			526.0	263.00	59298.53	2280.33
62	27.00			473.0	236.50	59525.03	2204.63
63	28.00			456.5	228.25	59753.28	2134.05
64	29.00			415.6	207.80	59961.08	2067.62
65	30.00			412.8	206.40	60167.48	2005.58
66	31.00			278.8	139.40	60306.88	1945.38
67	32.00			374.8	187.40	60494.28	1890.45
68	33.00			358.8	179.40	60673.68	1838.60
69	34.00			342.8	171.40	60845.08	1789.56
70	35.00	98.200	33000	322.8	161.40	61006.48	1743.04
71	36.00			310.4	155.20	61161.68	1698.94
72	37.00			304.0	152.00	61313.68	1657.13
73	38.00			244.0	122.00	61435.68	1616.73
74	39.00			224.0	112.00	61547.68	1578.15
75	40.00			140.0	70.00	61617.68	1540.44

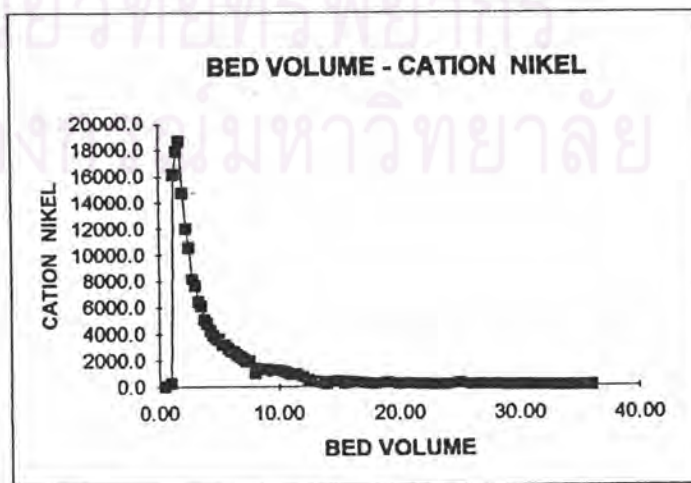
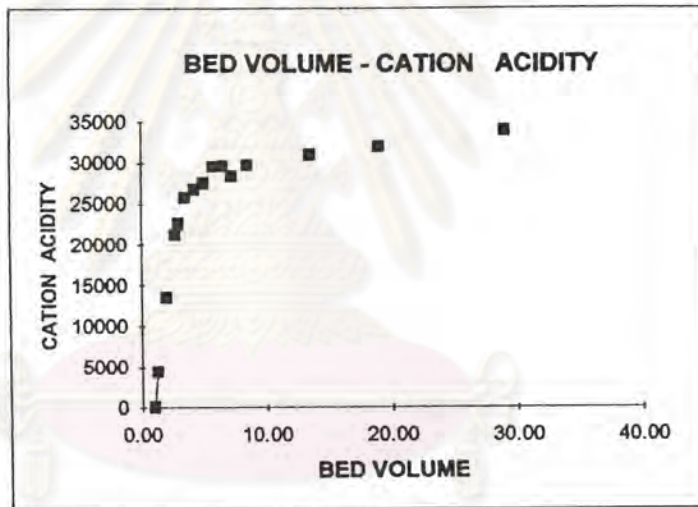
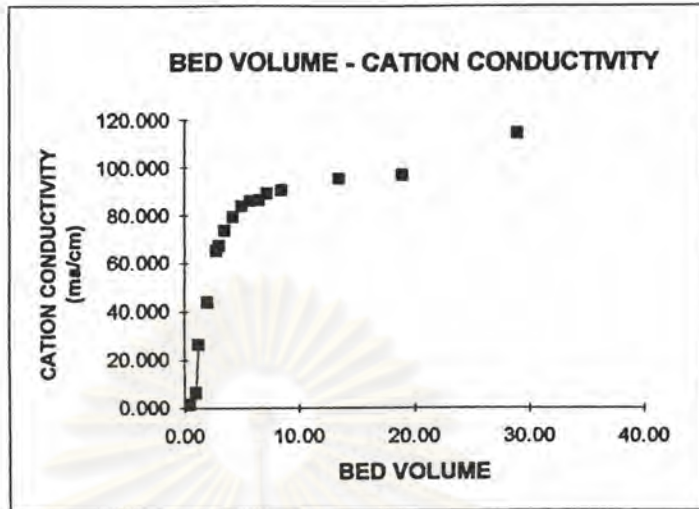
R1-1.XLS



REGENERATION WITH SULFURIC ACID 3%							
ACID INTRODUCE FLOWRATE 4.5 BV. Hr							
SERVICE INFLUENT Ni 200 mg/l ONLY ; RESIN TYPE : SULFONIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.50	1.400		2.0	1.00	1.00	2.00
2	1.00	6.200	76	250.0	93.75	94.75	94.75
3	1.25	26.400	4506	16160.0	4040.00	4134.75	3307.80
4	1.50			17920.0	4480.00	8614.75	5743.17
5	1.75			18680.0	4670.00	13284.75	7591.29
6	2.00	44.000	13550	14760.0	3690.00	16974.75	8487.38
7	2.25			12020.0	3005.00	19979.75	8879.89
8	2.50			10580.0	2645.00	22624.75	9049.90
9	2.75	65.200	21250	8160.0	2040.00	24664.75	8969.00
10	3.00	87.200	22625	7850.0	1912.50	26577.25	8859.08
11	3.25			6450.0	1612.50	28189.75	8673.77
12	3.50	73.600	25750	6100.0	1525.00	29714.75	8489.93
13	3.75			5050.0	1262.50	30977.25	8260.60
14	4.00			4800.0	1200.00	32177.25	8044.31
15	4.25	79.300	26750	4280.0	1070.00	33247.25	7822.88
16	4.50			3910.0	977.50	34224.75	7605.50
17	4.75			3650.0	912.50	35137.25	7397.32
18	5.00	84.000	27500	3575.0	893.75	36031.00	7206.20
19	5.25			3235.0	808.75	36839.75	7017.10
20	5.50			3164.0	791.00	37630.75	6841.96
21	5.75	86.100	29500	2920.0	730.00	38360.75	6671.43
22	6.00			2704.0	676.00	39036.75	6506.13
23	6.25			2654.0	666.00	39702.75	6352.44
24	6.50	86.700	29600	2424.0	606.00	40308.75	6201.35
25	6.75			2252.0	563.00	40871.75	6055.07
26	7.00			2116.0	529.00	41400.75	5914.39
27	7.25	89.200	28350	1940.0	485.00	41885.75	5777.34
28	7.50			1936.0	479.00	42611.75	5681.57
29	8.00			1040.0	1352.00	43963.75	5495.47
30	8.50	90.700	29750	1380.0	1332.00	45295.75	5328.91
31	9.00			1340.0	1212.00	46507.75	5167.53
32	9.50			1228.0	1128.00	47633.75	5014.08
33	10.00			1274.0	1058.00	48691.75	4869.18
34	10.50			1140.0	970.00	49661.75	4729.69
35	11.00			982.0	988.00	50629.75	4602.70
36	11.50			974.0	520.00	51149.75	4447.80
37	12.00			780.0	690.00	51839.75	4319.98
38	12.50			528.0	670.00	52509.75	4200.78
39	13.00			414.0	613.00	53122.75	4086.37
40	13.50	95.500	31000	338.0	637.00	53759.75	3982.20
41	14.00			216.0	570.00	54329.75	3880.70
42	14.50			378.0	481.00	54810.75	3780.05

REGENERATION WITH SULFURIC ACID 3%							
ACID INTRODUCE FLOWRATE 4.6 BV./hr							
SERVICE INFLUENT NI 200 mg/l ONLY ; RESIN TYPE : SULFONIC FUNCTIONAL GROUP							
SAMPLE No.	SED VOLUME (BV.)	CONDUCT. (mS/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
43	15.00			427.0	487.00	55297.75	3886.52
44	15.50			241.0	390.00	55687.75	3592.78
45	16.00			359.0	264.00	55951.75	3496.98
46	16.50			340.0	207.00	56158.75	3403.56
47	17.00			291.0	169.00	56327.75	3313.40
48	17.50			260.0	108.00	56435.75	3224.90
49	18.00			210.0	282.00	56717.75	3150.99
50	19.00	97.400	32000	285.0	285.00	57002.75	3000.14
51	20.00			191.5	191.50	57194.25	2859.71
52	21.00			192.0	192.00	57386.25	2732.68
53	22.00			172.0	172.00	57558.25	2616.28
54	23.00			146.5	146.50	57704.75	2508.90
55	24.00			136.0	136.00	57840.75	2410.03
56	25.00			246.0	246.00	58086.75	2323.47
57	26.00			129.0	129.00	58215.75	2239.07
58	27.00			119.0	119.00	58334.75	2160.55
59	28.00			143.6	143.60	58478.35	2088.51
60	29.00	114.500	34000	97.0	97.00	58575.35	2019.84
61	30.00			92.0	92.00	58667.35	1955.58
62	31.00			81.0	81.00	58748.35	1895.11
63	32.00			76.0	76.00	58824.35	1838.26
64	33.00			65.0	65.00	58889.35	1784.53
65	34.00			56.0	56.00	58945.35	1733.69
66	35.00			61.0	61.00	59006.35	1685.90
67	36.00			50.0	50.00	59056.35	1640.45

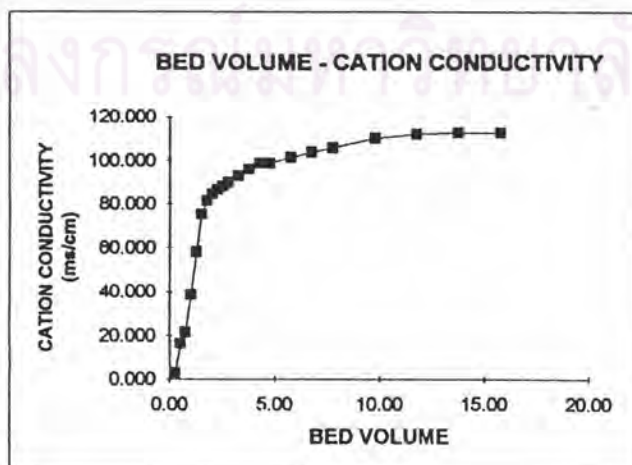
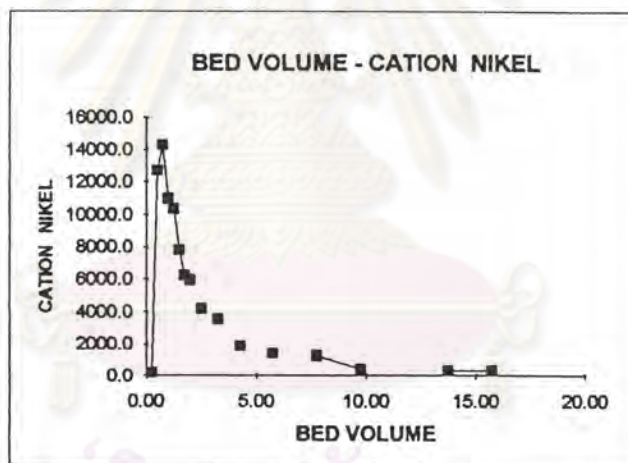
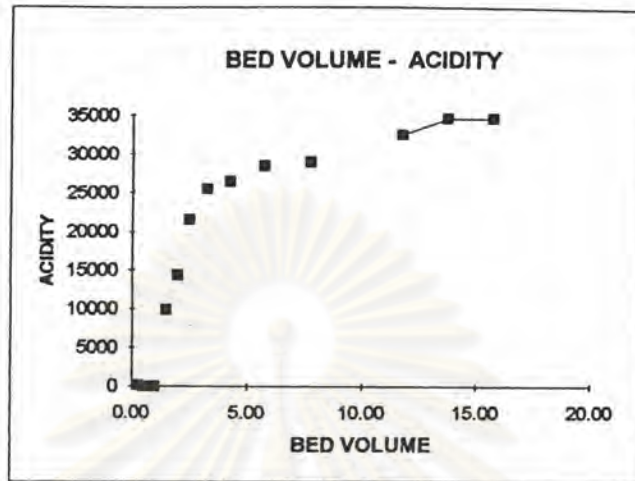
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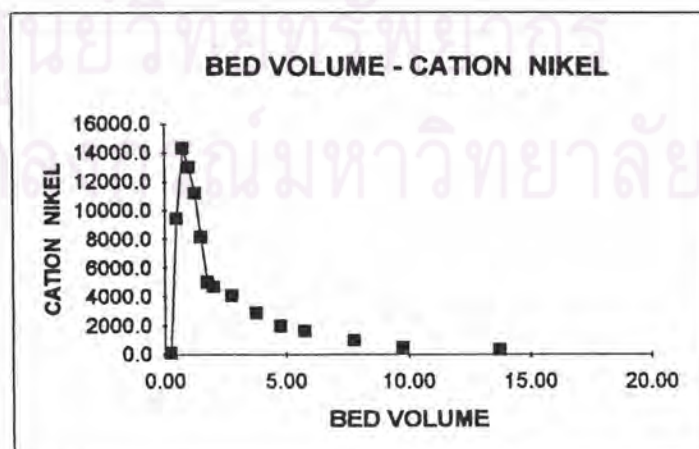
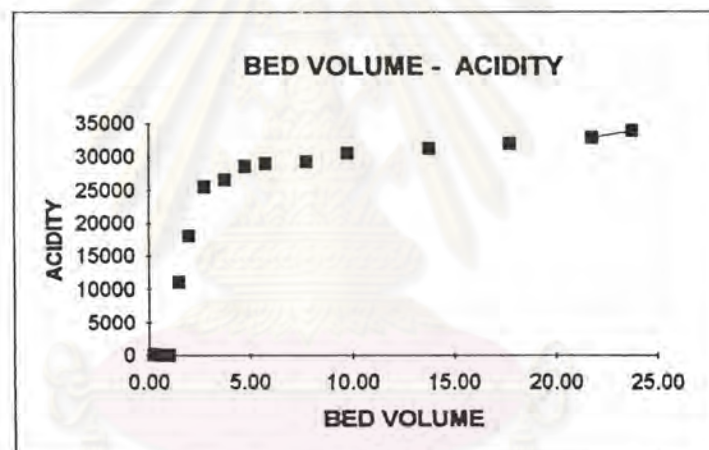
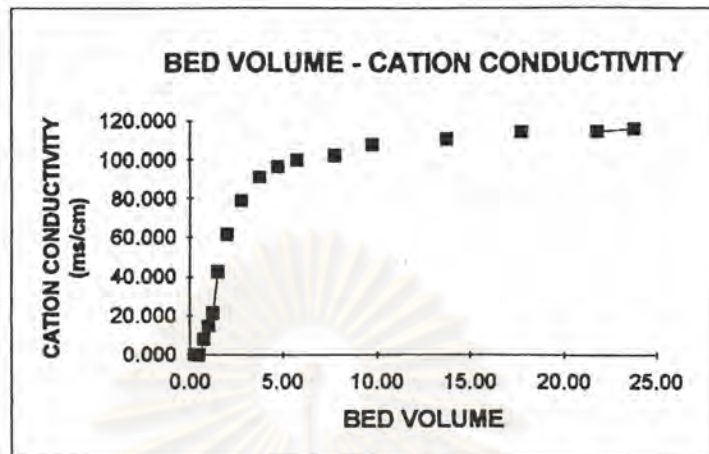
REGENERATION WITH SULFURIC ACID 3%							
ACID INTRODUCE FLOWRATE 4.5 BV./Hr							
SERVICE INFLUENT Ni .300 mg/l & OTHERS ; RESIN TYPE : SULFONIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI CONC. x BED VOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	2.720	140	220.0	55.00	55.00	220.00
2	0.50	16.400	0	12700.0	3175.00	3230.00	6480.00
3	0.75	21.300	0	14300.0	3575.00	6805.00	9073.33
4	1.00	38.400	0	10975.0	2743.75	9548.75	9548.75
5	1.25	58.000		10360.0	2590.00	12138.75	9711.00
6	1.50	75.100	9870	7800.0	1950.00	14088.75	9392.50
7	1.75	81.400		6235.0	1558.75	15647.50	8941.43
8	2.00	84.500	14325	5935.0	1483.75	17131.25	8565.63
9	2.25	86.600					
10	2.50	88.100	21500	4180.0	2612.50	19743.75	7897.50
11	2.75	89.800					
12	3.25	92.700	25500	3527.0	3086.13	22829.88	7024.58
13	3.75	95.800					
14	4.25	98.700	26500	1865.0	2331.25	25161.13	5920.26
15	4.75	98.900					
16	5.75	101.500	28500	1427.0	2497.25	27658.38	4810.15
17	6.75	103.900					
18	7.75	105.700	28950	1245.0	2490.00	30148.38	3890.11
19	9.75	110.200		440.0	1320.00	31468.38	3227.53
20	11.75	112.000	32500				
21	13.75	112.800	34500	343.0	1029.00	32497.38	2363.45
22	15.75	112.800	34500	340.0	1020.00	33517.38	2128.09

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R1-3.XLS



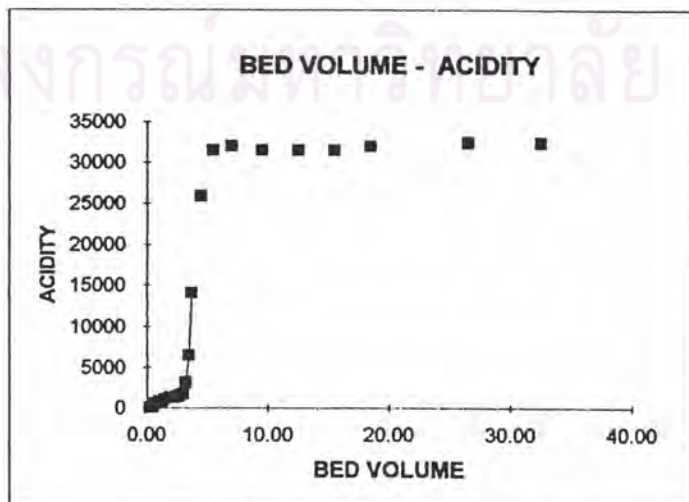
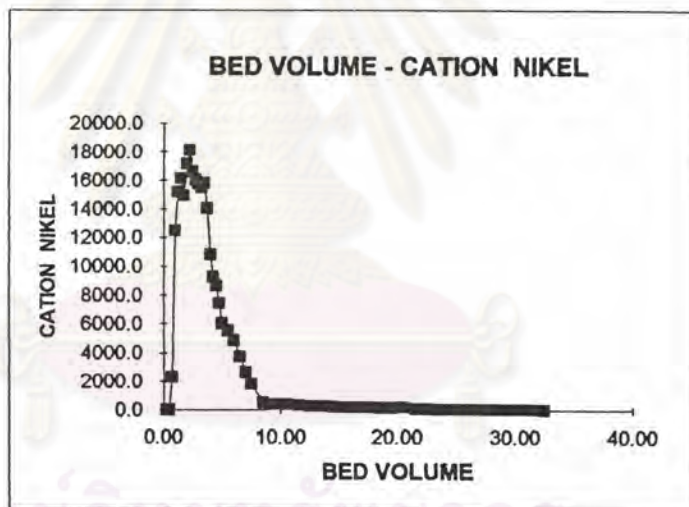
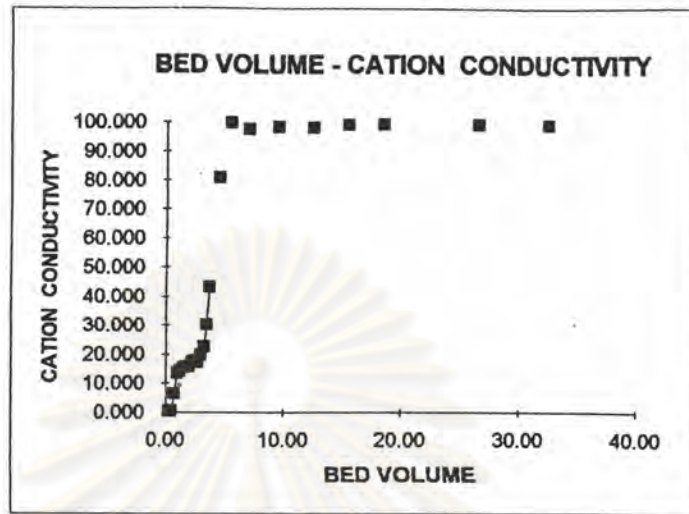
R14.XLS



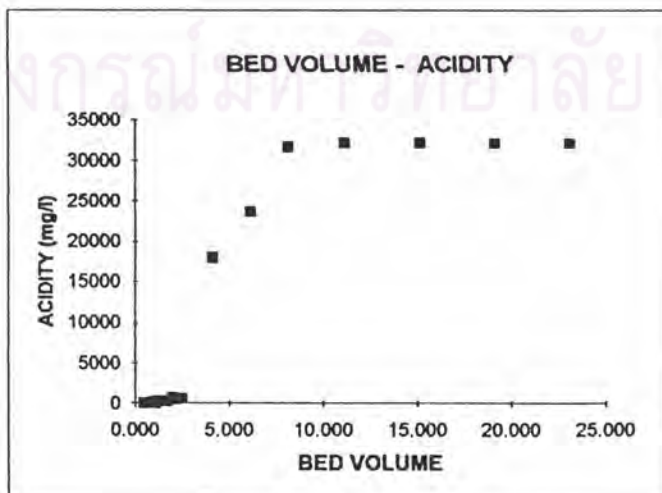
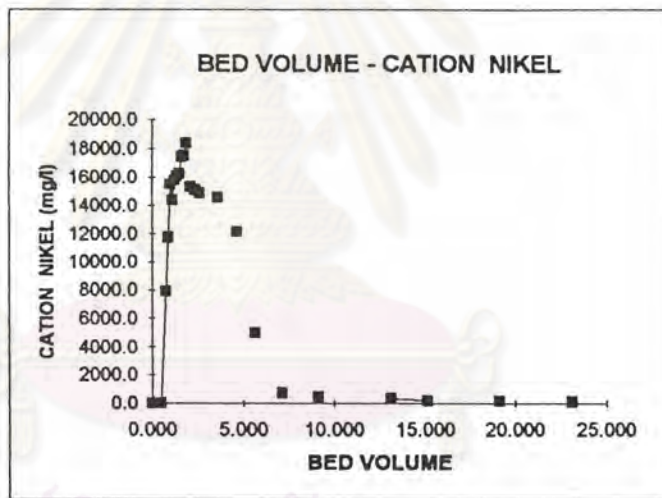
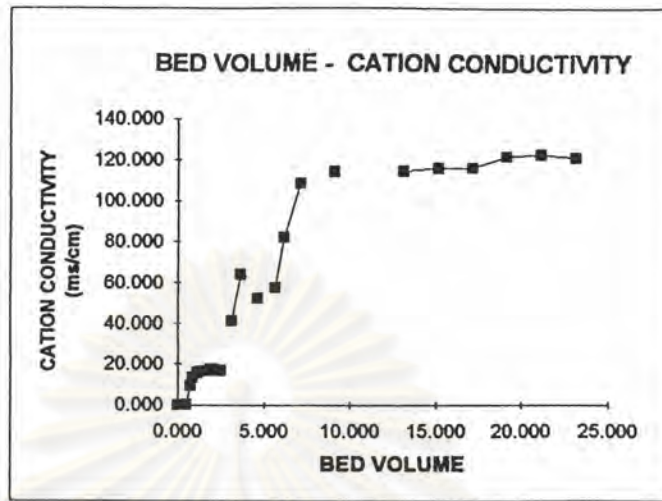
REGENERATION WITH SULFURIC ACID 3%							
ACID INTRODUCE FLOWRATE 4.6 BV./Hr							
SERVICE INFLUENT NI .300 mg/l ONLY ; RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (mc/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	0.530	0	1.6	0.40	0.40	1.60
2	0.50	0.630	100	1.2	0.30	0.70	1.40
3	0.75	6.590	500	2285.0	571.25	571.95	762.60
4	1.00	13.500	800	12500.0	3125.00	3696.95	3696.95
5	1.25	14.500	875	15200.0	3800.00	7496.95	5997.56
6	1.50	15.390	1050	16150.0	4037.50	11534.45	7689.63
7	1.75	15.720	1200	15000.0	3750.00	15284.45	8733.97
8	2.00	15.950	1275	17200.0	4300.00	19584.45	9792.23
9	2.25	17.300	1250	18150.0	4537.50	24121.95	10720.87
10	2.50	17.900	1350	16650.0	4162.50	28284.45	11313.78
11	2.75	17.330	1550	16050.0	4012.50	32296.95	11744.35
12	3.00	19.740	1750	15800.0	3950.00	36246.95	12082.32
13	3.25	22.700	3100	15500.0	3875.00	40121.95	12346.22
14	3.50	30.200	6500	15850.0	3962.50	44084.45	12595.56
15	3.75	43.200	14125	14040.0	3510.00	47594.45	12691.85
16	4.00			10840.0	2710.00	50304.45	12576.11
17	4.25			9280.0	2320.00	52624.45	12382.22
18	4.50	80.900	25875	8650.0	2162.50	54786.95	12174.88
19	4.75			7450.0	1862.50	56649.45	11926.20
20	5.00			6030.0	2261.25	58910.70	11782.14
21	5.50	99.800	31500	5540.0	2770.00	61680.70	11214.67
22	6.00			4870.0	2435.00	64115.70	10685.95
23	6.50			3720.0	1860.00	65975.70	10150.11
24	7.00	97.600	32000	2660.0	1330.00	67305.70	9615.10
25	7.50			1828.0	1371.00	68676.70	9156.89
26	8.50			538.0	538.00	69214.70	8142.91
27	9.50	98.300	31500	432.0	432.00	69646.70	7331.23
28	10.50			420.0	420.00	70066.70	6673.02
29	11.50			334.0	334.00	70400.70	6121.80
30	12.50	98.200	31500	282.0	282.00	70682.70	5654.62
31	13.50			254.0	254.00	70936.70	5254.57
32	14.50			241.0	241.00	71177.70	4908.81
33	15.50	99.300	31500	210.0	210.00	71387.70	4606.66
34	16.50			187.0	187.00	71574.70	4337.86
35	17.50			182.0	182.00	71756.70	4100.38
36	18.50	99.500	32000	164.0	164.00	71920.70	3887.61
37	19.50			151.0	151.00	72071.70	3695.98
38	20.50			205.0	205.00	72276.70	3525.69
39	21.50			81.0	81.00	72357.70	3365.47
40	22.50			64.5	64.50	72422.20	3218.76
41	23.50			58.5	58.50	72480.70	3084.29
42	24.50			53.0	53.00	72533.70	2960.56

REGENERATION WITH SULFURIC ACID 3%							
ACID INTRODUCE FLOWRATE 4.5 BV. /hr							
SERVICE INFLUENT NI .300 mg/l ONLY ; RESIN TYPE : IMMINOACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (mc/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
43	25.50			39.6	39.60	72573.30	2846.01
44	26.50	99.500	32500	39.9	139.65	72712.95	2743.88
45	27.50			53.0	53.00	72766.95	2646.03
46	28.50			40.2	40.20	72806.15	2554.60
47	29.50			40.5	141.75	72947.90	2472.81
48	30.50			53.0	53.00	73000.90	2393.47
49	31.50			40.8	40.80	73041.70	2318.78
50	32.50	99.300	32500	20.0	60.00	72772.95	2239.17

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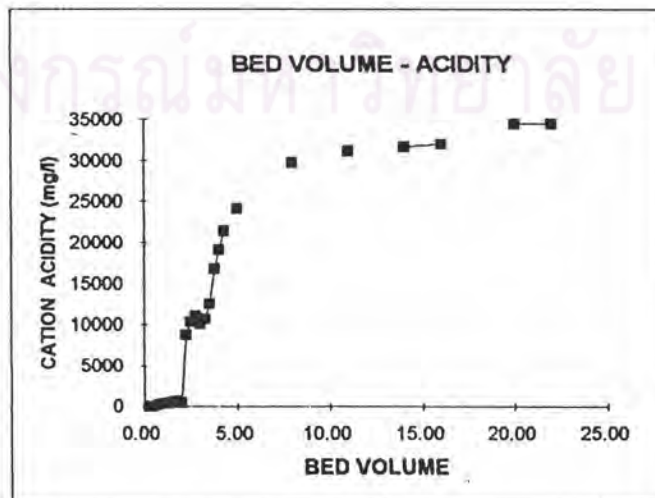
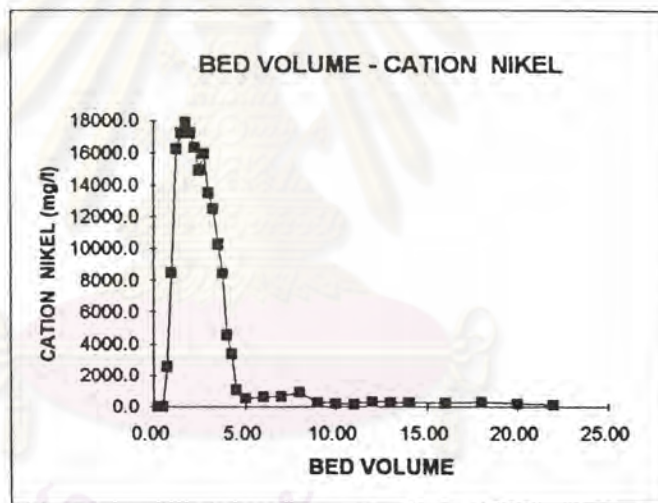
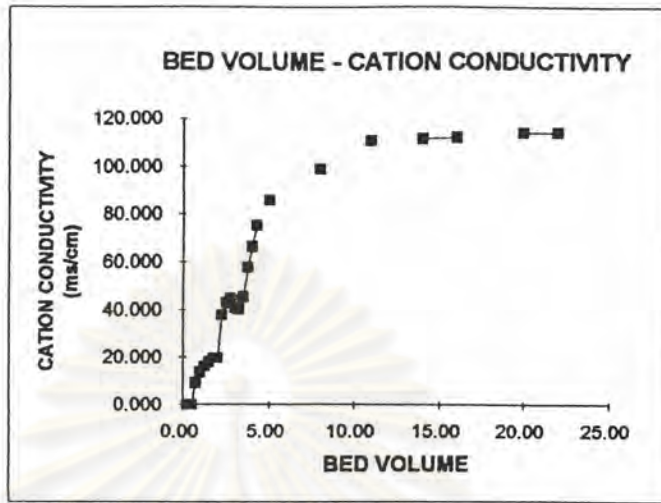
REGENERATION WITH SULFURIC ACID 3%							
ACID INTRODUCE FLOWRATE 4.5 BV. /hr							
SERVICE INFLUENT NI. 200 mg/l ONLY ; RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	SED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI CONC. x SEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.00	0.037		4.0	1.00	1.00	
2	0.50	0.158		45.0	16.88	17.88	35.75
3	0.75	9.600		7920.0	1485.00	1502.88	2003.83
4	0.88	13.360		11760.0	1470.00	2972.88	3397.57
5	1.00		180	15500.0	1937.50	4910.38	4910.38
6	1.13	15.920		14375.0	1796.88	6707.25	5962.00
7	1.25		310	15800.0	1975.00	8682.25	6945.80
8	1.38	16.260		16100.0	2012.50	10694.75	7778.00
9	1.50		300	16275.0	2034.38	12729.13	8486.08
10	1.63	16.670		17450.0	2181.25	14910.38	9175.62
11	1.75		310	17550.0	2193.75	17104.13	9773.79
12	1.88	17.290		18400.0	2300.00	19404.13	10348.87
13	2.00	17.270	734				
14	2.13			15325.0	3831.25	23235.38	10934.29
15	2.25	16.560	465				
16	2.38			15100.0	3775.00	27010.38	11372.79
17	2.50	16.920	625				
18	2.63			14875.0	9296.88	36307.25	13831.33
19	3.13	41.200					
20	3.63	64.200		14575.0	14575.00	50882.25	14038.48
21	4.13		18000				
22	4.63	52.400		12140.0	12140.00	63022.25	13626.43
23	5.13						
24	5.63	57.700		5000.0	6250.00	69272.25	12315.07
25	6.13	82.100	23666				
26	7.13	108.700		740.0	1295.00	70567.25	9904.18
27	8.13		31625				
28	9.13	114.200		458.0	1374.00	71941.25	7883.97
29	11.13		32166				
30	13.13	114.200		365.0	1095.00	73036.25	5564.67
31	15.13	115.900	32145	214.0	642.00	73678.25	4871.29
32	17.13	116.100					
33	19.13	121.900	32100	162.5	650.00	74328.25	3886.44
34	21.13	123.000					
35	23.13	121.500	32100	154.0	308.00	74636.25	3227.51



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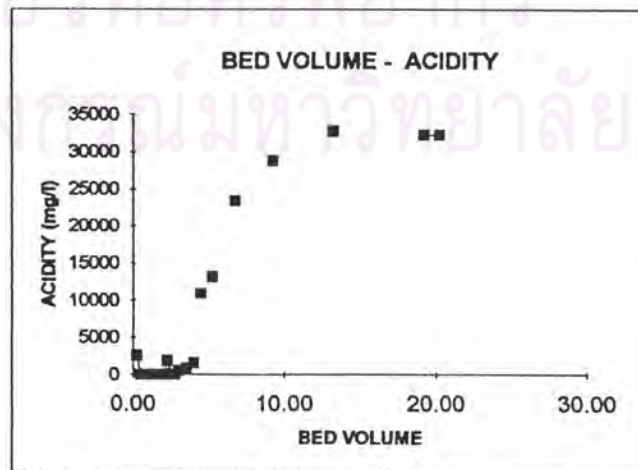
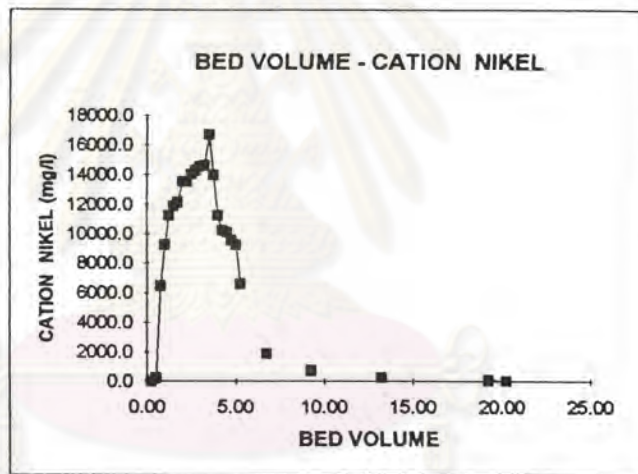
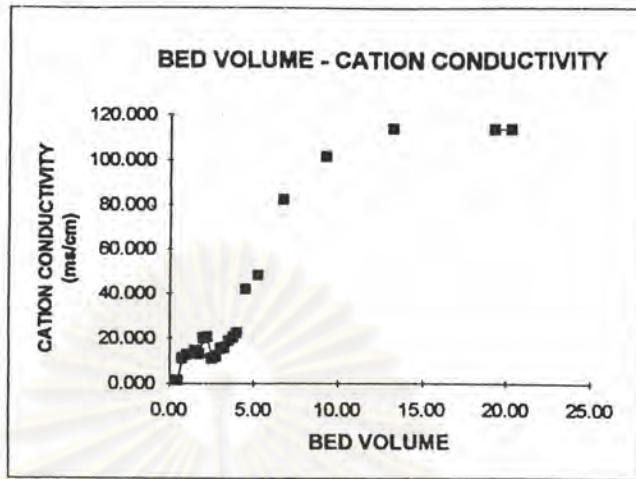
REGENERATION WITH SULFURIC ACID 3%							
ACID INTRODUCE FLOWRATE 4.5 BV./hr							
SERVICE INFLUENT NI. 300 mg/l & OTHERS ; RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	SED VOLUME (BV.)	CONDUCT. (ma/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI CONC. x BED VOLUME (mg/l.resin)	CUMULATIVE NICKEL (mg/l.resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	0.000	0	0.3	0.08	0.08	0.30
2	0.50	0.300	0	6.8	1.70	1.78	3.55
3	0.75	9.330	150	2550.0	637.50	639.28	852.37
4	1.00	13.830	300	8475.0	2118.75	2758.03	2758.03
5	1.25	18.160	350	18250.0	4062.50	6820.53	5456.42
6	1.50	17.960	500	18750.0	4687.50	11508.03	7672.02
7	1.75	19.480	680	19400.0	4850.00	16358.03	9347.44
8	2.00	19.750	450	20225.0	5056.25	21414.28	10707.14
9	2.25	38.000	8810	20125.0	5031.25	26445.53	11753.57
10	2.50	43.000	10400	19225.0	4806.25	31251.78	12500.71
11	2.75	45.000	11100	19750.0	4937.50	36189.28	13159.74
12	3.00	40.900	10100	17300.0	4325.00	40514.28	13504.76
13	3.25	40.400	10700	14775.0	3693.75	44208.03	13602.47
14	3.50	45.800	12500	13075.0	3268.75	47478.78	13564.79
15	3.75	57.900	16770	11350.0	2837.50	50314.28	13417.14
16	4.00	66.800	19112	8360.0	2090.00	52404.28	13101.07
17	4.25	75.500	21400	4860.0	1215.00	53619.28	12616.30
18	4.50			2555.0	638.75	54258.03	12057.34
19	5.00	86.100	24100	1520.0	760.00	55018.03	11003.61
20	6.00			1130.0	1130.00	56148.03	9358.00
21	7.00			655.0	655.00	56803.03	8114.72
22	8.00	99.300	29750	925.0	925.00	57728.03	7216.00
23	9.00			257.0	257.00	57985.03	6442.78
24	10.00			197.0	197.00	58182.03	5818.20
25	11.00	110.900	31200	181.0	181.00	58363.03	5305.73
26	12.00			322.0	322.00	58685.03	4890.42
27	13.00			253.0	253.00	58938.03	4533.69
28	14.00	111.900	31725	255.0	255.00	59193.03	4228.07
29	16.00	112.200	32000	-26.0	-52.00	59141.03	3696.31
30	18.00			82.0	164.00	59305.03	3294.72
31	20.00	113.700	34500	12.0	24.00	59329.03	2966.45
32	22.00	113.700	34500	20.0	40.00	59369.03	2698.59

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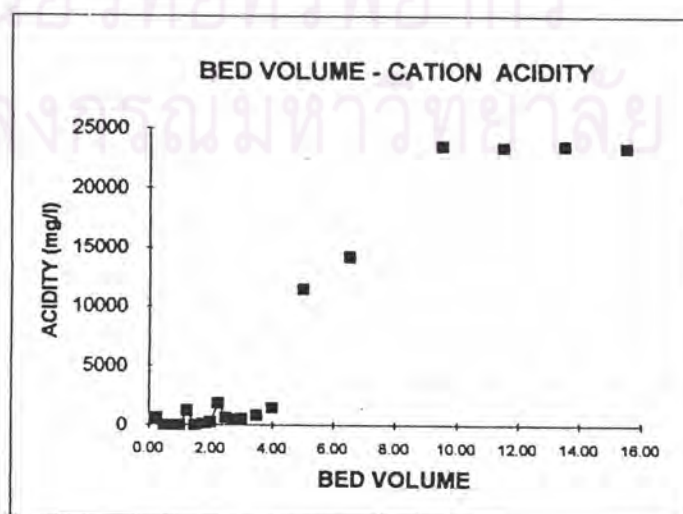
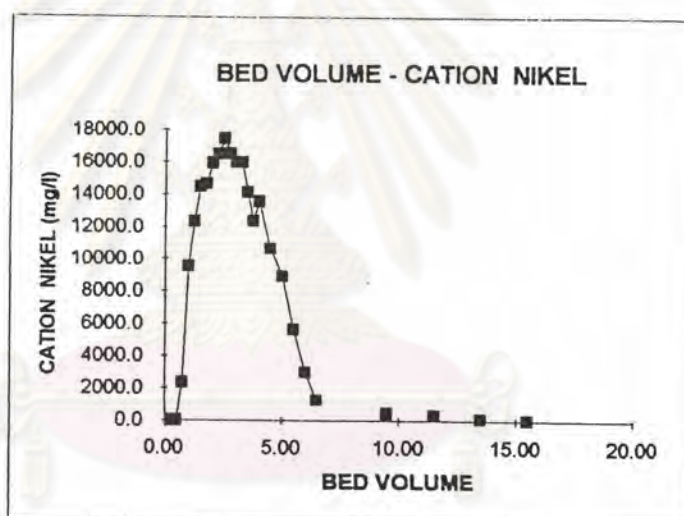
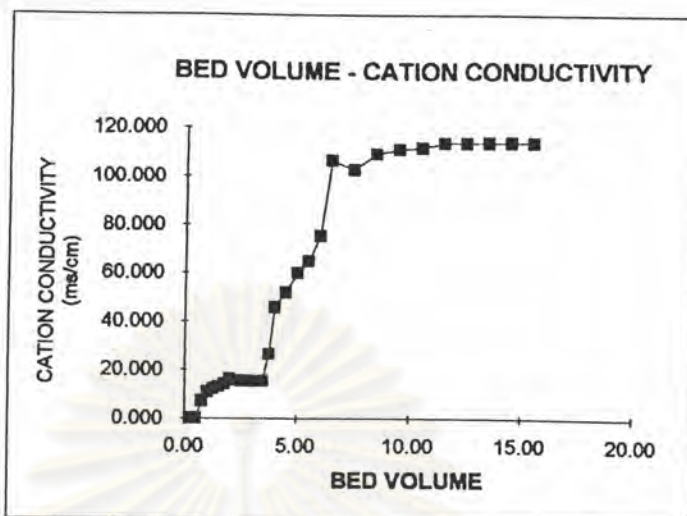
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จุฬาลงกรณ์มหาวิทยาลัย

REGENERATION WITH SULFURIC ACID 3%							
ACID INTRODUCE FLOWRATE 4.5 BV./Hr							
SERVICE INFLUENT NI. 200 mg/l & OTHERS ; RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI CONC. x BEDVOLUME (mg/l.resin)	CUMULATIVE NICKEL (mg/l.resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25		2610	17.2	4.30	4.30	17.20
2	0.50	1.470	0	224.0	56.00	60.30	120.60
3	0.75	11.110	0	6460.0	1615.00	1675.30	2233.73
4	1.00	12.630	0	9250.0	2312.50	3987.80	3987.80
5	1.25		0	11225.0	2806.25	6794.05	5435.24
6	1.50	14.230	0	11875.0	2968.75	9762.80	6608.53
7	1.75	12.850	0	12150.0	3037.50	12800.30	7314.46
8	2.00	19.970	0	13525.0	3381.25	16181.55	8090.78
9	2.25	20.700	1850	13550.0	3387.50	19569.05	8697.36
10	2.50	11.020	0	14050.0	3512.50	23081.55	9232.62
11	2.75	12.050	0	14275.0	3568.75	26650.30	9691.02
12	3.00	15.400	600	14525.0	3631.25	30281.55	10093.85
13	3.25	15.660		14600.0	3650.00	33931.55	10440.48
14	3.50	18.900	910	16725.0	4181.25	38112.80	10889.37
15	3.75	20.400		13950.0	3487.50	41600.30	11093.41
16	4.00	22.300	1575	11255.0	2813.75	44414.05	11103.51
17	4.25			10250.0	2562.50	46976.55	11053.31
18	4.50	42.000	10950	10100.0	2525.00	49501.55	11000.34
19	4.75			9560.0	2390.00	51891.55	10924.54
20	5.00			9230.0	2307.50	54199.05	10839.81
21	5.25	48.200	13100	6625.0	5796.88	59995.93	11427.80
22	5.75						
23	6.25						
24	6.75	82.000	23400	1870.0	4675.00	64670.93	9580.88
25	7.25						
26	8.25						
27	9.25	101.500	28750	720.0	2700.00	67370.93	7283.34
28	10.25						
29	11.25						
30	13.25	114.200	32750	260.0	520.00	67890.93	5123.84
31	15.25						
32	17.25						
33	19.25	114.100	32250	97.5	390.00	68280.93	3547.06
34	20.25	114.300	32250	64.8	129.50	68410.43	3378.29



REGENERATION WITH SULFURIC ACID 3%							
ACID INTRODUCE FLOWRATE 4.6 BV. /hr							
SERVICE INFLUENT NI. 100 mg/l & OTHERS ; RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	SED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI CONC. x BED VOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	0.072	610	5.4	1.35	1.35	5.40
2	0.50	0.182	0	15.8	3.95	5.30	10.60
3	0.75	7.070	0	2385.0	596.25	601.55	802.07
4	1.00	10.790	0	9543.0	2385.75	2987.30	2987.30
5	1.25	12.180	1220	12320.0	3080.00	6067.30	4853.84
6	1.50	13.130	0	14500.0	3625.00	9442.30	6294.87
7	1.75	14.180	120	14675.0	3668.75	12861.05	7349.17
8	2.00	16.390	240	15925.0	3981.25	16842.30	8421.15
9	2.25	15.660	1850	16480.0	4120.00	20962.30	9316.58
10	2.50	15.140	650	17450.0	4362.50	25094.80	10037.92
11	2.75	15.600	420	18530.0	4132.50	29227.30	10828.11
12	3.00	15.150	500	15970.0	3992.50	33219.80	11073.27
13	3.25	15.290		15960.0	3990.00	37069.80	11403.02
14	3.50	15.550	820	14150.0	3537.50	40597.30	11599.23
15	3.75	26.500		12375.0	3093.75	43691.05	11650.95
16	4.00	45.630	1450	13565.0	5086.88	48777.93	12194.48
17	4.50	51.700		10660.0	5330.00	54107.93	12023.98
18	5.00	59.800	11480	8960.0	4480.00	58587.93	11717.59
19	5.50	64.700		5674.0	2837.00	61424.93	11168.17
20	6.00	75.000		3009.0	1504.50	62929.43	10488.24
21	6.50	106.500	14200	1298.0	2271.50	65200.93	10030.91
22	7.50	102.800					
23	8.50	109.600					
24	9.50	111.600	23500	459.0	459.00	65659.93	6911.57
25	10.50	112.500					
26	11.50	114.500	28750	349.5	699.00	66358.93	5770.34
27	12.50	114.500					
28	13.50	114.600	32150	120.0	240.00	66598.93	4933.25
29	14.50	114.600					
30	15.50	114.500	32100	50.0	100.00	66698.93	4303.16

R2-5.XLS





ภาคผนวก จ. ๑
ตารางแสดงข้อมูลการทดลองขั้นตอนการหาพารามิเตอร์ที่สำคัญ
ช่วงการรีเจนเนอเรชั่น

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

$$\bar{X}_n = \sum_{a=n}^{a=n+1} X_a / 2$$

9. RATIO Ni.IN/Ni. OUT TOTAL (Z_n) แสดงการรวมค่า RATIO Ni.IN/Ni. OUT ช่วงปริมาณน้ำเสียใด ๆ หรือพื้นที่ได้กราฟ RATIO Ni./Ni OUT บริเวณความแตกต่าง ปริมาตรระหว่างปริมาณน้ำเสียใดๆ BV_n กับปริมาณน้ำเสียก่อนหน้า BV_{n-1}

$$Z_n = \bar{X}_n * (BV_n - BV_{n-1})$$

10. ผลรวมค่า RATIO Ni.IN/Ni.OUT รวมจนถึงจุดอิมิตัว แสดงค่า

$$\sum_{n=1}^{n=nt} Z_n$$

โดย nt = จุดที่ความเข้มข้นเข้าระบบเท่ากับความเข้มข้นออกจากระบบ

11. ปริมาณนิกเกิดที่เรซินแลกเปลี่ยนได้จนถึงจุดอิมิตัว

$$\text{แสดงค่า} = (C_1 * BV_{nt}) - C_1 * \sum_{n=1}^{n=nt} Z_n \quad \text{หน่วย มก./ล. เรซิน}$$

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

รูปแบบแสดงข้อมูลในตารางผลการทดลอง การหาพารามิเตอร์ที่สำคัญช่วงการรีเจนเนอเรชัน
ในขั้นตอนการล้างด้วยกรด

SAMPLE No.	BED VOLUME (BV)	CATION CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	Ni CONC. (mg/l)	Ni CONC. x BEDVOLUME (mg/l.resin)	CUMULATIVE NICKEL (mg/l.resin)	CUMULATIVE Ni CONC. (mg/l)
1	2	3	4	5	6	7	8

- SAMPLE No. แสดงอันดับการเก็บตัวอย่างที่ปริมาตรน้ำเสียใด ๆ
- BED VOLUME (BV_n) แสดง ปริมาตรน้ำเสียใด ๆ ผ่านถึงปฏิกรณ์แคทไอออน หรือถึงปฏิกรณ์แอนไอออนใด ๆ ที่ทำการเก็บตัวอย่าง
- CATION CONDUCT แสดงค่าการนำไฟฟ้าหลังจากล้างด้วยกรดที่ออกจากถังแคทไอออนเรซิน
- CATION pH แสดง ค่า pH หลังจากล้างด้วยกรดที่ออกจากถังแคทไอออนเรซิน
- CATION Ni CONC. (C_n) แสดงค่าความเข้มข้นหลังจากล้างด้วยกรดที่ออกจากถังแคทไอออนเรซิน
- Ni CONC. * BEDVOLUME (N_n) แสดงค่า ปริมาณนิกเกิลที่ปริมาตรกรดล้างใด ๆ

$$N_n = C_n * (BV_n - BV_{n-1})$$
 หน่วย มก./ล. เรซิน
- CUMULATIVE NICKEL (Y_n) แสดง ค่าผลรวมปริมาณนิกเกิลจนถึงปริมาตรกรดล้างใด ๆ
 โดย
$$Y_n = \sum_{i=1}^{n-1} C_i$$
 หน่วย มก./ล. เรซิน
- CUMULATIVE NICKEL CONC. (G_n) แสดงค่าความเข้มข้นรวมนิกเกิลจนถึงจุดปริมาตรกรดล้างใด ๆ

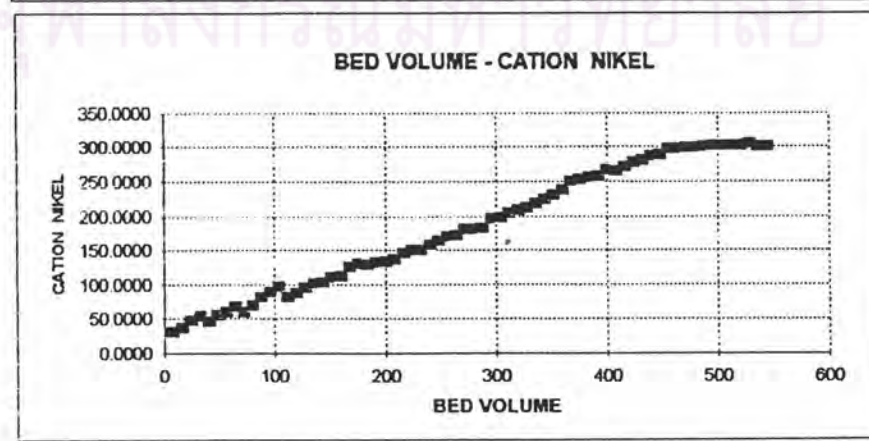
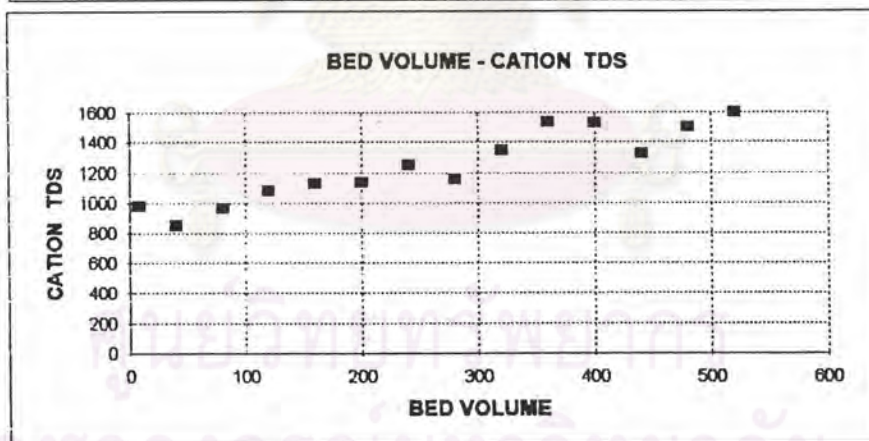
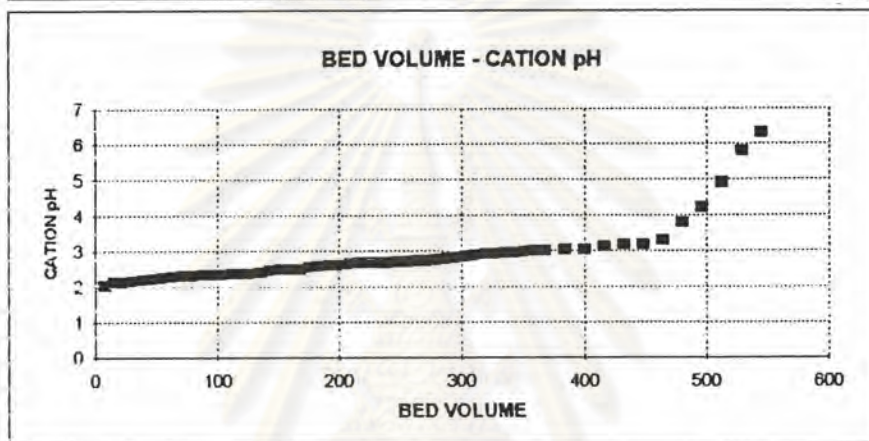
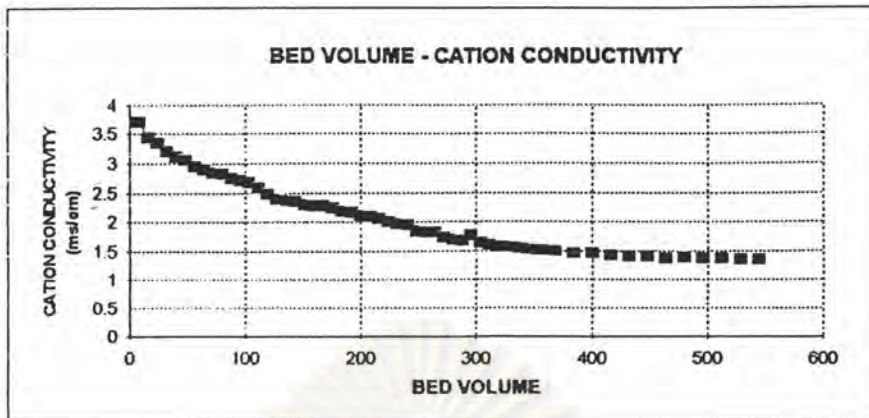
โดย

$$G_n = Y_n / BV_n$$

หน่วย มก./ล. เรซิน

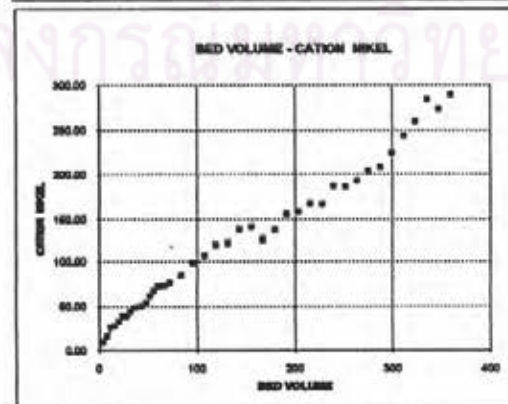
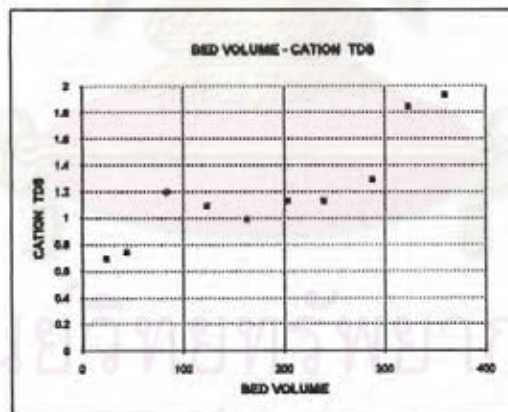
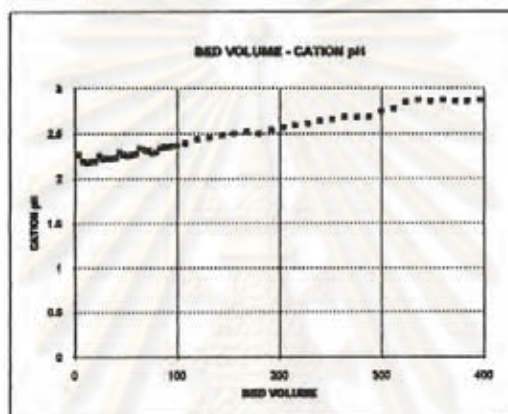
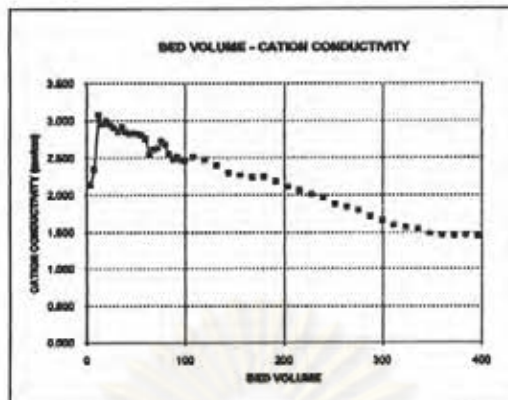
RAW WATER: INFLUENT NL = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 3% flowrate 3 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (mc/cm.)	CATION		TDS (mg/l)	RATIO NL. IN/ NL. OUT		
			pH	NICEL (mg/l)		VALUE	AVERAGE	TOTAL
1	8	3.700	2.03	30.00	980	0.1000	0.1113	0.890
2	16	3.430	2.13	36.76		0.1225	0.1402	1.122
3	24	3.350	2.13	47.35		0.1578	0.1888	1.349
4	32	3.190	2.14	53.82		0.1794	0.1876	1.341
5	40	3.110	2.17	46.76	850	0.1559	0.1701	1.361
6	48	3.050	2.2	55.29		0.1843	0.1931	1.545
7	56	2.950	2.25	60.59		0.2020	0.2127	1.702
8	64	2.890	2.28	67.06		0.2235	0.2108	1.688
9	72	2.840	2.29	59.41		0.1980	0.2142	1.714
10	80	2.810	2.3	69.12	906	0.2304	0.2505	2.004
11	88	2.750	2.32	81.18		0.2706	0.2838	2.271
12	96	2.710	2.34	89.12		0.2971	0.3088	2.471
13	104	2.670	2.33	96.18		0.3206	0.2958	2.365
14	112	2.590	2.35	81.18		0.2706	0.2804	2.243
15	120	2.480	2.36	87.06	1075	0.2902	0.3049	2.439
16	128	2.390	2.37	95.88		0.3196	0.3295	2.636
17	136	2.370	2.39	101.82		0.3394	0.3413	2.730
18	144	2.340	2.44	102.94		0.3431	0.3549	2.839
19	152	2.300	2.47	109.98		0.3666	0.3709	2.967
20	160	2.280	2.48	112.57	1125	0.3752	0.3969	3.175
21	168	2.270	2.49	125.59		0.4186	0.4272	3.417
22	176	2.240	2.54	130.72		0.4357	0.4321	3.457
23	184	2.190	2.57	128.53		0.4284	0.4338	3.471
24	192	2.170	2.59	131.76		0.4392	0.4426	3.541
25	200	2.120	2.61	133.82	1130	0.4461	0.4507	3.606
26	208	2.090	2.65	136.62		0.4554	0.4718	3.775
27	216	2.050	2.66	148.47		0.4882	0.4942	3.954
28	224	2.010	2.67	150.04		0.5001	0.4996	3.997
29	232	1.970	2.67	149.71		0.4990	0.5123	4.096
30	240	1.943	2.68	157.65	1250	0.5255	0.5353	4.282
31	248	1.840	2.69	163.53		0.5451	0.5564	4.451
32	256	1.831	2.7	170.29		0.5676	0.5711	4.569
33	264	1.824	2.73	172.36		0.5745	0.5878	4.702
34	272	1.725	2.74	180.29		0.6010	0.6031	4.824
35	280	1.695	2.75	181.54	1152	0.6051	0.6290	5.032
36	288	1.679	2.79	182.35		0.6529	0.6554	5.243
37	296	1.767	2.82	195.88		0.6578	0.6691	5.353
38	304	1.650	2.86	197.35		0.6904	0.6892	5.614
39	312	1.607	2.88	204.12		0.6980	0.7027	5.621
40	320	1.572	2.9	209.41	1344	0.7073	0.7164	5.731
41	328	1.565	2.9	212.20		0.7255	0.7255	5.804
42	336	1.542	2.93	217.64		0.7255	0.7388	5.894
43	344	1.535	2.95	224.41		0.7480	0.7583	6.067
44	352	1.516	2.97	230.59		0.7686	0.7814	6.251
45	360	1.511	3	238.24	1540	0.7941	0.8132	6.506
46	368	1.500	3.01	249.71		0.8324	0.8380	6.704
47	376			253.11		0.8437	0.8488	6.791
48	384	1.468	3.04	256.18		0.8539	0.8574	6.859
49	392			258.24		0.8608	0.8760	7.008
50	400	1.462	3.04	267.35	1528	0.8912	0.8887	7.110
51	408			265.88		0.8863	0.8961	7.169
52	416	1.428	3.13	271.76		0.8863	0.9203	7.362
53	424			277.65		0.9059	0.9448	7.558
54	432	1.398	3.19	280.41		0.9347	0.9448	7.558
55	440			286.47	1328	0.9549	0.9593	7.675

3-R2-3L.XLS



RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 3% flowrate 4.5 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NICKEL (mg/l)	TDS (mg/l)	RATIO Ni. IN/ Ni. OUT		
						VALUE	AVERAGE	TOTAL
1	4	2.140	2.26	9.71		0.0324	0.0422	0.169
2	8	2.350	2.19	15.59		0.0520	0.0708	0.282
3	12	3.070	2.17	26.76		0.0892	0.0912	0.365
4	16	2.950	2.18	27.94		0.0931	0.1005	0.402
5	20	2.990	2.19	32.35		0.1078	0.1191	0.476
6	24	2.940	2.25	39.12	0.692	0.1304	0.1299	0.520
7	28	2.900	2.21	38.82		0.1294	0.1377	0.551
8	32	2.850	2.22	43.82		0.1461	0.1534	0.614
9	36	2.910	2.22	48.24		0.1608	0.1627	0.651
10	40	2.840	2.23	49.41		0.1647	0.1652	0.661
11	44	2.820	2.29	49.71	0.742	0.1657	0.1725	0.690
12	48	2.830	2.25	53.82		0.1794	0.1917	0.767
13	52	2.820	2.25	61.18		0.2039	0.2127	0.851
14	56	2.800	2.26	66.47		0.2216	0.2309	0.924
15	60	2.750	2.27	72.06		0.2402	0.2410	0.964
16	64	2.540	2.34	72.53		0.2418	0.2433	0.973
17	68	2.610	2.32	73.47		0.2449	0.2494	0.998
18	72	2.630	2.31	76.18		0.2539	0.2676	3.212
19	76	2.720	2.28					
20	80	2.680	2.29					
21	84	2.550	2.34	84.41	1.196	0.2814	0.3049	3.659
22	88	2.480	2.35					
23	92	2.510	2.35					
24	96	2.470	2.36	98.53		0.3284	0.3422	4.106
25	100	2.460	2.36					
26	104							
27	108	2.510	2.39	106.78		0.3559	0.3775	4.529
28	112							
29	116							
30	120	2.470	2.43	119.71		0.3990	0.4029	4.835
31	124				1.088			
32	128							
33	132	2.400	2.45	122.06		0.4069	0.4338	5.206
34	136							
35	140							
36	144	2.300	2.48	138.24		0.4608	0.4657	5.588
37	148							
38	152							
39	156	2.270	2.5	141.18		0.4708	0.4481	5.353
40	160							
41	164				0.988			
42	168	2.240	2.52	126.47		0.4216	0.4407	5.288
43	172							
44	176							
45	180	2.250	2.5	137.94		0.4598	0.4897	5.876
46	184							
47	188							
48	192	2.180	2.54	155.88		0.5196	0.5235	6.282
49	196							
50	200							
51	204	2.110	2.57	158.24	1.13	0.5275	0.5426	6.512
52	208							
53	212							
54	216	2.060	2.59	167.35		0.5578	0.5569	6.682
55	220							

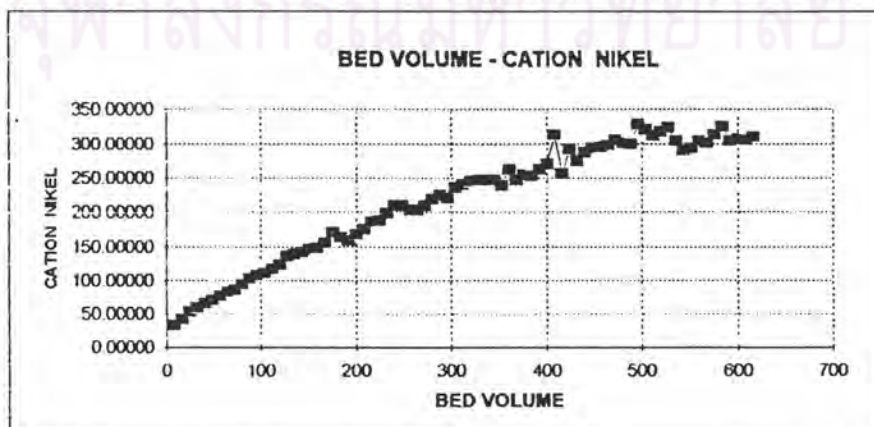
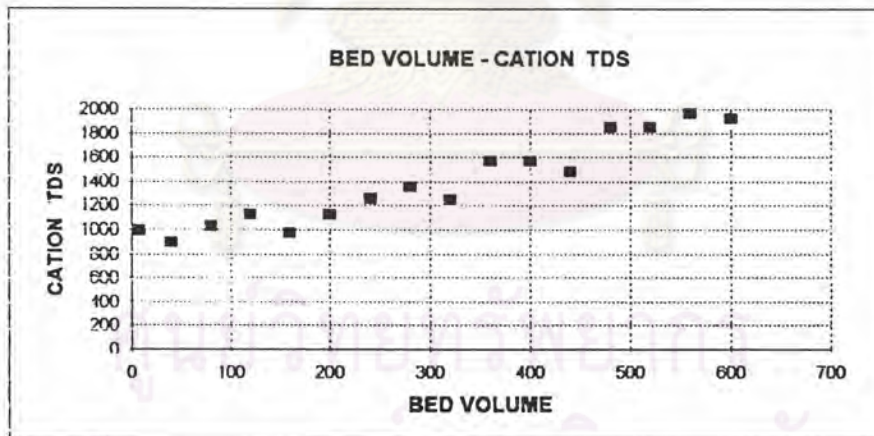
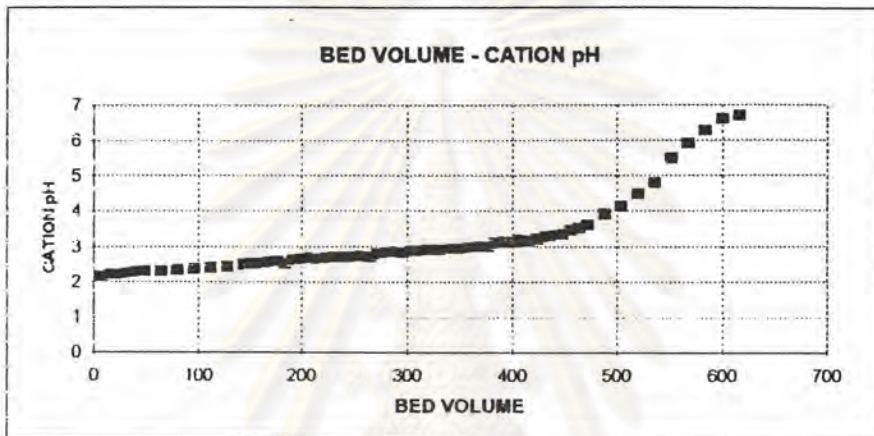
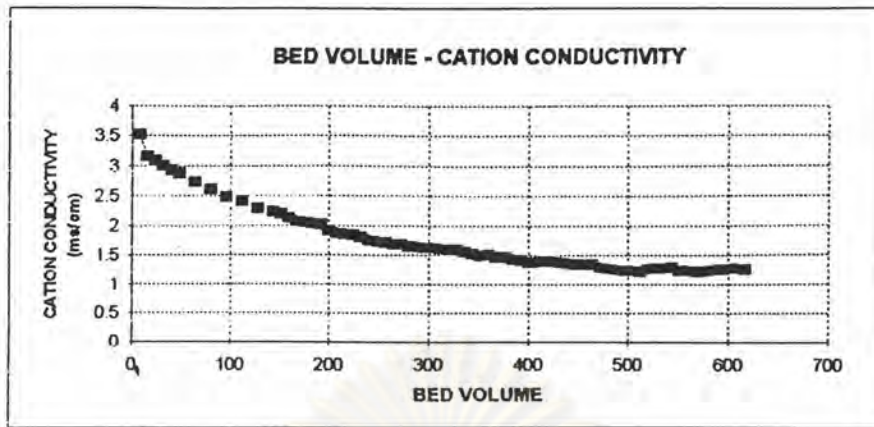
RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 3% flowrate 4.5 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (msecm.)	CATION pH	NI/NEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
56	224							
57	228	2.010	2.61	166.76		0.5559	0.5897	7.076
58	232							
59	236							
60	240	1.970	2.64	187.06	1.13	0.6235	0.6221	7.465
61	244							
62	248							
63	252	1.882	2.66	186.18		0.6206	0.6319	7.582
64	256							
65	260							
66	264	1.843	2.69	192.94		0.6431	0.6623	7.947
67	268							
68	272							
69	276	1.793	2.68	204.41		0.6814	0.6886	8.264
70	280							
71	284							
72	288	1.720	2.69	208.76	1.286	0.6959	0.7212	8.654
73	292							
74	296							
75	300	1.659	2.75	223.94		0.7465	0.7782	9.339
76	304							
77	308							
78	312	1.598	2.78	243.00		0.8100	0.8374	10.048
79	316							
80	320							
81	324	1.564	2.85	259.41	1.846	0.8647	0.9059	10.871
82	328							
83	332							
84	336	1.542	2.87	284.12		0.9471	0.9284	11.141
85	340							
86	344							
87	348	1.479	2.86	272.94		0.9096	0.9373	11.247
88	352							
89	356							
90	360	1.458	2.87	289.41	1.932	0.9647	0.9656	11.587
91	364							
92	368							
93	372	1.465	2.86	289.94		0.9665	0.9759	11.711
94	376							
95	380							
96	384	1.462	2.86	295.59		0.9853	0.9930	11.916
97	388							
98	392							
99	396	1.447	2.87	300.20		1.0007	0.5003	6.004
SUM(RATIO OF NI. IN TO NI. OUT TOTAL)						218.8374118		
TOTAL EXCHANGE NICKEL (mg /l.resin)						53148.77647		



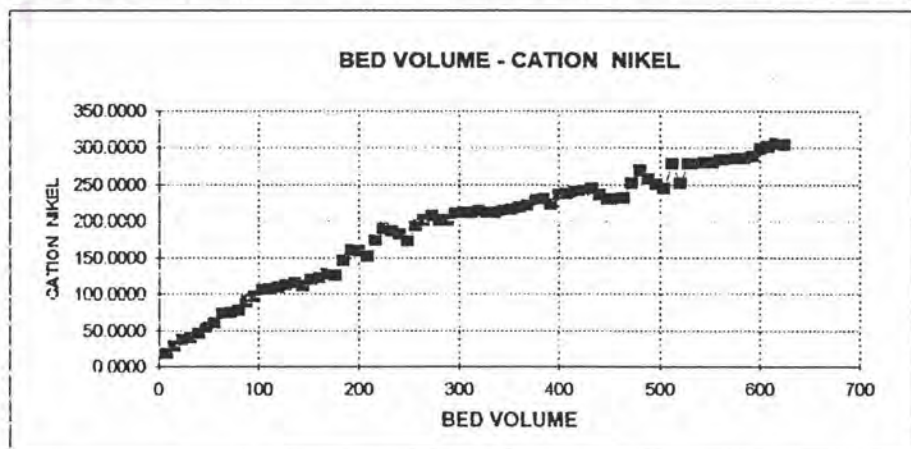
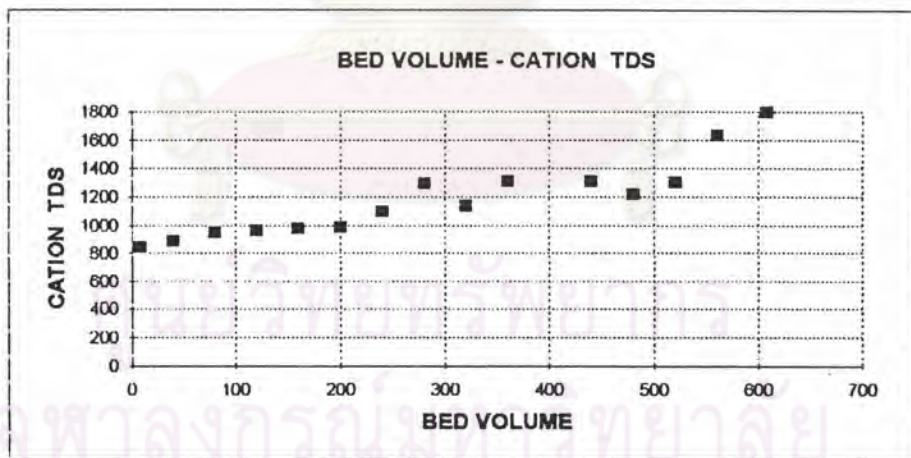
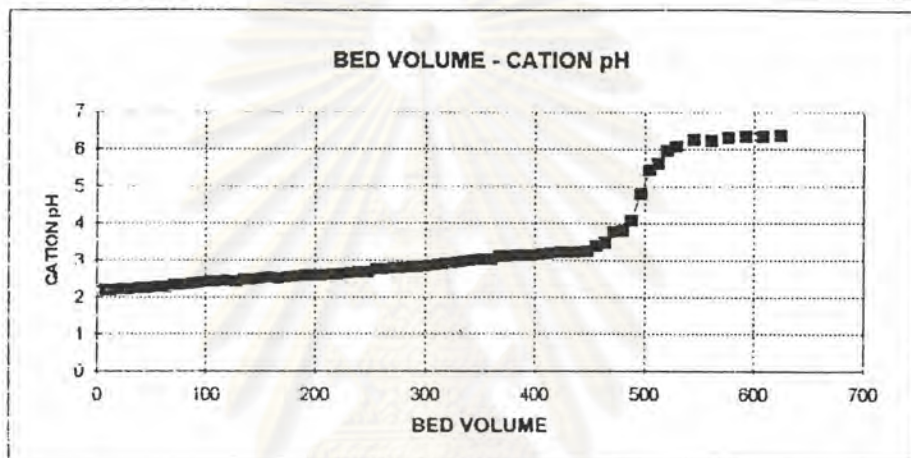
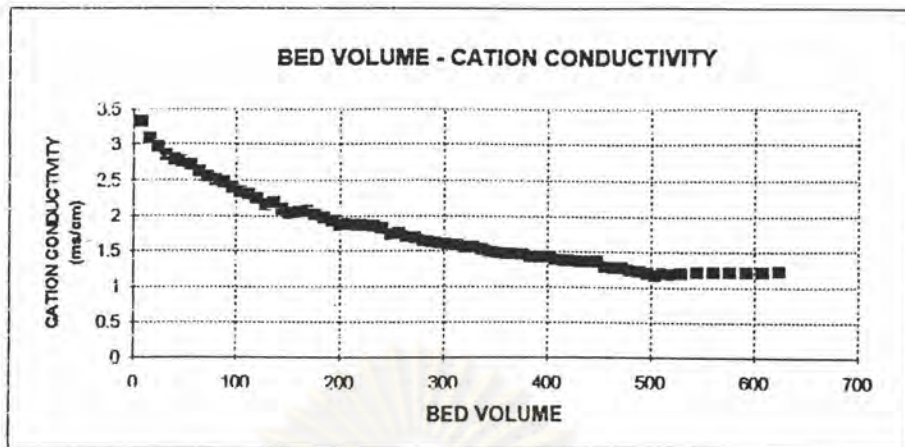
RAW WATER: INFLUENT NL = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 3% flowrate 6 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (mc/cm)	CATION pH	NICKEL (mg/l)	TDS (mg/l)	RATIO NL BY NL OUT		
						VALUE	AVERAGE	TOTAL
1	8	3.520	2.14	32.79	994	0.1093	0.1255	1.004
2	16	3.150	2.2	42.50		0.1417	0.1603	1.282
3	24	3.080	2.22	53.88		0.1789	0.1887	1.510
4	32	2.990	2.23	59.56		0.1985	0.2093	1.675
5	40	2.920	2.26	66.03	896	0.2201	0.2275	1.820
6	48	2.860	2.29	70.44		0.2348	0.2441	1.953
7	56			76.03		0.2534	0.2642	2.114
8	64	2.730	2.29	82.50		0.2750	0.2804	2.243
9	72			85.74		0.2858	0.2980	2.384
10	80	2.600	2.34	93.09	1026	0.3103	0.3270	2.616
11	88			103.09		0.3436	0.3510	2.808
12	96	2.470	2.37	107.50		0.3583	0.3637	2.910
13	104			110.74		0.3691	0.3794	3.035
14	112	2.400	2.39	116.91		0.3897	0.3995	3.196
15	120			122.79	1126	0.4093	0.4311	3.449
16	128	2.280	2.43	135.88		0.4529	0.4569	3.655
17	136			138.24		0.4608	0.4652	3.722
18	144	2.220	2.48	140.88		0.4696	0.4775	3.820
19	152	2.200	2.5	145.59		0.4853	0.4897	3.918
20	160	2.120	2.52	148.24	969	0.4941	0.5054	4.043
21	168	2.060	2.55	155.00		0.5187	0.5431	4.345
22	176	2.050	2.57	170.88		0.5696	0.5569	4.455
23	184	2.040	2.51	163.24		0.5441	0.5368	4.294
24	192	2.010	2.6	158.82		0.5294	0.5441	4.353
25	200	1.905	2.63	187.65	1123	0.5588	0.5725	4.580
26	208	1.877	2.66	175.88		0.5863	0.6049	4.839
27	216	1.854	2.64	187.06		0.6235	0.6250	5.000
28	224	1.832	2.66	187.94		0.6265	0.6441	5.153
29	232	1.800	2.69	198.53		0.6618	0.6804	5.443
30	240	1.754	2.7	209.71	1256	0.6990	0.6995	5.596
31	248	1.732	2.71	210.00		0.7000	0.6892	5.514
32	256	1.709	2.74	203.53		0.6784	0.6794	5.435
33	264	1.684	2.71	204.12		0.6804	0.6892	5.514
34	272	1.668	2.78	209.41		0.6980	0.7132	5.706
35	280	1.650	2.81	218.53	1358	0.7284	0.7319	5.855
36	288	1.640	2.85	225.59		0.7353	0.7603	6.082
37	296	1.630	2.83	220.59		0.7853	0.7941	6.353
38	304	1.620	2.87	236.59		0.8029	0.8103	6.482
39	312	1.600	2.898	240.88		0.8176	0.8196	6.557
40	320	1.590	2.9	245.29	1245	0.8216	0.8216	6.573
41	328	1.580	2.9	246.47		0.8216	0.8216	6.573
42	336	1.550	2.91	246.47		0.8216	0.8230	6.584
43	344	1.520	2.93	247.35		0.8245	0.8098	6.478
44	352	1.490	2.95	238.53		0.7951	0.8358	6.886
45	360	1.502	2.97	262.94	1569	0.8765	0.8490	6.792
46	368	1.460	2.99	246.47		0.8216	0.8353	6.682
47	376	1.470	3.01	254.71		0.8490	0.8451	6.761
48	384	1.420	3.08	252.35		0.8412	0.8574	6.859
49	392	1.402	3.11	262.06		0.8735	0.8858	7.086
50	400	1.383	3.13	269.41	1569	0.8980	0.9706	7.765
51	408	1.379	3.19	312.94		1.0431	0.9490	7.592
52	416	1.396	3.16	256.47		1.0431	0.8953	7.090
53	424	1.384	3.2	291.18		0.8549	0.9382	7.506
54	432	1.373	3.26	275.29		0.9176	0.9382	7.506
55	440	1.365	3.3	287.65	1478	0.9588	0.9691	7.753

RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 3% flowrate 6 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NICKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
56	448	1.342	3.34	293.82		0.9794	0.9804	7.843
57	456	1.338	3.45	294.41		0.9814	0.9863	7.890
58	464	1.331	3.5	297.35		0.9812	1.0039	8.031
59	472	1.287	3.6	305.00		1.0167	1.0097	0.003
60	480	1.262		300.80	1852	1.0027	1.0008	8.005
61	488	1.250	3.9	299.56		0.9985	1.0485	8.388
62	496	1.240		329.56		1.0985	1.0838	8.671
63	504	1.230	4.11	320.74		1.0691	1.0549	8.439
64	512	1.211		312.21		1.0407	1.0485	8.398
65	520	1.250	4.5	317.50	1850	1.0583	1.0691	8.553
66	528	1.267		323.97		1.0799	1.0475	8.380
67	536	1.270	4.8	304.56		1.0152	0.9902	7.922
68	544	1.287		289.56		0.9652	0.9725	7.790
69	552	1.237	5.5	293.97		0.9799	0.9876	7.980
70	560	1.224		304.56	1963	1.0152	1.0091	8.073
71	568	1.215	5.92	300.87		1.0029	1.0238	8.190
72	576	1.223		313.38		1.0446	1.0642	8.514
73	584	1.238	6.28	325.15		1.0838	1.0485	8.388
74	592	1.250		303.97		1.0132	1.0196	8.157
75	600	1.250	6.6	307.79	1925	1.0280	1.0216	8.173
76	608	1.260		305.15		1.0172	1.0255	8.204
77	616	1.250	6.69	310.15		1.0338	0.5169	4.135
						SUM(RATIO OF NI. IN TO NI. O	435.11	
						TOTAL EXCHANGE NICKEL (54265.81	

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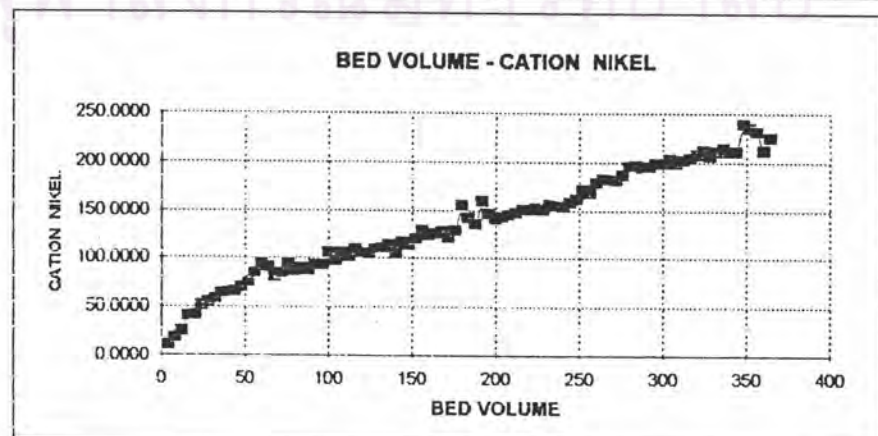
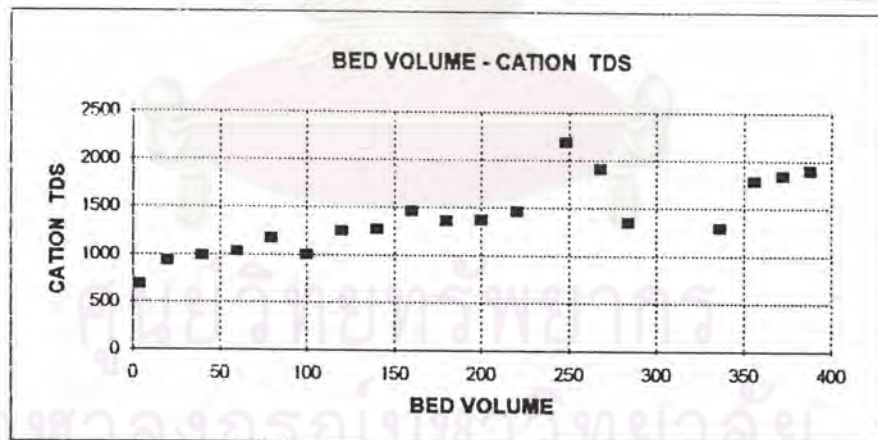
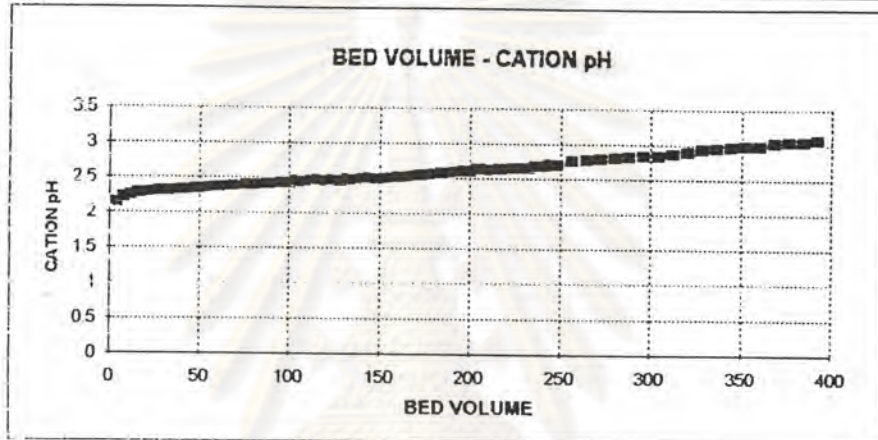
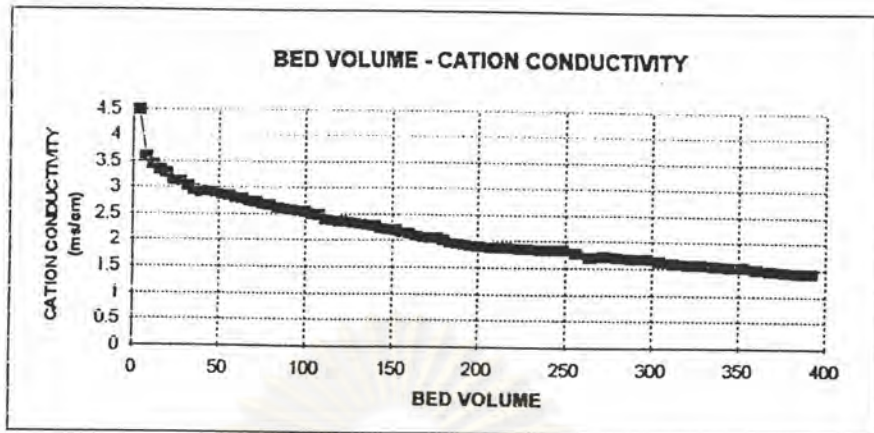
RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 5% flowrate 3 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ma/cm.)	CATION pH	NICKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
1	8	3.330	2.2	19.12	844	0.0637	0.0814	0.651
2	16	3.100	2.21	29.71		0.0990	0.1127	0.902
3	24	2.970	2.22	37.94		0.1265	0.1309	1.047
4	32	2.860	2.24	40.59		0.1353	0.1456	1.165
5	40	2.800	2.25	46.76	890	0.1559	0.1706	1.365
6	48	2.770	2.27	55.59		0.1853	0.1951	1.561
7	56	2.720	2.28	61.47		0.2049	0.2245	1.796
8	64	2.630	2.29	73.24		0.2441	0.2480	1.984
9	72	2.560	2.34	75.59		0.2520	0.2569	2.055
10	80	2.510	2.35	78.53	955	0.2618	0.2814	2.251
11	88	2.480	2.37	90.29		0.3010	0.3118	2.494
12	96	2.400	2.41	96.76		0.3225	0.3368	2.694
13	104	2.350	2.43	105.29		0.3510	0.3539	2.831
14	112	2.320	2.44	107.06		0.3569	0.3627	2.902
15	120	2.250	2.45	110.59	968	0.3688	0.3725	2.980
16	128	2.170	2.42	112.94		0.3765	0.3814	3.051
17	136	2.190	2.48	115.88		0.3863	0.3789	3.031
18	144	2.110	2.5	111.47		0.3716	0.3858	3.086
19	152	2.040	2.53	120.00		0.4000	0.4054	3.243
20	160	2.060	2.56	123.24	980	0.4108	0.4191	3.353
21	168	2.070	2.51	128.24		0.4275	0.4245	3.396
22	176	2.030	2.55	128.47		0.4216	0.4549	3.639
23	184	1.978	2.58	148.47		0.4882	0.5127	4.102
24	192	1.945	2.6	161.18		0.5373	0.5348	4.278
25	200	1.885	2.6	159.71	991	0.5324	0.5211	4.169
26	208	1.887	2.61	152.94		0.5098	0.5461	4.369
27	216	1.883	2.63	174.71		0.5824	0.6074	4.859
28	224	1.876	2.64	189.71		0.6324	0.6289	5.031
29	232	1.862	2.66	187.65		0.6255	0.6162	4.929
30	240	1.830	2.68	182.06	1104	0.6069	0.5922	4.737
31	248	1.749	2.69	173.24		0.5775	0.6118	4.894
32	256	1.762	2.78	193.82		0.6461	0.6588	5.271
33	264	1.709	2.79	201.47		0.6716	0.6824	5.459
34	272	1.692	2.81	207.94		0.6931	0.6833	5.467
35	280	1.658	2.82	202.06	1294	0.6735	0.6977	5.502
36	288	1.634	2.83	202.06		0.7020	0.7039	5.631
37	296	1.624	2.84	210.59		0.7059	0.7059	5.647
38	304	1.612	2.86	211.76		0.7059	0.7098	5.678
39	312	1.591	2.9	211.76		0.7137	0.7108	5.686
40	320	1.571	2.92	214.12	1136	0.7078	0.7078	5.663
41	328	1.567	2.95	212.35		0.7078	0.7078	5.663
42	336	1.541	2.97	212.35		0.7078	0.7113	5.690
43	344	1.509	3.01	214.41		0.7147	0.7186	5.749
44	352	1.483	3.03	216.76		0.7225	0.7270	5.816
45	360	1.473	3.05	219.41	1316	0.7314	0.7343	5.875
46	368	1.472	3.11	221.18		0.7373	0.7505	6.004
47	376	1.459	3.13	229.12		0.7637	0.7652	6.122
48	384	1.437	3.14	230.00		0.7667	0.7544	6.035
49	392	1.435	3.16	222.65		0.7422	0.7642	6.114
50	400	1.433	3.15	235.88		0.7863	0.7897	6.318
51	408	1.402	3.19	237.94		0.7931	0.7971	6.376
52	416	1.383	3.22	240.29		0.7931	0.8098	6.478
53	424	1.382	3.24	242.35		0.8010	0.8044	6.435
54	432	1.367	3.24	245.59		0.8186	0.8044	6.435
55	440	1.370	3.25	237.06	1316	0.7902	0.7804	6.243



RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 5% flowrate 4.5 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
1	4	4.480	2.14	10.29		0.0343	0.0485	0.194
2	8	3.580	2.22	18.82		0.0627	0.0730	0.292
3	12	3.430	2.25	25.00		0.0833	0.1088	0.435
4	16	3.330	2.27	40.29		0.1343	0.1368	0.547
5	20	3.270	2.27	41.76	824	0.1392	0.1549	0.620
6	24	3.140	2.29	51.18		0.1706	0.1765	0.706
7	28	3.110	2.3	54.71		0.1824	0.1873	0.749
8	32	3.020	2.31	57.65		0.1922	0.2020	0.808
9	36	2.950	2.31	63.53		0.2118	0.2132	0.853
10	40	2.910	2.32	64.41	989	0.2147	0.2172	0.869
11	44	2.930	2.32	65.88		0.2196	0.2265	0.906
12	48	2.900	2.33	70.00		0.2333	0.2412	0.965
13	52	2.870	2.34	74.71		0.2490	0.2647	1.059
14	56	2.840	2.35	84.12		0.2804	0.2971	1.188
15	60	2.800	2.36	94.12	1025	0.3137	0.3083	1.233
16	64	2.780	2.37	90.88		0.3029	0.2863	1.145
17	68	2.750	2.38	80.88		0.2696	0.2750	1.100
18	72	2.730	2.38	84.12		0.2804	0.2961	1.184
19	76	2.690	2.39	93.53		0.3118	0.2995	1.198
20	80	2.660	2.4	86.18	1169	0.2873	0.2931	1.173
21	84	2.630	2.4	89.71		0.2990	0.2951	1.180
22	88	2.590	2.41	87.35		0.2912	0.3005	1.202
23	92	2.570	2.41	92.94		0.3098	0.3093	1.237
24	96	2.550	2.42	92.65		0.3088	0.3299	1.320
25	100	2.530	2.43	105.29	996	0.3510	0.3368	1.347
26	104	2.490	2.45	96.76		0.3225	0.3373	1.349
27	108	2.470	2.44	105.59		0.3520	0.3456	1.382
28	112	2.390	2.45	101.76		0.3392	0.3520	1.408
29	116	2.380	2.47	109.41		0.3647	0.3563	1.433
30	120	2.360	2.46	105.59	1250	0.3520	0.3505	1.402
31	124	2.350	2.47	104.71		0.3490	0.3564	1.425
32	128	2.330	2.46	109.12		0.3637	0.3662	1.465
33	132	2.310	2.48	110.59		0.3688	0.3735	1.494
34	136	2.300	2.47	113.53		0.3784	0.3637	1.455
35	140	2.270	2.48	104.71	1269	0.3490	0.3637	1.455
36	144	2.240	2.5	116.76		0.3784	0.3892	1.557
37	148	2.220	2.49	113.53		0.4000	0.4147	1.659
38	152	2.190	2.48	120.00		0.4294	0.4201	1.680
39	156	2.150	2.5	128.82		0.4108	0.4142	1.657
40	160	2.130	2.51	123.24	1463	0.4176	0.4221	1.688
41	164	2.100	2.52	125.29		0.4265	0.4265	1.706
42	168	2.080	2.53	127.94		0.4265	0.4157	1.663
43	172	2.060	2.54	121.47		0.4049	0.4167	1.667
44	176	2.040	2.55	128.53		0.4284	0.4730	1.892
45	180	2.010	2.56	155.29	1356	0.5178	0.4951	1.980
46	184	1.970	2.57	141.76		0.4725	0.4613	1.845
47	188	1.950	2.58	135.00		0.4500	0.4912	1.965
48	192	1.930	2.59	159.71		0.5324	0.5098	2.039
49	196	1.900	2.6	146.18		0.4873	0.4784	1.914
50	200	1.890	2.61	140.88	1368	0.4696	0.4730	1.892
51	204	1.880	2.64	142.94		0.4765	0.4794	1.918
52	208	1.870	2.63	144.71		0.4765	0.4926	1.971
53	212	1.860	2.62	147.35		0.4824	0.5020	2.008
54	216	1.857	2.64	150.88		0.5029	0.5020	2.008
55	220	1.859	2.64	150.29	1456	0.5010	0.5044	2.018

RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 5% flowrate 4.5 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
56	224	1.852	2.65	152.35		0.5078	0.5054	2.022
57	228	1.847	2.65	150.88		0.5029	0.5108	2.043
58	232	1.844	2.68	155.59		0.5186	0.5172	2.069
59	236	1.835	2.68	154.71		0.5157	0.5147	2.059
60	240	1.830	2.69	154.12		0.5137	0.5201	2.080
61	244	1.827	2.71	157.94		0.5265	0.5324	2.129
62	248	1.816	2.7	161.47	2188	0.5382	0.5549	2.220
63	252			171.47		0.5718	0.5662	2.265
64	256	1.757	2.76	168.24		0.5608	0.5789	2.316
65	260			179.12		0.5971	0.6029	2.412
66	264	1.684	2.77	182.65		0.6088	0.6074	2.429
67	268			181.76	1916	0.6059	0.6044	2.418
68	272	1.708	2.79	180.88		0.6029	0.6127	2.451
69	276			186.76		0.6225	0.6377	2.551
70	280	1.686	2.81	195.88		0.6529	0.6534	2.614
71	284			196.18	1352	0.6539	0.6505	2.602
72	288	1.665	2.82	194.12		0.6471	0.6495	2.598
73	292			195.59		0.6520	0.6569	2.627
74	296	1.654	2.83	198.53		0.6618	0.6618	2.647
75	300			198.53		0.6618	0.6686	2.675
76	304	1.615	2.84	202.65		0.6755	0.6681	2.673
77	308			198.24		0.6608	0.6667	2.667
78	312	1.578	2.87	201.76		0.6725	0.6770	2.708
79	316			204.41		0.6814	0.6863	2.745
80	320	1.567	2.9	207.35		0.6912	0.6980	2.792
81	324			211.47		0.7049	0.6971	2.788
82	328	1.552	2.94	206.76		0.6892	0.6951	2.780
83	332			210.29		0.7010	0.7078	2.831
84	336	1.539	2.95	214.41	1292	0.7147	0.7093	2.837
85	340			211.18		0.7039	0.7025	2.810
86	344	1.527	2.97	210.29		0.7010	0.7485	2.994
87	348			238.82		0.7961	0.7892	3.157
88	352	1.522	2.99	234.71		0.7824	0.7765	3.106
89	356			231.18	1796	0.7706	0.7377	2.951
90	360	1.477	2.98	211.47		0.7049	0.7265	2.906
91	364			224.41		0.7480	0.7176	2.871
92	368	1.453	3.03	206.18		0.6873	0.7123	2.849
93	372			221.18	1844	0.7373	0.7319	2.927
94	376	1.432	3.04	217.94		0.7265	0.7167	2.867
95	380			212.06		0.7069	0.7044	2.818
96	384	1.419	3.05	210.59		0.7020	0.6980	2.792
97	388			208.24	1904	0.6941	0.7078	2.831
98	392	1.411	3.08	216.47		0.7216	0.7230	2.892
99	396			217.35		0.7245	0.7377	2.951
100	400	1.402	3.1	225.29		0.7510	0.7471	2.988
101	404			222.94		0.7431	0.7515	3.006
102	408	1.394	3.1	227.94		0.7596	0.7593	3.037
103	412			227.65		0.7588	0.7627	3.051
104	416	1.388	3.11	230.00		0.7667	0.7735	3.094
105	420			234.12		0.7804	0.7706	3.082
106	424	1.390	3.11	228.24		0.7608	0.7735	3.094
107	428			235.88		0.7863	0.7647	3.059
108	432	1.393	3.12	222.94		0.7431	0.7725	3.090
109	436			240.59		0.8020	0.8044	3.218
110	440	1.396	3.12	242.06		0.8069	0.8147	3.259

RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 5%, flowrate 4.5 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ma/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
111	444			246.76		0.8225	0.8309	3.324
112	446	1.380	3.13	251.76		0.8392	0.8415	3.366
113	452			253.15		0.8438	0.8430	3.372
114	456	1.384	3.2	252.65		0.8422	0.8343	3.337
115	460			247.94		0.8265	0.8211	3.284
116	464	1.335	3.25	244.71		0.8157	0.8044	3.218
117	468			237.94		0.7931	0.7966	3.186
118	472	1.326	3.29	240.00		0.8000	0.8049	3.220
119	476			242.94		0.8098	0.8142	3.257
120	480	1.318	3.31	245.59		0.8186	0.8191	3.276
121	484			245.88		0.8196	0.8245	3.298
122	488	1.299	3.38	248.82		0.8294	0.8309	3.324
123	492			249.71		0.8324	0.8373	3.349
124	496	1.298	3.47	252.65		0.8422	0.8466	3.386
125	500			255.29		0.8510	0.8505	3.402
126	504	1.296	3.51	255.00		0.8500	0.8534	3.414
127	508			257.06		0.8569	0.8642	3.457
128	512	1.285	3.52	261.47		0.8716	0.8853	3.541
129	516			269.71		0.8990	0.8907	3.563
130	520	1.296	3.78	264.71		0.8824	0.8863	3.545
131	524			287.08		0.8902	0.8873	3.549
132	528	1.297	3.98	265.29		0.8843	0.8892	3.557
133	532			268.24		0.8941	0.8966	3.586
134	536	1.296	4.53	269.71		0.8990	0.9044	3.618
135	540			272.94		0.9098	0.9093	3.637
136	544	1.287	4.98	272.65		0.9088	0.9142	3.657
137	548			275.88		0.9196	0.9196	3.678
138	552	1.286	5.28	275.88		0.9196	0.9250	3.700
139	556			279.12		0.9304	0.9284	3.714
140	560	1.285	5.97	277.94		0.9265	0.9328	3.731
141	564			281.76		0.9392	0.9515	3.806
142	568	1.274	6.03	289.12		0.9637	0.9559	3.824
143	572			284.41		0.9480	0.9627	3.851
144	576	1.276	6.45	293.24		0.9775	0.9779	3.912
145	580			293.53		0.9784	0.9907	3.963
146	584	1.279	6.49	300.88		1.0029	1.0103	4.041
147	588			305.29		1.0176	1.0162	4.065
148	592	1.281	6.59	304.41		1.0147	0.5074	2.029
SUM(RATIO OF NI. IN TO NI. OUT TOTAL)						357.29		
TOTAL EXCHANGE NICKEL (mg / l.resin)						70413.88		



RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 5% flowrate 6 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
1	8	3.660	2.11	30.29	960	0.1010	0.1270	1.016
2	16	3.310	2.17	45.88		0.1529	0.1681	1.345
3	24	3.070	2.23	55.00		0.1833	0.1824	1.459
4	32	3.000	2.3	54.41		0.1814	0.1868	1.484
5	40	2.910	2.36	57.65	871	0.1922	0.1985	1.588
6	48	2.870	2.37	61.47		0.2049	0.2137	1.710
7	56	2.820	2.38	66.76		0.2225	0.2275	1.820
8	64	2.730	2.37	69.71		0.2324	0.2426	1.941
9	72	2.660	2.37	75.88		0.2529	0.2613	2.090
10	80	2.540	2.4	80.88	1025	0.2696	0.2765	2.212
11	88	2.490	2.43	85.00		0.2833	0.2922	2.337
12	96	2.480	2.45	90.29		0.3010	0.3059	2.447
13	104	2.450	2.47	93.24		0.3108	0.3182	2.529
14	112	2.350	2.49	96.47		0.3216	0.3201	2.561
15	120	2.320	2.5	95.59	1125	0.3186	0.3250	2.600
16	128	2.280	2.51	99.41		0.3314	0.3333	2.667
17	136	2.180	2.52	100.59		0.3353	0.3480	2.784
18	144	2.110	2.53	108.24		0.3608	0.3652	2.922
19	152	2.000	2.55	110.88		0.3696	0.3784	3.027
20	160	1.980	2.59	116.18	1147	0.3873	0.3990	3.192
21	168	1.950	2.62	123.24		0.4108	0.4142	3.314
22	176	1.947	2.64	125.29		0.4176	0.4181	3.345
23	184	1.936	2.65	125.59		0.4186	0.4235	3.388
24	192	1.911	2.67	128.53		0.4284	0.4392	3.514
25	200	1.897	2.68	135.00	1369	0.4500	0.4637	3.710
26	208	1.850	2.71	143.24		0.4775	0.4843	3.875
27	216	1.762	2.72	147.35		0.4912	0.5074	4.059
28	224	1.738	2.73	157.06		0.5235	0.5358	4.286
29	232	1.721	2.75	164.41		0.5480	0.5578	4.463
30	240	1.714	2.78	170.29	1298	0.5676	0.5922	4.737
31	248	1.708	2.81	185.00		0.6167	0.6338	5.071
32	256	1.625	2.83	195.29		0.6510	0.6672	5.337
33	264	1.644	2.84	205.00		0.6833	0.6794	5.435
34	272	1.615	2.87	202.65		0.6755	0.6569	5.255
35	280	1.561	2.91	191.47	1478	0.6382	0.6740	5.392
36	288	1.590	2.93	206.76		0.7098	0.7235	5.788
37	296	1.577	2.94	212.94		0.7373	0.7240	5.792
38	304	1.570		221.18		0.7108	0.6721	5.376
39	312	1.562	2.95	213.24		0.6333	0.6422	5.137
40	320			190.00	1596	0.6510	0.6510	5.208
41	328	1.547	2.97	195.29		0.6510	0.6510	5.208
42	336			195.29		0.6510	0.6745	5.396
43	344	1.472	3.04	209.41		0.6980	0.7044	5.635
44	352			213.24		0.7108	0.7123	5.698
45	360	1.437	3.13	214.12	1698	0.7137	0.7196	5.757
46	368			217.65		0.7255	0.7363	5.890
47	376	1.404	3.15	224.12		0.7471	0.7672	6.137
48	384			236.18		0.7873	0.7941	6.353
49	392	1.360	3.24	240.29		0.8010	0.8025	6.420
50	400			241.18	1789	0.8039	0.8044	6.435
51	408		3.31	241.47		0.8049	0.8074	6.459
52	416	1.349	3.34	242.94		0.8049	0.8167	6.533
53	424			245.88		0.8098	0.8250	6.600
54	432	1.276	3.49	247.06		0.8235	0.8250	6.600
55	440			247.94	1874	0.8265	0.8255	6.604

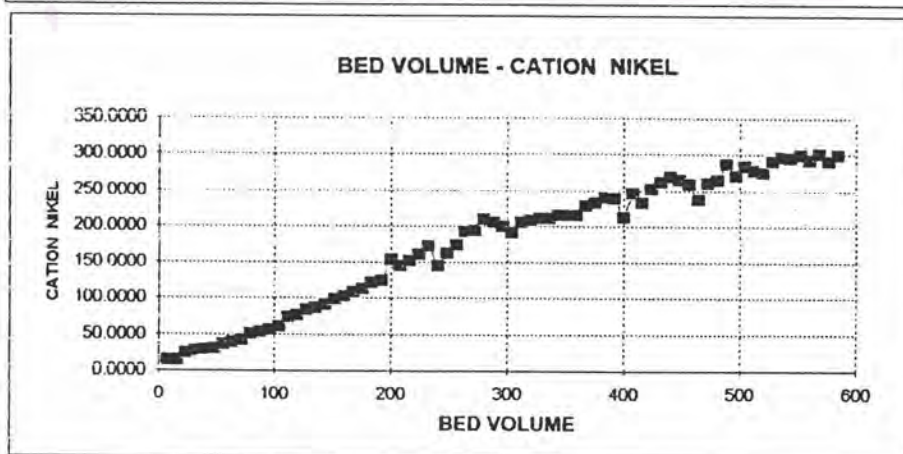
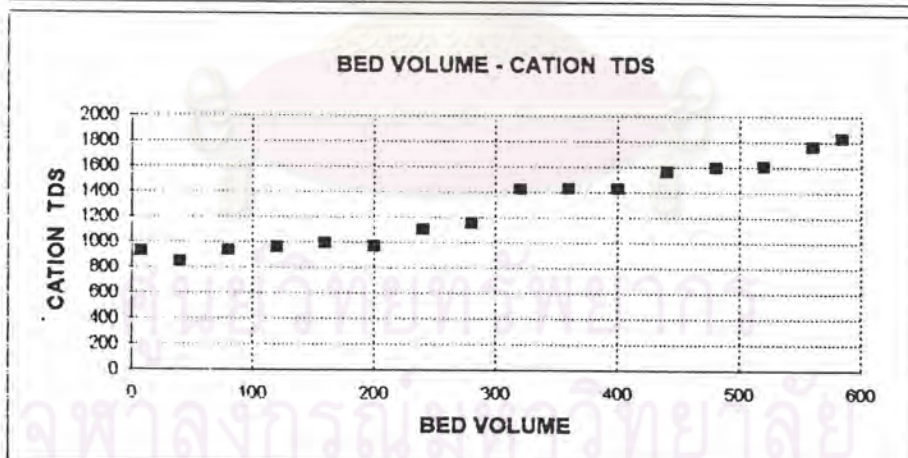
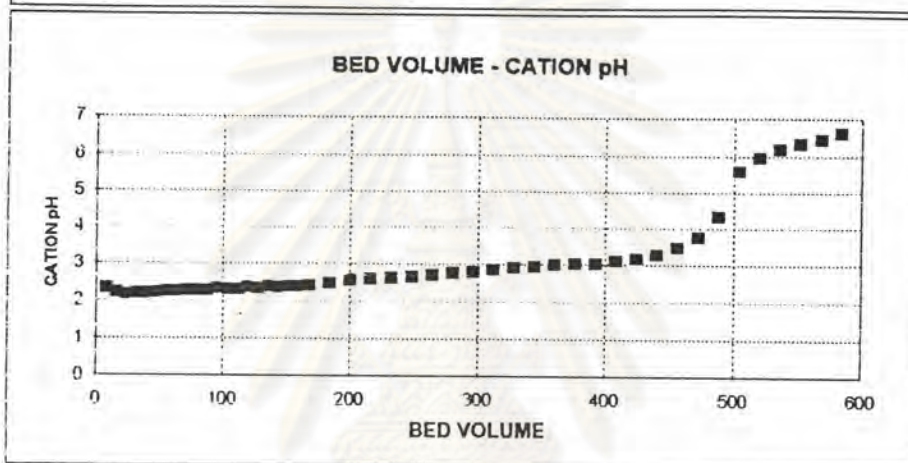
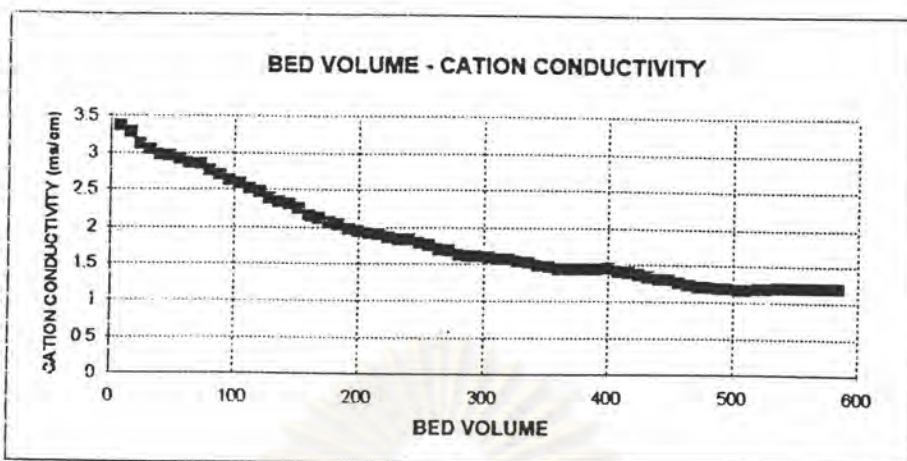
RAW WATER: INFLUENT NI = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 5% flowrate 6 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
56	448	1.258	3.53	247.35		0.8245	0.8240	6.592
57	456			247.06		0.8235	0.8225	6.580
58	464	1.204	3.85	248.47		0.8216	0.8250	6.600
59	472			248.50		0.8283	0.8302	6.641
60	480	1.265	3.64	249.60	1963	0.8320	0.8390	6.712
61	488			253.82		0.8461	0.8672	6.937
62	496	1.215	4.29	266.47		0.8882	0.8799	7.039
63	504			261.47		0.8716	0.8750	7.000
64	512	1.205	5.91	263.53		0.8784	0.8892	7.114
65	520			270.00	1964	0.9000	0.8946	7.157
66	528	1.204	6.02	266.78		0.8892	0.8951	7.161
67	536			270.29		0.9010	0.9034	7.227
68	544	1.246	6.15	271.78		0.9059	0.9206	7.365
69	552			280.59		0.9353	0.9515	7.612
70	560	1.257	6.34	280.29	1852	0.9676	0.9828	7.863
71	568			299.41		0.9980	1.0010	8.008
72	576	1.247	6.38	301.18		1.0039	1.0054	8.043
73	584			302.06		1.0069	1.0118	8.094
74	592	1.235	6.47	305.00		1.0167	0.5083	4.067
						SUM(RATIO OF NI. IN TO NI. OUT TOTAL)		361.76
						TOTAL EXCHANGE NICKEL (mg / l.resin)		69071.67

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

RAW WATER: INFLUENT NI = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 7% flowrate 3 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
1	8	3.370	2.34	15.00		0.0500	0.0480	0.384
2	16	3.290	2.24	13.82		0.0461	0.0632	0.506
3	24	3.130	2.16	24.12		0.0804	0.0863	0.690
4	32	3.050	2.19	27.65		0.0922	0.0956	0.765
5	40	2.990	2.2	29.71	850	0.0990	0.1010	0.808
6	48	2.970	2.23	30.88		0.1029	0.1118	0.894
7	56	2.930	2.25	36.18		0.1206	0.1260	1.008
8	64	2.870	2.27	39.41		0.1314	0.1368	1.094
9	72	2.850	2.29	42.65		0.1422	0.1559	1.247
10	80	2.770	2.28	50.88	942	0.1696	0.1750	1.400
11	88	2.700	2.3	54.12		0.1804	0.1848	1.478
12	96	2.640	2.34	56.76		0.1892	0.1971	1.576
13	104	2.590	2.31	61.47		0.2049	0.2265	1.812
14	112	2.520	2.33	74.41		0.2480	0.2525	2.020
15	120	2.480	2.38	77.06	969	0.2569	0.2676	2.141
16	128	2.390	2.35	83.53		0.2784	0.2838	2.271
17	136	2.340	2.39	86.76		0.2892	0.2975	2.380
18	144	2.310	2.38	91.76		0.3059	0.3162	2.529
19	152	2.250	2.4	97.94		0.3265	0.3353	2.682
20	160	2.150	2.41	103.24	996	0.3441	0.3544	2.835
21	168	2.120	2.42	109.41		0.3647	0.3706	2.965
22	176	2.070		112.94		0.3765	0.3917	3.133
23	184	2.040	2.49	122.06		0.4069	0.4118	3.294
24	192	1.980		125.00		0.4167	0.4637	3.710
25	200	1.950	2.57	153.24	976	0.5108	0.4980	3.984
26	208	1.927		145.59		0.4853	0.4975	3.980
27	216	1.913	2.6	152.94		0.5098	0.5221	4.176
28	224	1.870		160.29		0.5343	0.5539	4.431
29	232	1.840	2.63	172.06		0.5735	0.5284	4.227
30	240	1.833		145.00	1110	0.4833	0.5132	4.106
31	248	1.789	2.67	162.94		0.5431	0.5613	4.490
32	256	1.767		173.82		0.5794	0.6108	4.886
33	264	1.708	2.73	192.65		0.6422	0.6451	5.161
34	272	1.689		194.41		0.6480	0.6735	5.388
35	280	1.629	2.77	209.71	1156	0.6990	0.6819	5.455
36	288	1.623		205.29		0.6647	0.6505	5.204
37	296	1.619	2.81	199.41		0.6363	0.6613	5.290
38	304	1.608		190.88		0.6863	0.6912	5.529
39	312	1.577	2.86	205.88		0.6961	0.7015	5.612
40	320	1.568		208.82	1426	0.7069	0.7069	5.655
41	328	1.540	2.91	212.06		0.7069	0.7069	5.655
42	336	1.524		212.06		0.7069	0.7127	5.702
43	344	1.491	2.95	215.59		0.7186	0.7191	5.753
44	352	1.475		215.88		0.7196	0.7196	5.757
45	360	1.444	3	215.88	1436	0.7196	0.7422	5.937
46	368	1.440		229.41		0.7647	0.7706	6.165
47	376	1.439	3.04	232.94		0.7765	0.7902	6.322
48	384	1.440		241.18		0.8039	0.7995	6.396
49	392	1.448	3.03	238.53		0.7951	0.7529	6.024
50	400	1.451		213.24	1432	0.7108	0.7652	6.122
51	408	1.415	3.11	245.88		0.8196	0.7985	6.388
52	416	1.399		233.24		0.8196	0.8260	6.608
53	424	1.369	3.19	252.94		0.7775	0.8863	7.090
54	432	1.346		262.35		0.8745	0.8863	7.090
55	440	1.312	3.3	269.41	1568	0.8980	0.8917	7.133

RAW WATER: INFLUENT NI = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 7% flowrate 3 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (mS/cm.)	CATION			RATIO NI. IN/ NI. OUT		
			pH	NIKEL (mg/l)	TDS (mg/l)	VALUE	AVERAGE	TOTAL
56	448	1.308		265.59		0.8853	0.8760	7.008
57	456	1.261	3.49	260.00		0.8667	0.8294	6.635
58	484	1.234		237.65		0.7922	0.8311	6.649
59	472	1.207	3.79	261.00		0.8700	0.8767	7.013
60	480	1.205		265.00	1600	0.8833	0.9191	7.353
61	488	1.201	4.35	286.47		0.9549	0.9304	7.443
62	496	1.198		271.76		0.9059	0.9260	7.408
63	504	1.177	5.6	283.82		0.9461	0.9382	7.506
64	512	1.187		279.12		0.9304	0.9250	7.400
65	520	1.199	5.97	275.88	1612	0.9196	0.9456	7.565
66	528	1.201		291.47		0.9716	0.9819	7.855
67	536	1.204	6.21	297.65		0.9922	0.9882	7.906
68	544	1.203		295.29		0.9843	0.9917	7.933
69	552	1.202	6.34	299.71		0.9990	0.9873	7.898
70	560	1.203		292.65	1768	0.9755	0.9902	7.922
71	568	1.204	6.47	301.47		1.0049	0.9877	7.902
72	576	1.204		291.18		0.9706	0.9858	7.886
73	584	1.203	6.64	300.29	1836	1.0010	0.5005	4.004
						SUM(RATIO OF NI. IN TO NI. OUT TOTAL)		346.63
						TOTAL EXCHANGE NICKEL (mg / l.resin)		71212.00

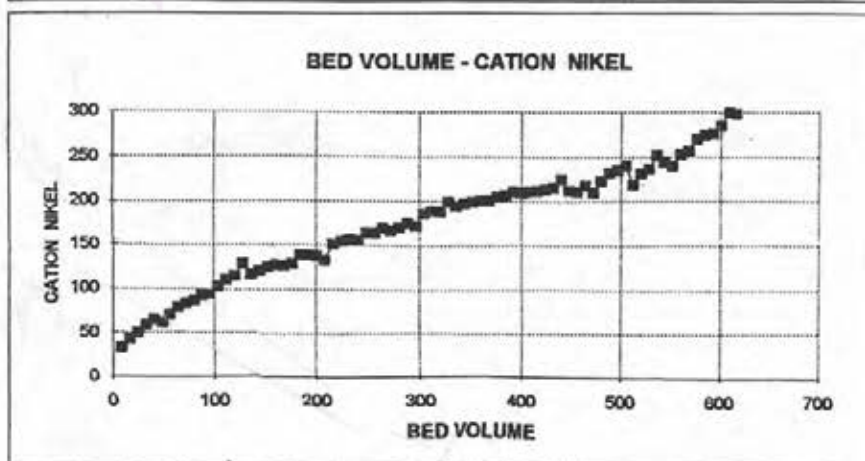
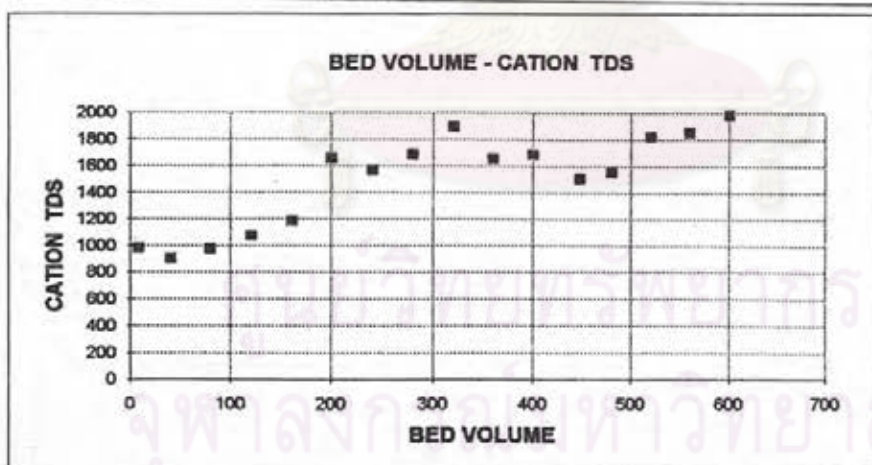
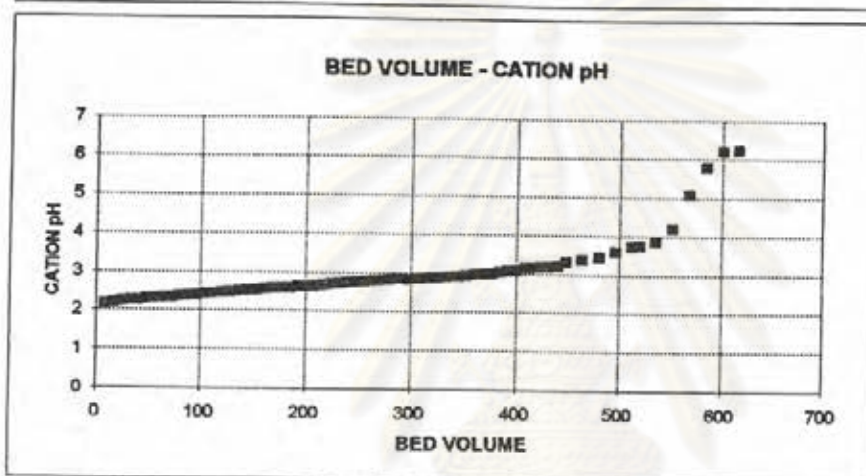
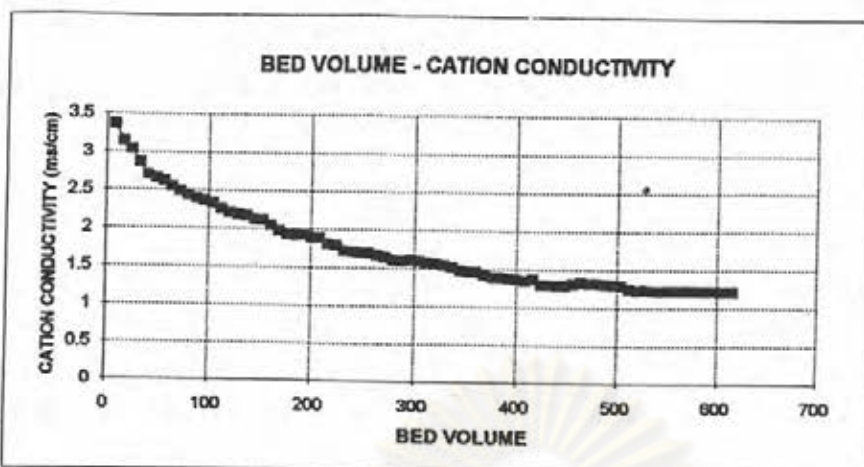
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RAW WATER: INFLUENT NI = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 7% flowrate 4.5 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (mS/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
1	8	3.370	2.15	32.94		0.1098	0.1265	1.012
2	16	3.150	2.2	42.94		0.1431	0.1539	1.231
3	24	3.050	2.24	49.41		0.1647	0.1799	1.439
4	32	2.970	2.26	58.53		0.1951	0.2064	1.651
5	40	2.710	2.27	65.29	904	0.2176	0.2108	1.696
6	48	2.660	2.31	61.18		0.2039	0.2201	1.761
7	56	2.630	2.32	70.88		0.2363	0.2495	1.996
8	64	2.550	2.33	78.82		0.2627	0.2696	2.157
9	72	2.490	2.35	82.94		0.2765	0.2833	2.267
10	80	2.440	2.38	87.06	980	0.2902	0.2990	2.392
11	88	2.400	2.39	92.35		0.3078	0.3116	2.493
12	96	2.360	2.41	94.59		0.3153	0.3302	2.642
13	104	2.340	2.44	103.53		0.3451	0.3569	2.855
14	112	2.260	2.46	110.59		0.3686	0.3770	3.016
15	120	2.210	2.47	115.59	1076	0.3853	0.4078	3.263
16	128	2.190	2.48	129.12		0.4304	0.4107	3.285
17	136	2.170	2.51	117.29		0.3910	0.3969	3.176
18	144	2.120	2.53	120.86		0.4029	0.4098	3.278
19	152	2.110	2.54	125.00		0.4167	0.4209	3.368
20	160	2.050	2.57	127.57	1188	0.4252	0.4234	3.387
21	168	1.970	2.58	126.45		0.4215	0.4250	3.400
22	176	1.930	2.59	128.56		0.4285	0.4452	3.561
23	184	1.920	2.6	138.53		0.4618	0.4618	3.694
24	192	1.932	2.63	138.53		0.4618	0.4603	3.682
25	200	1.899	2.64	137.85	1658	0.4588	0.4502	3.601
26	208	1.887	2.65	132.46		0.4415	0.4732	3.786
27	216	1.812	2.68	151.47		0.5049	0.5102	4.081
28	224	1.802	2.7	154.63		0.5154	0.5190	4.152
29	232	1.723	2.72	156.78		0.5226	0.5203	4.162
30	240	1.712	2.74	155.40	1568	0.5180	0.5315	4.252
31	248	1.701	2.76	163.49		0.5450	0.5455	4.364
32	256	1.692	2.78	163.79		0.5460	0.5554	4.443
33	264	1.674	2.8	169.46		0.5649	0.5617	4.494
34	272	1.645	2.81	167.59		0.5586	0.5636	4.508
35	280	1.612	2.83	170.54	1689	0.5685	0.5717	4.574
36	288	1.601	2.85	175.99		0.5750	0.5978	4.782
37	296	1.621	2.84	172.51		0.6206	0.6260	5.008
38	304	1.600	2.86	186.18		0.6314	0.6300	5.040
39	312	1.578	2.87	189.41		0.6286	0.6472	5.177
40	320	1.562	2.89	188.59	1897	0.6657	0.6578	5.263
41	328	1.542	2.9	199.71		0.6500	0.6500	5.200
42	336	1.521	2.91	195.00		0.6500	0.6544	5.235
43	344	1.478	2.93	197.65		0.6588	0.6623	5.298
44	352	1.465	2.95	199.71		0.6657	0.6686	5.349
45	360	1.456	2.98	201.47	1654	0.6716	0.6711	5.369
46	368	1.423	2.99	201.18		0.6706	0.6775	5.420
47	376	1.398	3.01	205.29		0.6843	0.6877	5.502
48	384	1.395	3.05	207.35		0.6912	0.6975	5.590
49	392	1.380	3.08	211.18		0.7039	0.7025	5.620
50	400	1.364	3.09	210.29	1689	0.7010	0.7029	5.624
51	408	1.350	3.16	211.47		0.7049	0.7054	5.643
52	416	1.372	3.17	211.76		0.7049	0.7132	5.706
53	424	1.299	3.19	213.53		0.7059	0.7353	5.882
54	432	1.296	3.2	216.18		0.7206	0.7353	5.882
55	440	1.293	3.21	225.00		0.7500	0.7289	5.831

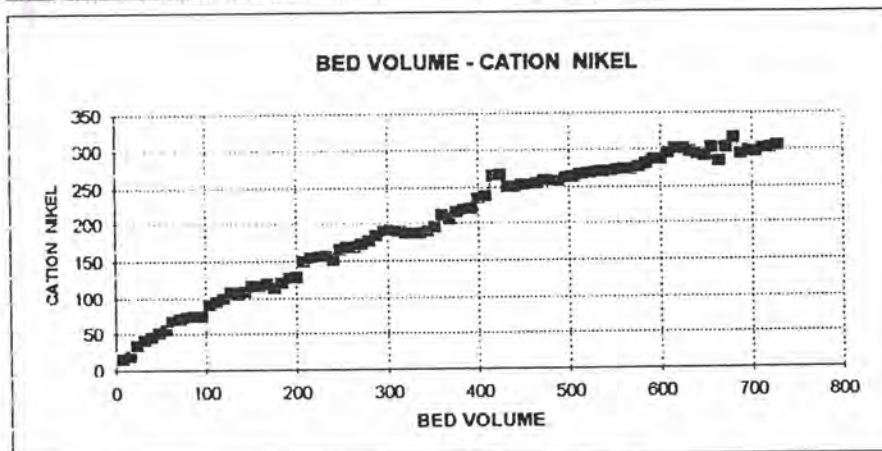
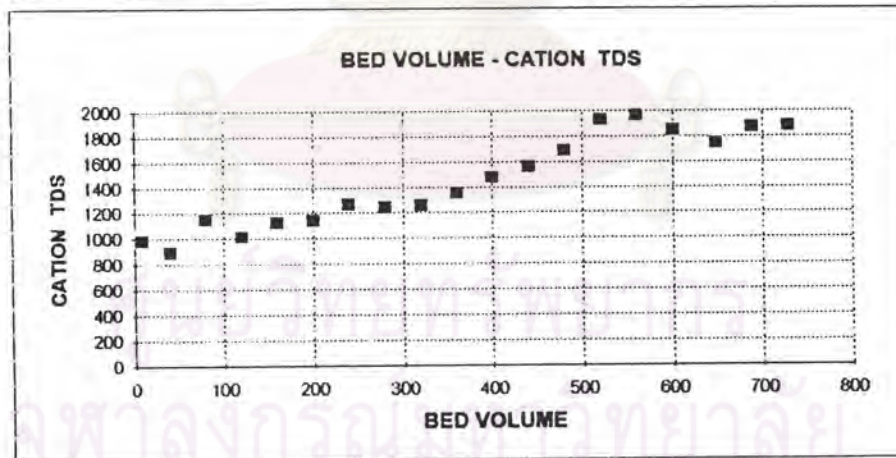
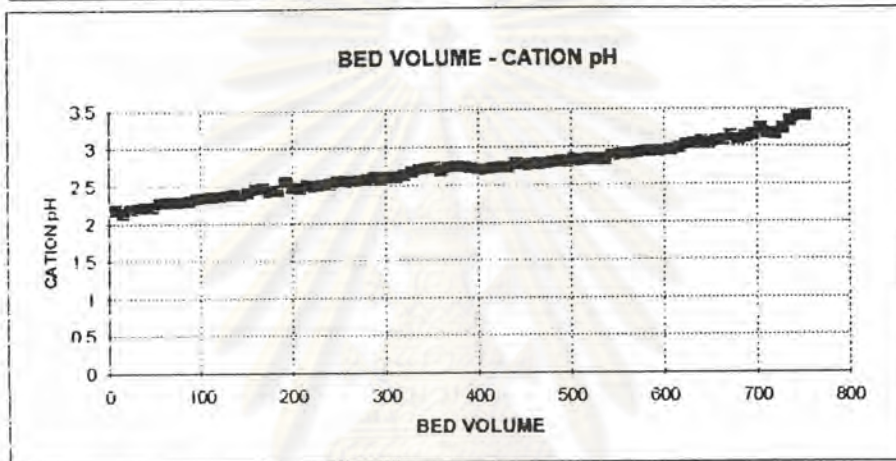
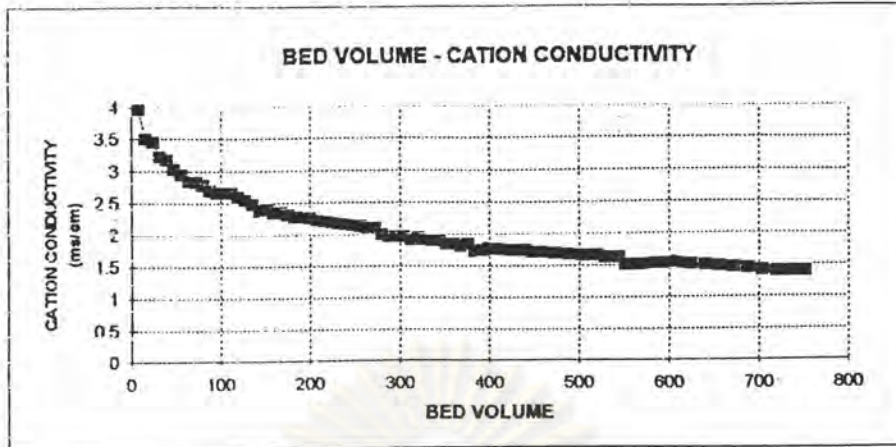
RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 7% flowrate 4.5 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
56	448	1.292	3.32	212.36	1508	0.7079	0.7063	5.651
57	456	1.311		211.45		0.7048	0.7155	5.724
58	464	1.335	3.39	217.85		0.7262	0.7137	5.709
59	472	1.320		210.36		0.7012	0.7231	5.785
60	480	1.318	3.46	223.53	1552	0.7451	0.7598	6.078
61	488	1.309		232.35		0.7745	0.7794	6.235
62	496	1.302	3.6	235.29		0.7843	0.7936	6.349
63	504	1.295		240.88		0.8029	0.7672	6.137
64	512	1.248	3.73	219.41		0.7314	0.7520	6.018
65	520	1.228	3.76	231.76	1820	0.7725	0.7819	6.255
66	528	1.238		237.35		0.7912	0.8157	6.525
67	536	1.227	3.87	252.06		0.8402	0.8284	6.627
68	544	1.224		245.00		0.8167	0.8083	6.467
69	552	1.225	4.2	240.00		0.8000	0.8222	6.578
70	560	1.226		253.33	1856	0.8444	0.8502	6.801
71	568	1.227	5.09	256.76		0.8559	0.8775	7.020
72	576	1.229		269.71		0.8990	0.9074	7.259
73	584	1.227	5.8	274.71		0.9157	0.9172	7.337
74	592	1.227		275.59		0.9186	0.9338	7.471
75	600	1.226	6.21	284.71	1986	0.9490	0.9735	7.788
76	608	1.221		299.41		0.9980	0.9951	7.961
77	616	1.220	6.24	297.65		0.9922	0.4961	3.969
								359.26
								77021.02

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RAW WATER: INFLUENT NI = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 7% flowrate 6 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
1	8	3.980	2.18	16.47	986	0.0549	0.0618	0.494
2	16	3.500	2.14	20.59		0.0686	0.0931	0.745
3	24	3.450	2.19	35.29		0.1176	0.1289	1.031
4	32	3.220	2.2	42.06		0.1402	0.1471	1.176
5	40	3.170	2.22	46.18	896	0.1539	0.1632	1.306
6	48	3.030	2.22	51.76		0.1725	0.1804	1.443
7	56	2.950	2.27	56.47		0.1882	0.2069	1.655
8	64	2.850	2.29	67.65		0.2255	0.2304	1.843
9	72	2.820	2.29	70.59		0.2353	0.2407	1.925
10	80	2.770	2.28	73.82	1152	0.2461	0.2480	1.984
11	88	2.700	2.3	75.00		0.2500	0.2505	2.004
12	96	2.660	2.33	75.29		0.2610	0.2760	2.208
13	104	2.660	2.34	90.29		0.3010	0.3088	2.471
14	112	2.660	2.35	95.00		0.3167	0.3235	2.588
15	120	2.590	2.38	99.12	1024	0.3304	0.3451	2.761
16	128	2.540	2.37	107.94		0.3598	0.3564	2.851
17	136	2.470	2.38	105.88		0.3529	0.3603	2.862
18	144	2.380	2.39	110.29		0.3676	0.3784	3.027
19	152	2.390	2.42	116.76		0.3892	0.3907	3.125
20	160	2.340	2.45	117.65	1129	0.3922	0.3961	3.169
21	168	2.350	2.47	120.00		0.4000	0.3902	3.122
22	176	2.310	2.43	114.12		0.3804	0.3932	3.145
23	184	2.280	2.44	121.78		0.4059	0.4152	3.322
24	192	2.270	2.55	127.35		0.4245	0.4260	3.408
25	200	2.260	2.48	128.24	1145	0.4275	0.4852	3.722
26	208	2.230	2.47	150.88		0.5029	0.5083	4.067
27	216	2.210	2.51	154.12		0.5137	0.5157	4.125
28	224	2.200	2.5	155.29		0.5176	0.5216	4.173
29	232	2.180	2.52	157.65		0.5255	0.5152	4.122
30	240	2.160	2.53	151.47	1268	0.5049	0.5294	4.235
31	248	2.140	2.55	166.17		0.5539	0.5577	4.462
32	256	2.130	2.57	168.45		0.5615	0.5622	4.498
33	264	2.100	2.56	168.88		0.5629	0.5703	4.562
34	272	2.090	2.57	173.29		0.5776	0.5845	4.676
35	280	1.990	2.58	177.41	1249	0.5914	0.6139	4.911
36	288	1.960	2.61	185.06		0.6365	0.6394	5.115
37	296	1.970	2.59	190.94		0.6424	0.6384	5.107
38	304	1.960	2.62	192.71		0.6345	0.6301	5.041
39	312	1.920	2.61	190.35		0.6257	0.6247	4.998
40	320	1.950	2.65	187.71	1263	0.6237	0.6237	4.990
41	328	1.920	2.68	187.12		0.6237	0.6237	4.990
42	336	1.900	2.71	187.12		0.6237	0.6291	5.033
43	344	1.890	2.73	190.35		0.6345	0.6448	5.158
44	352	1.850	2.75	196.53		0.6551	0.6806	5.445
45	360	1.850	2.7	211.82	1358	0.7061	0.6968	5.574
46	368	1.820	2.75	206.24		0.6875	0.7041	5.633
47	376	1.840	2.76	216.24		0.7208	0.7252	5.802
48	384	1.730	2.76	218.88		0.7286	0.7330	5.864
49	392	1.740	2.74	220.94		0.7365	0.7600	6.080
50	400	1.780	2.73	235.06	1479	0.7835	0.7884	6.307
51	408	1.770	2.72	238.00		0.7933	0.8404	6.723
52	416	1.760	2.73	266.24		0.7933	0.8614	6.891
53	424	1.740	2.74	266.53		0.8875	0.8353	6.682
54	432	1.740	2.75	250.59		0.8353	0.8353	6.682
55	440	1.750	2.78	250.59	1563	0.8353	0.8402	6.722

RAW WATER: INFLUENT NI = 300 mg/l & OTHER								
SERVICE FLOWRATE = 20 BV/Hr								
RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 7% flowrate 6 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
56	448	1.720	2.79	253.53		0.8451	0.8456	6.785
57	456	1.718	2.77	253.82		0.8461	0.8490	6.792
58	464	1.710	2.78	255.59		0.8520	0.8593	6.875
59	472	1.700	2.79	260.00		0.8667	0.8657	6.925
60	480	1.694	2.8	259.41	1693	0.8647	0.8627	6.902
61	488	1.680	2.81	258.24		0.8608	0.8691	6.953
62	496	1.672	2.82	253.24		0.8776	0.8799	7.039
63	504	1.670	2.84	264.71		0.8824	0.8868	7.094
64	512	1.664	2.83	267.35		0.8912	0.8936	7.149
65	520	1.658	2.84	268.82	1936	0.8961	0.8980	7.184
66	528	1.635	2.85	270.00		0.9000	0.9025	7.220
67	536	1.628	2.85	271.47		0.9049	0.9059	7.247
68	544	1.624	2.89	272.06		0.9069	0.9078	7.263
69	552	1.508	2.9	272.65		0.9088	0.9118	7.294
70	560	1.509	2.91	274.41	1963	0.9147	0.9157	7.325
71	568	1.512	2.92	275.00		0.9167	0.9196	7.357
72	576	1.519	2.93	276.76		0.9225	0.9294	7.435
73	584	1.523	2.94	280.88		0.9363	0.9461	7.569
74	592	1.524	2.95	286.76		0.9559	0.9578	7.663
75	600	1.536	2.95	287.94	1852	0.9598	0.9740	7.792
76	608	1.553	2.96	296.47		0.9882	0.9968	7.973
77	616	1.523	2.98	301.47		1.0049	1.0044	8.035
78	624	1.515	3.03	301.18		1.0039	0.9975	7.980
79	632		3.04	297.35		0.9912	0.9863	7.890
80	640	1.498	3.07	294.41		0.9814	0.9775	7.820
81	648		3.05	292.06	1748	0.9735	0.9917	7.933
82	656	1.478	3.07	302.94		1.0098	0.9799	7.839
83	664		3.09	285.00		0.9500	0.9804	7.843
84	672	1.464	3.15	303.24		1.0108	1.0324	8.259
85	680		3.1	316.16		1.0539	1.0172	8.137
86	688	1.441	3.13	294.12	1872	0.9804	0.9892	7.914
87	696		3.16	299.41		0.9980	0.9946	7.957
88	704	1.421	3.25	297.35		0.9912	0.9980	7.984
89	712		3.19	301.47		1.0049	1.0069	8.055
90	720	1.404	3.17	302.65		1.0088	1.0142	8.114
91	728		3.25	305.88	1879	1.0196	1.0250	8.200
92	736	1.399	3.35	309.12		1.0304	1.0284	8.227
93	744		3.4	307.94		1.0265	1.0309	8.247
94	752	1.392	3.42	310.59		1.0363	0.5176	4.141
SUM(RATIO OF NI. IN TO NI. OUT TOTAL)								508.47
TOTAL EXCHANGE NICKEL (mg / l.resin)								73059.37

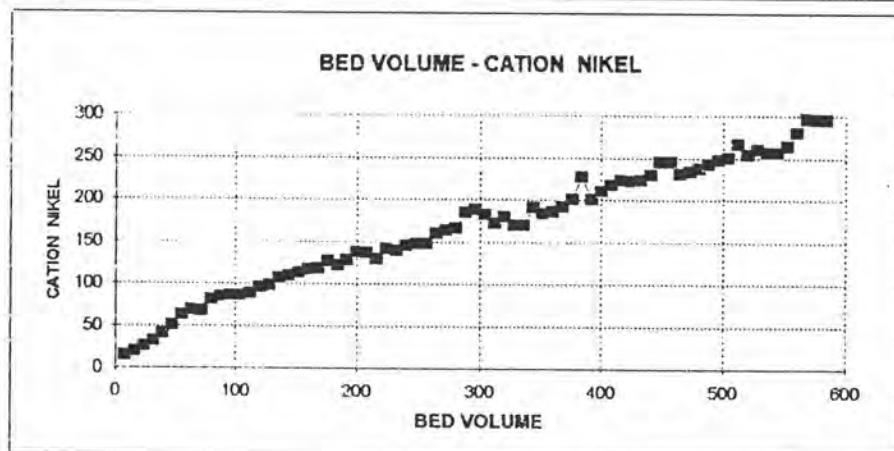
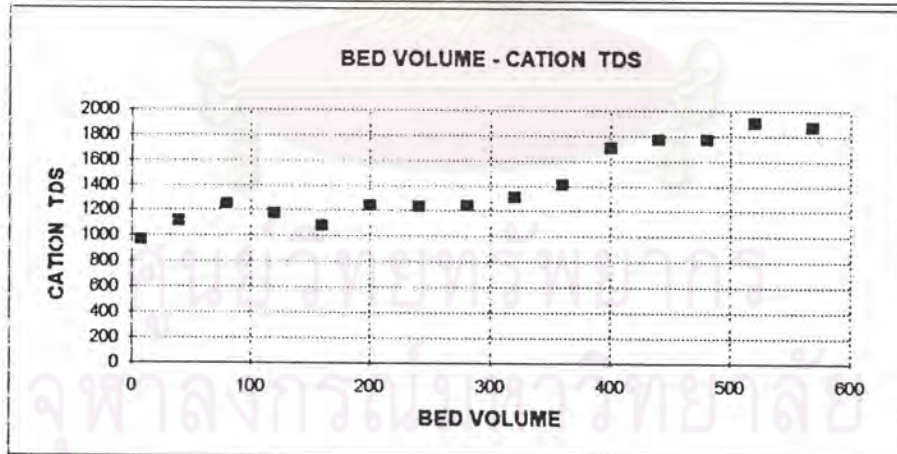
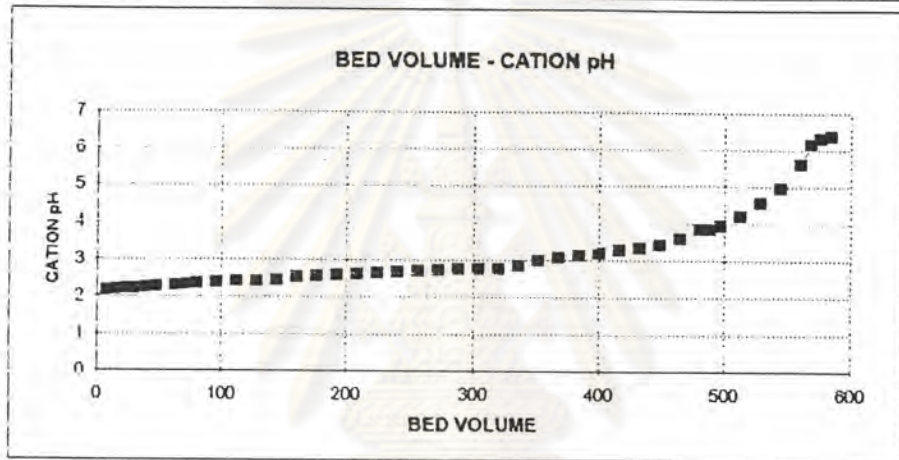
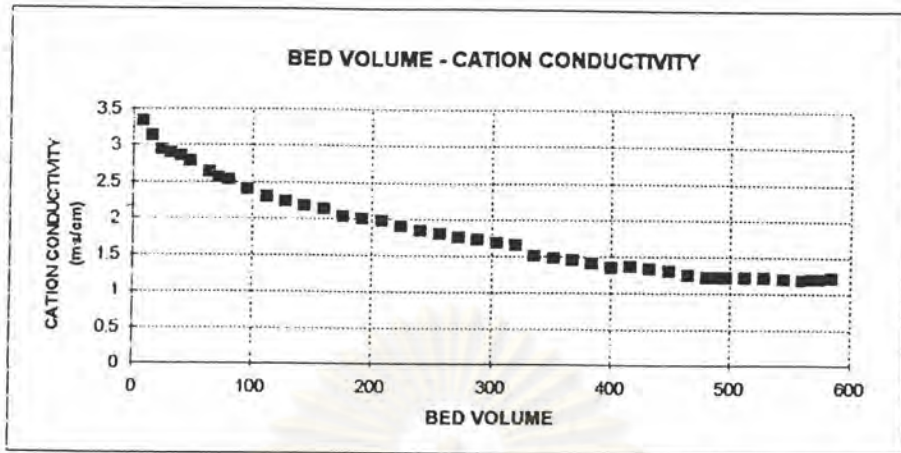


RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 9% flowrate 3 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
1	8	3.340	2.16	15.00	972	0.0500	0.0578	0.463
2	16	3.140	2.18	19.71		0.0657	0.0760	0.608
3	24	2.950	2.22	25.88		0.0863	0.0966	0.773
4	32	2.910	2.23	32.06		0.1069	0.1216	0.973
5	40	2.860	2.24	40.88	1120	0.1363	0.1520	1.216
6	48	2.780	2.28	50.29		0.1676	0.1887	1.510
7	56			62.94		0.2096	0.2196	1.757
8	64	2.640	2.31	68.82		0.2294	0.2275	1.820
9	72	2.560	2.34	67.65		0.2255	0.2495	1.996
10	80	2.530	2.37	82.06	1252	0.2735	0.2794	2.235
11	88			85.59		0.2853	0.2863	2.290
12	96	2.410	2.39	86.18		0.2873	0.2882	2.306
13	104			86.76		0.2892	0.2941	2.353
14	112	2.300	2.41	89.71		0.2990	0.3103	2.482
15	120			96.47	1178	0.3216	0.3250	2.600
16	128	2.240	2.43	96.53		0.3284	0.3431	2.745
17	136			107.35		0.3578	0.3627	2.902
18	144	2.180	2.46	110.29		0.3676	0.3740	2.992
19	152			114.12		0.3804	0.3853	3.082
20	160	2.140	2.53	117.06	1085	0.3902	0.3941	3.153
21	168			119.41		0.3980	0.4123	3.298
22	176	2.040	2.56	127.94		0.4265	0.4181	3.345
23	184			122.94		0.4098	0.4186	3.349
24	192	2.010	2.59	128.24		0.4275	0.4456	3.565
25	200			139.12	1250	0.4637	0.4613	3.690
26	208	1.980	2.62	137.65		0.4588	0.4461	3.569
27	216			130.00		0.4333	0.4549	3.639
28	224	1.904	2.64	142.94		0.4765	0.4711	3.769
29	232			139.71		0.4657	0.4770	3.816
30	240	1.845	2.68	146.47	1240	0.4882	0.4922	3.937
31	248			148.82		0.4961	0.4961	3.969
32	256	1.802	2.72	148.82		0.4961	0.5157	4.125
33	264			160.59		0.5353	0.5426	4.341
34	272	1.756	2.74	165.00		0.5500	0.5544	4.435
35	280			167.65	1247	0.5588	0.5951	4.761
36	288	1.726	2.76	185.29		0.6314	0.6201	4.961
37	296			189.41		0.6088	0.5936	4.749
38	304	1.687	2.77	182.65		0.5784	0.5902	4.722
39	312			173.53		0.6020	0.5853	4.682
40	320	1.652	2.78	180.59	1316	0.5686	0.5686	4.549
41	328			170.59		0.5686	0.5686	4.549
42	336	1.517	2.84	170.59		0.5686	0.6044	4.835
43	344			192.06		0.6402	0.6270	5.016
44	352	1.478	3	184.12		0.6137	0.6176	4.941
45	360			186.47	1415	0.6216	0.6324	5.059
46	368	1.447	3.09	192.94		0.6431	0.6588	5.271
47	376			202.35		0.6745	0.7196	5.757
48	384	1.412	3.15	229.41		0.7647	0.7196	5.757
49	392			202.35		0.6745	0.6902	5.522
50	400	1.355	3.21	211.78	1708	0.7059	0.7176	5.741
51	408			218.82		0.7294	0.7392	5.914
52	416	1.360	3.27	224.71		0.7294	0.7500	6.000
53	424			223.82		0.7490	0.7618	6.094
54	432	1.334	3.33	225.29		0.7510	0.7618	6.094
55	440			231.78	1776	0.7725	0.7966	6.373

RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 9% flowrate 3 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
56	448	1.309	3.43	246.18		0.8206	0.8216	6.573
57	456			246.76		0.8225	0.7985	6.388
58	464	1.252	3.59	232.35		0.7745	0.7788	6.230
59	472			234.90		0.7830	0.7898	6.318
60	480	1.223	3.84	238.96	1772	0.7965	0.8041	6.433
61	488	1.224	3.86	243.53		0.8118	0.8206	6.565
62	496	1.223	3.95	248.82		0.8294	0.8338	6.671
63	504			251.47		0.8382	0.8637	6.910
64	512	1.218	4.21	266.76		0.8892	0.8706	6.965
65	520			255.59	1904	0.8520	0.8623	6.898
66	528	1.216	4.57	261.76		0.8725	0.8652	6.922
67	536			257.35		0.8578	0.8574	6.859
68	544	1.211	4.98	257.06		0.8569	0.8696	6.957
69	552			264.71		0.8824	0.9098	7.278
70	560	1.188	5.64	281.18		0.9373	0.9637	7.710
71	568	1.199	6.16	297.06	1876	0.9902	0.9873	7.898
72	576	1.204	6.35	295.29		0.9843	0.9843	7.875
73	584	1.212	6.39	295.29		0.9843	0.4922	3.937
SUM(RATIO OF NI. IN TO NI. OUT TOTAL)								325.83
TOTAL EXCHANGE NICKEL (mg / l. resin)								77450.30

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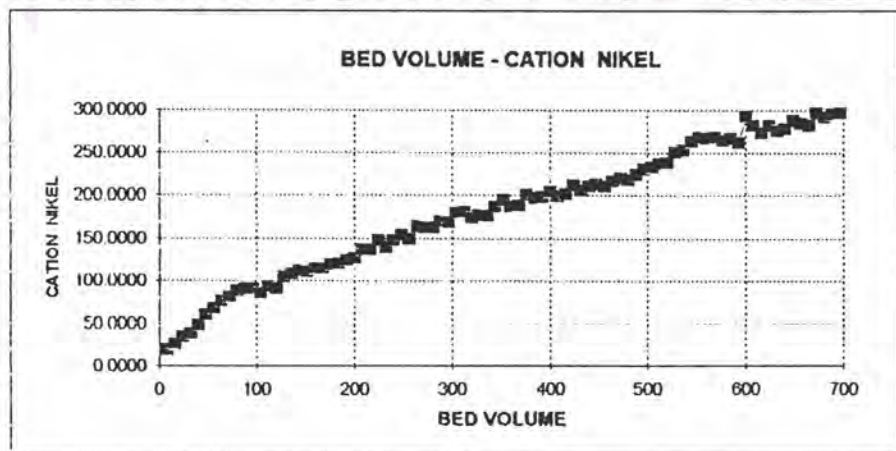
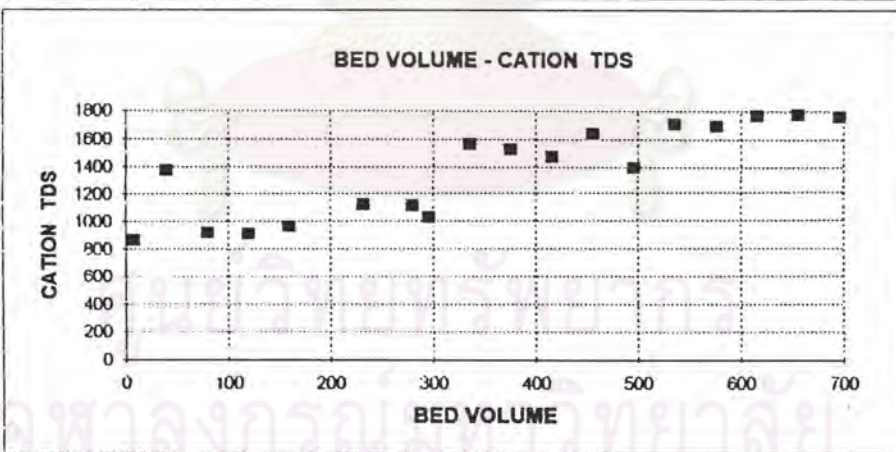
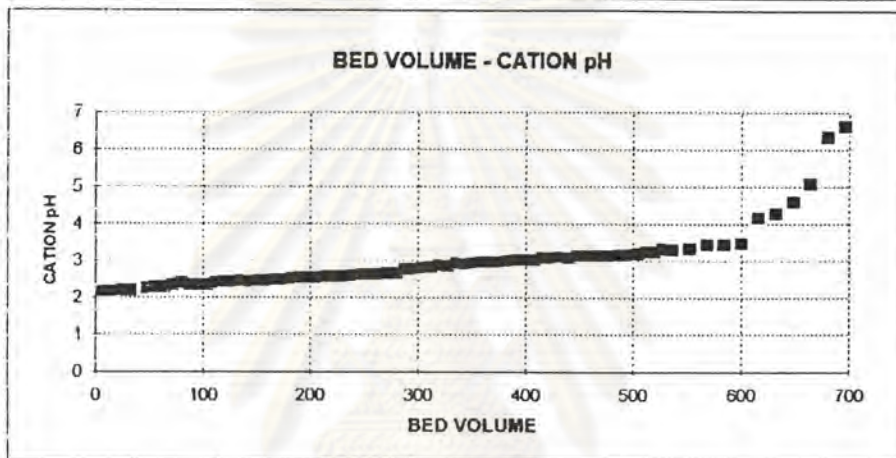
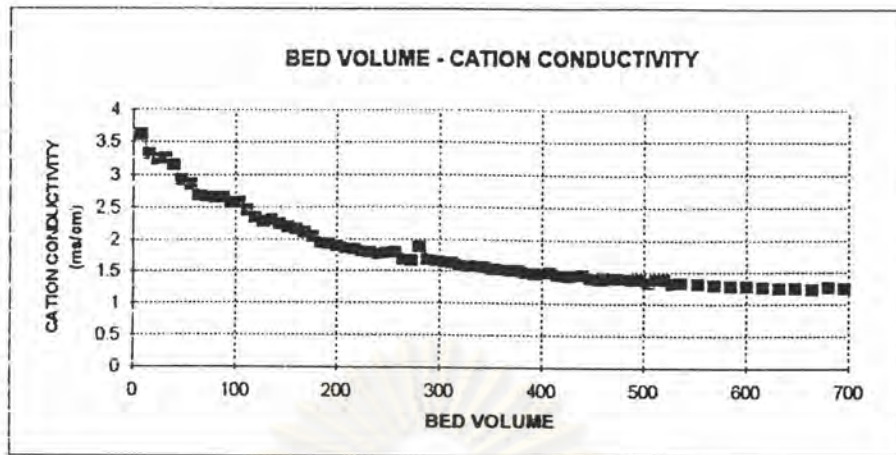
3-R2-9L.XLS



RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 9% flowrate 4.5 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
1	8	3.630	2.16	19.71	864	0.0657	0.0770	0.618
2	16	3.320	2.17	26.47		0.0882	0.1020	0.816
3	24	3.250	2.18	34.71		0.1157	0.1221	0.976
4	32	3.260	2.19	38.53		0.1284	0.1446	1.157
5	40	3.160		48.24	1376	0.1608	0.1814	1.451
6	48	2.930	2.24	60.59		0.2020	0.2137	1.710
7	56	2.860	2.27	67.65		0.2255	0.2407	1.925
8	64	2.700	2.29	76.76		0.2559	0.2647	2.118
9	72	2.680	2.33	82.06		0.2735	0.2858	2.286
10	80	2.660	2.39	89.41	916	0.2980	0.3015	2.412
11	88	2.660	2.34	91.47		0.3049	0.3059	2.447
12	96	2.570	2.35	92.06		0.3069	0.2960	2.368
13	104	2.570	2.35	85.55		0.2852	0.2999	2.400
14	112	2.460	2.38	94.41		0.3147	0.3108	2.486
15	120	2.350	2.42	92.06	912	0.3069	0.3284	2.627
16	128	2.280	2.43	105.00		0.3500	0.3561	2.849
17	136	2.310	2.44	108.65		0.3622	0.3688	2.951
18	144	2.240	2.43	112.65		0.3755	0.3730	2.984
19	152	2.190	2.45	111.16		0.3705	0.3779	3.023
20	160	2.160	2.46	115.59	964	0.3853	0.3843	3.075
21	168	2.110	2.47	115.00		0.3833	0.3926	3.141
22	176	2.050	2.48	120.59		0.4020	0.4034	3.227
23	184	1.950	2.5	121.47		0.4049	0.4098	3.278
24	192	1.930	2.53	124.41		0.4147	0.4196	3.357
25	200	1.900	2.54	127.35		0.4245	0.4422	3.537
26	208	1.870	2.55	137.94		0.4598	0.4588	3.671
27	216	1.852	2.56	137.35		0.4578	0.4760	3.808
28	224	1.810	2.57	148.23		0.4941	0.4810	3.848
29	232	1.794	2.58	140.35	1125	0.4678	0.4820	3.856
30	240	1.756	2.59	148.82		0.4961	0.5054	4.043
31	248	1.774	2.61	154.41		0.5147	0.5078	4.063
32	256	1.789	2.62	150.29		0.5010	0.5242	4.194
33	264	1.687	2.63	164.25		0.5475	0.5454	4.363
34	272	1.668	2.64	162.97		0.5432	0.5442	4.353
35	280	1.880	2.66	163.53	1112	0.5451	0.5544	4.435
36	288	1.678	2.76	170.88		0.5637	0.5823	4.659
37	296	1.663	2.77	169.12	1032	0.6010	0.6029	4.823
38	304	1.648	2.79	180.29		0.6049	0.5941	4.753
39	312	1.637	2.81	181.47		0.5833	0.5878	4.702
40	320	1.596	2.89	175.00		0.5922	0.5916	4.733
41	328	1.584	2.85	177.87		0.5910	0.5910	4.728
42	336	1.576	2.93	177.30	1564	0.5910	0.6097	4.878
43	344	1.562	2.92	188.53		0.6284	0.6392	5.114
44	352	1.538	2.94	195.00		0.6500	0.6392	5.114
45	360	1.535	2.96	188.53		0.6284	0.6304	5.043
46	368	1.509	2.97	189.71		0.6324	0.6525	5.220
47	376	1.512	2.97	201.76	1528	0.6725	0.6657	5.325
48	384	1.481	2.99	197.65		0.6588	0.6622	5.297
49	392	1.467	3.02	199.65		0.6655	0.6749	5.399
50	400	1.459	3.03	205.29		0.6843	0.6785	5.412
51	408	1.480	3.01	200.59		0.6686	0.6735	5.388
52	416	1.450	3.07	203.53	1476	0.6686	0.6833	5.467
53	424	1.438	3.08	212.94		0.6784	0.6961	5.569
54	432	1.425	3.1	206.46		0.6882	0.6961	5.569
55	440	1.453	3.07	211.18		0.7039	0.7088	5.671

RAW WATER: INFLUENT Ni. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 9% flowrate 4.5 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
56	448	1.399	3.13	214.12		0.7137	0.7098	5.678
57	456	1.389	3.14	211.76	1640	0.7059	0.7167	5.733
58	464	1.389	3.14	218.24		0.7275	0.7337	5.870
59	472	1.396	3.14	222.00		0.7400	0.7358	5.887
60	480	1.396	3.15	219.50		0.7317	0.7423	5.938
61	488	1.385	3.17	225.88		0.7529	0.7618	6.094
62	496	1.382	3.18	231.18	1400	0.7706	0.7750	6.200
63	504	1.338	3.21	233.82		0.7794	0.7848	6.279
64	512	1.387	3.25	237.07		0.7902	0.7941	6.353
65	520	1.388	3.24	239.41		0.7980	0.8186	6.549
66	528	1.318	3.33	251.76		0.8392	0.8431	6.745
67	536	1.337	3.32	254.12	1708	0.8471	0.8637	6.910
68	544			264.12		0.8804	0.8882	7.106
69	552	1.318	3.34	268.82		0.8961	0.8946	7.157
70	560			267.94		0.8931	0.8946	7.157
71	568	1.295	3.45	268.82		0.8961	0.8892	7.114
72	576			264.71	1692	0.8824	0.8873	7.098
73	584	1.278	3.45	267.65		0.8922	0.8833	7.067
74	592			262.36		0.8745	0.9255	7.404
75	600	1.278	3.47	292.94		0.9765	0.9578	7.663
76	608			281.76		0.9392	0.9250	7.400
77	616	1.263	4.18	273.24	1772	0.9108	0.9255	7.412
78	624			282.65		0.9422	0.9319	7.455
79	632	1.254	4.29	276.47		0.9216	0.9250	7.400
80	640			278.53		0.9284	0.9451	7.561
81	648	1.247	4.59	288.53		0.9618	0.9559	7.647
82	656			285.00	1778	0.9500	0.9451	7.561
83	664	1.233	5.08	282.06		0.9402	0.9652	7.722
84	672			297.06		0.9902	0.9819	7.855
85	680	1.266	6.34	292.06		0.9735	0.9799	7.839
86	688			295.88		0.9863	0.9882	7.906
87	696	1.248	6.64	297.06	1765	0.9902	0.9951	3.961
SUM(RATIO OF NI. IN TO NI. OUT TOTAL)								422.43
TOTAL EXCHANGE NICKEL. (mg / l.resin)								82070.31

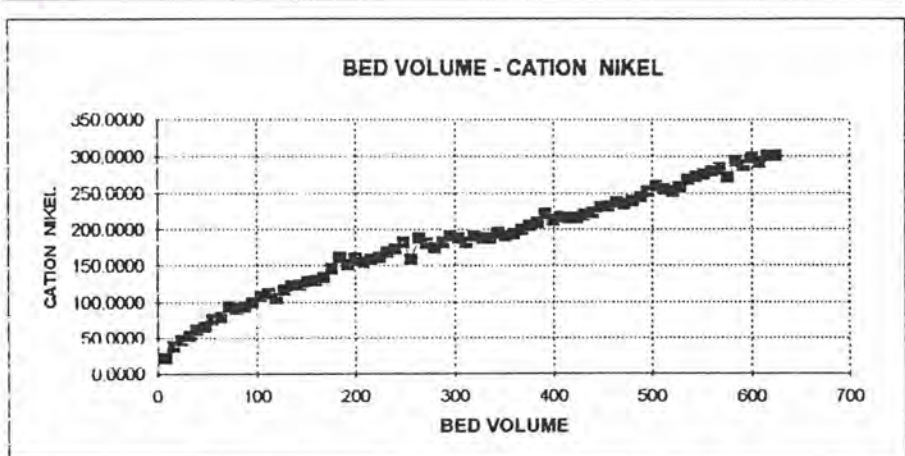
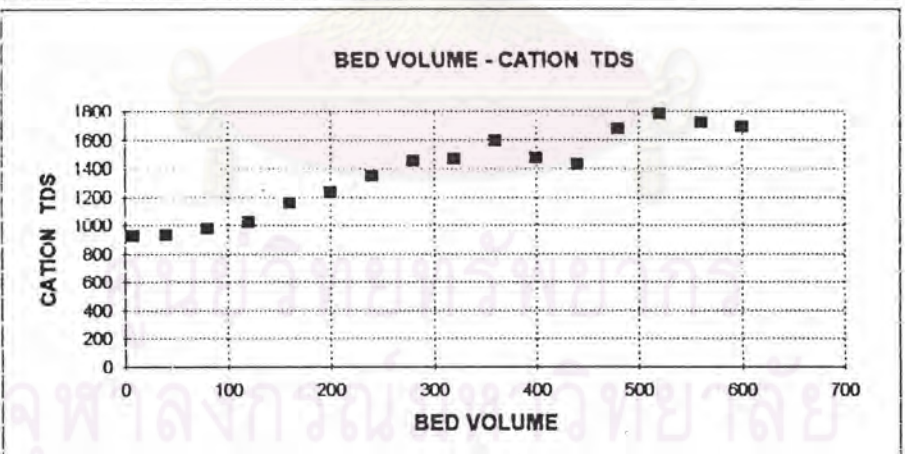
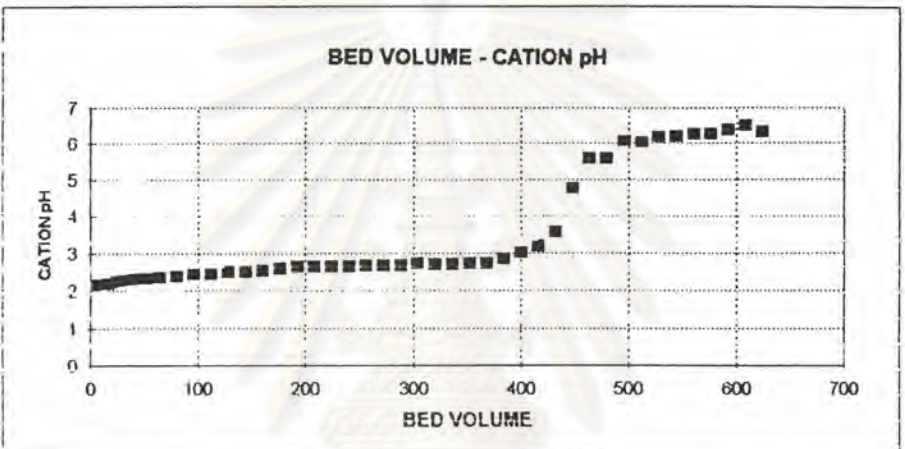
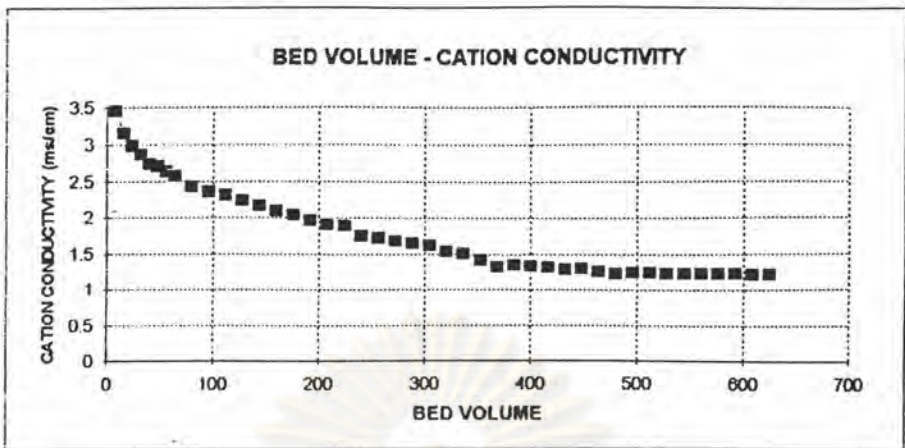
ศูนย์วิจัยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย



RAW WATER: INFLUENT NL = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 9% flowrate 6 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NL. IN/ NL. OUT		
						VALUE	AVERAGE	TOTAL
1	8	3.470	2.17	22.85	922	0.0755	0.1025	0.820
2	16	3.160	2.2	38.82		0.1294	0.1428	1.141
3	24	2.980	2.25	46.78		0.1559	0.1662	1.329
4	32	2.970	2.28	52.94		0.1765	0.1897	1.518
5	40	2.740	2.3	60.88	936	0.2029	0.2118	1.694
6	48	2.710	2.35	66.18		0.2206	0.2377	1.902
7	56	2.640	2.33	76.47		0.2549	0.2598	2.078
8	64	2.580	2.37	79.41		0.2647	0.2882	2.306
9	72			93.53		0.3118	0.3074	2.459
10	80	2.440	2.39	90.88	975	0.3029	0.3064	2.451
11	88			92.94		0.3098	0.3216	2.573
12	96	2.360	2.44	100.00		0.3333	0.3475	2.780
13	104			108.53		0.3618	0.3681	2.945
14	112	2.320	2.44	112.35		0.3745	0.3623	2.898
15	120			105.00	1025	0.3500	0.3696	2.957
16	128	2.250	2.5	116.76		0.3892	0.3995	3.198
17	136			122.94		0.4098	0.4127	3.302
18	144	2.170	2.52	124.71		0.4157	0.4216	3.373
19	152			128.24		0.4275	0.4314	3.451
20	160	2.100	2.55	130.59	1156	0.4353	0.4412	3.529
21	168			134.12		0.4471	0.4672	3.737
22	176	2.040	2.6	146.18		0.4873	0.5132	4.106
23	184			161.76		0.5392	0.5221	4.176
24	192	1.974	2.65	151.47		0.5049	0.5201	4.161
25	200			160.59	1236	0.5353	0.5265	4.212
26	208	1.914	2.66	155.29		0.5176	0.5250	4.200
27	216			159.71		0.5324	0.5373	4.298
28	224	1.895	2.66	162.65		0.5422	0.5525	4.420
29	232			168.82		0.5627	0.5701	4.581
30	240	1.752	2.65	173.24	1349	0.5775	0.5941	4.753
31	248			183.24		0.6108	0.5711	4.569
32	256	1.724	2.67	159.41		0.5314	0.5789	4.631
33	264			187.94		0.6265	0.6162	4.929
34	272	1.685	2.68	181.76		0.6059	0.5961	4.769
35	280			175.88	1456	0.5883	0.6132	4.906
36	288	1.654	2.69	183.24		0.6402	0.6333	5.067
37	296			192.06		0.6265	0.6188	4.949
38	304	1.621	2.73	187.94		0.6108	0.6235	4.988
39	312			183.24		0.6363	0.6333	5.067
40	320	1.534	2.71	190.88	1468	0.6304	0.6304	5.043
41	328			189.12		0.6304	0.6304	5.043
42	336	1.511	2.72	189.12		0.6304	0.6426	5.141
43	344			196.47		0.6549	0.6475	5.180
44	352	1.423	2.73	192.06		0.6402	0.6451	5.161
45	360			195.00	1598	0.6500	0.6578	5.263
46	368	1.321	2.73	199.71		0.6657	0.6770	5.416
47	376			206.47		0.6882	0.6946	5.557
48	384	1.346	2.84	210.29		0.7010	0.7201	5.761
49	392			221.78		0.7392	0.7255	5.804
50	400	1.328	3.01	213.53	1478	0.7118	0.7181	5.745
51	408			217.35		0.7245	0.7221	5.778
52	416	1.314	3.21	215.88		0.7245	0.7270	5.816
53	424			216.47		0.7196	0.7392	5.914
54	432	1.298	3.56	220.29		0.7343	0.7392	5.914
55	440			223.24	1432	0.7441	0.7559	6.047

RAW WATER: INFLUENT NI = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 9% flowrate 6 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
56	448	1.299	4.77	230.29		0.7676	0.7701	6.161
57	456			231.76		0.7725	0.7843	6.275
58	464	1.264	5.61	238.82		0.7961	0.7890	6.312
59	472			234.60		0.7820	0.7907	6.325
60	480	1.239	5.59	239.80	1678	0.7993	0.8095	6.476
61	488			245.88		0.8196	0.8304	6.643
62	496	1.247	6.08	252.35		0.8412	0.8544	6.835
63	504			260.29		0.8676	0.8598	6.878
64	512	1.246	6.05	255.59		0.8520	0.8466	6.773
65	520			252.35	1785	0.8412	0.8505	6.804
66	528	1.239	6.21	257.94		0.8598	0.8770	7.016
67	536			268.24		0.8941	0.9020	7.216
68	544	1.235	6.22	272.94		0.9098	0.9142	7.314
69	552			275.59		0.9186	0.9279	7.424
70	560	1.234	6.29	281.18	1724	0.9373	0.9402	7.522
71	568			282.94		0.9431	0.9240	7.392
72	576	1.229	6.3	271.47		0.9049	0.9417	7.533
73	584			293.53		0.9784	0.9686	7.749
74	592	1.226	6.4	287.65		0.9588	0.9760	7.808
75	600			297.94	1696	0.9931	0.9824	7.859
76	608	1.221	6.51	291.47		0.9716	0.9873	7.898
77	616			300.88		1.0029	1.0029	8.024
78	624	1.221	6.34	300.88		1.0029	0.5015	4.012
						SUM(RATIO OF NI. IN TO NI. OUT TOTAL)		384.03
						TOTAL EXCHANGE NICKEL (mg / l.resin)		71991.86

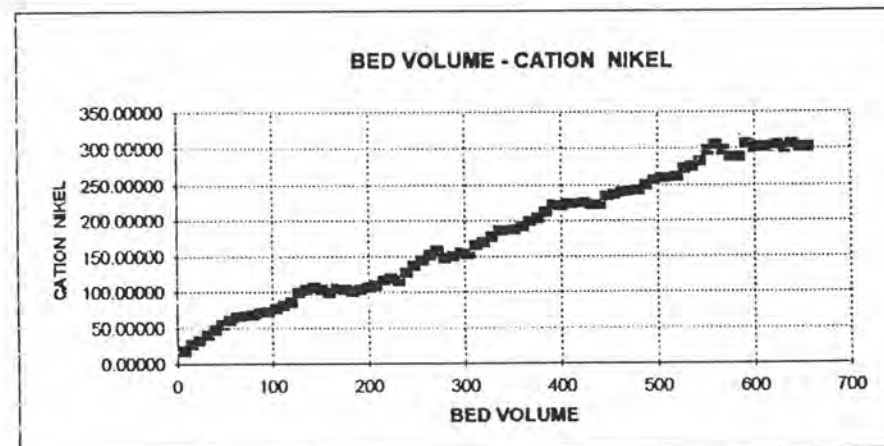
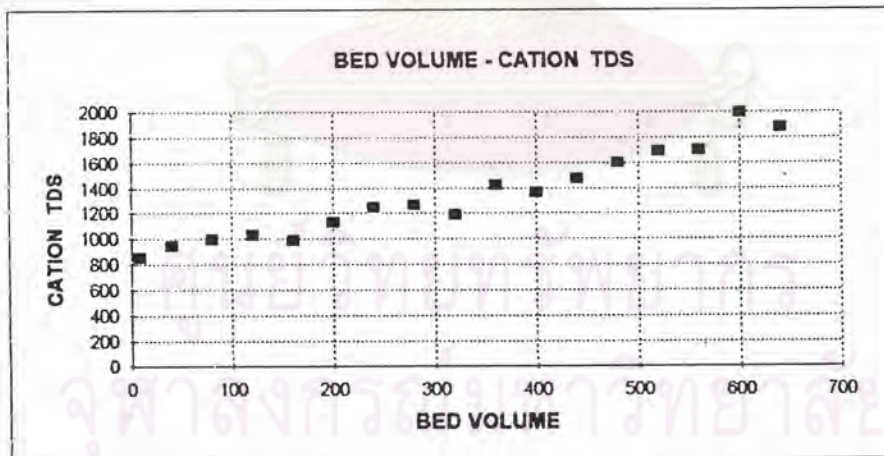
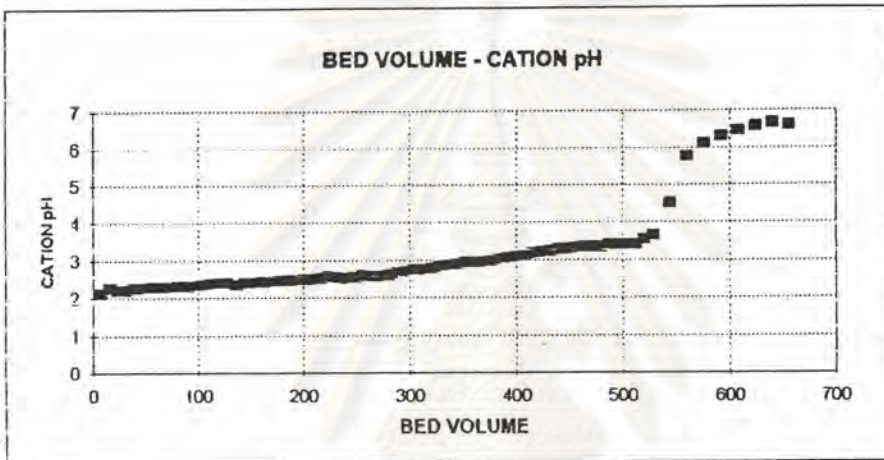
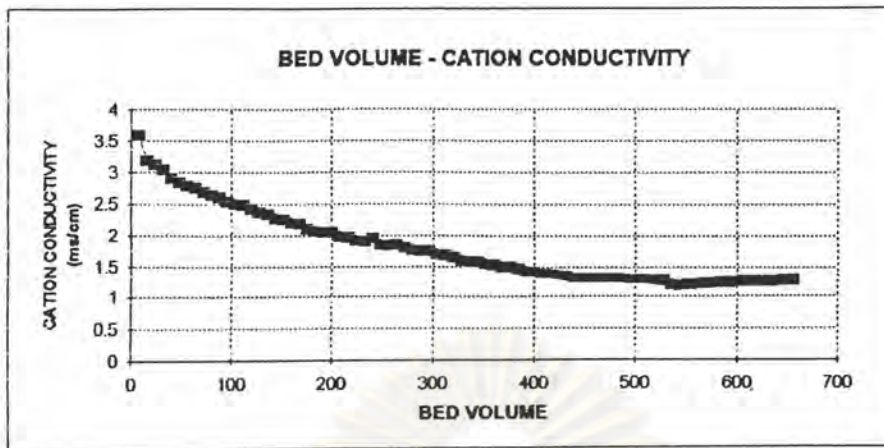
ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย



RAW WATER: INFLUENT NI = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 12% flowrate 3 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
1	8	3.580	2.12	18.53		0.0618	0.0745	0.596
2	16	3.180	2.24	26.18		0.0873	0.0975	0.780
3	24	3.110	2.2	32.35		0.1075	0.1211	0.969
4	32	3.030	2.2	40.29		0.1343	0.1466	1.173
5	40	2.900	2.24	47.65	941	0.1588	0.1696	1.357
6	48	2.840	2.25	54.12		0.1804	0.1912	1.529
7	56	2.780	2.28	60.59		0.2020	0.2088	1.671
8	64	2.750	2.27	64.71		0.2157	0.2181	1.745
9	72	2.680	2.29	66.18		0.2206	0.2225	1.780
10	80	2.640	2.3	67.35	997	0.2245	0.2304	1.843
11	88	2.590	2.31	70.88		0.2363	0.2387	1.910
12	96	2.530	2.32	72.35		0.2412	0.2485	1.988
13	104	2.500	2.34	76.76		0.2559	0.2637	2.110
14	112	2.480	2.37	81.47		0.2716	0.2779	2.224
15	120	2.410	2.38	85.29	1025	0.2843	0.3074	2.459
16	128	2.370	2.38	99.12		0.3304	0.3373	2.698
17	136	2.330	2.35	103.24		0.3441	0.3475	2.780
18	144	2.270	2.39	105.29		0.3510	0.3461	2.769
19	152	2.250	2.4	102.35		0.3412	0.3343	2.675
20	160	2.200	2.41	98.24	985	0.3275	0.3368	2.694
21	168	2.180	2.43	103.82		0.3461	0.3451	2.761
22	176	2.090	2.44	103.24		0.3441	0.3397	2.718
23	184	2.070	2.46	100.59		0.3353	0.3386	2.709
24	192	2.050	2.45	102.60		0.3420	0.3468	2.774
25	200	2.040	2.49	105.49	1125	0.3516	0.3582	2.866
26	208	1.980	2.47	109.46		0.3649	0.3754	3.003
27	216	1.960	2.51	115.79		0.3860	0.3904	3.123
28	224	1.920	2.57	118.46		0.3949	0.3881	3.105
29	232	1.900	2.54	114.41		0.3814	0.4010	3.208
30	240	1.950	2.51	126.18	1250	0.4206	0.4368	3.494
31	248	1.850	2.55	135.88		0.4529	0.4672	3.737
32	256	1.830	2.59	144.41		0.4814	0.4926	3.941
33	264	1.840	2.57	151.18		0.5039	0.5147	4.118
34	272	1.800	2.58	157.65		0.5255	0.5074	4.059
35	280	1.760	2.59	146.78	1266	0.4892	0.5025	4.020
36	288	1.751	2.66	150.29		0.5157	0.5132	4.106
37	296	1.746	2.68	154.71		0.5108	0.5304	4.243
38	304	1.702	2.73	153.24		0.5500	0.5567	4.453
39	312	1.672	2.75	185.00		0.5833	0.5741	4.593
40	320	1.648	2.77	169.00	1190	0.5848	0.6008	4.806
41	328	1.602	2.82	175.45		0.6167	0.6167	4.933
42	336	1.585	2.85	185.00		0.6167	0.6176	4.941
43	344	1.575	2.87	185.59		0.6186	0.6206	4.965
44	352	1.543	2.93	186.76		0.6225	0.6304	5.043
45	360	1.522	2.94	191.47	1420	0.6382	0.6485	5.188
46	368	1.502	2.95	197.65		0.6588	0.6657	5.325
47	376	1.491	2.98	201.76		0.6725	0.6892	5.514
48	384	1.452	3.01	211.76		0.7059	0.7211	5.769
49	392	1.419	3.05	220.88		0.7363	0.7348	5.878
50	400	1.402	3.08	220.00	1364	0.7333	0.7377	5.902
51	408	1.382	3.11	222.65		0.7422	0.7426	5.941
52	416	1.371	3.17	222.94		0.7422	0.7407	5.925
53	424	1.363	3.21	224.12		0.7431	0.7373	5.898
54	432	1.335	3.22	221.47		0.7382	0.7373	5.898
55	440	1.312	3.28	220.88	1475	0.7363	0.7572	6.058

RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINOACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 12% flowrate 3 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
56	448	1.310	3.27	233.46		0.7782	0.7832	6.266
57	456	1.307	3.32	236.46		0.7882	0.7915	6.332
58	464	1.308	3.34	238.46		0.7949	0.7980	6.384
59	472	1.306	3.35	240.37		0.8012	0.8046	6.003
60	480	1.304	3.33	242.37	1588	0.8079	0.8206	6.565
61	488	1.302	3.4	250.00		0.8333	0.8454	6.763
62	496	1.299	3.4	257.22		0.8574	0.8613	6.890
63	504	1.294	3.39	259.56		0.8652	0.8662	6.930
64	512	1.290	3.41	260.16		0.8672	0.8699	6.959
65	520	1.279	3.54	261.76	1689	0.8725	0.8904	7.123
66	528	1.252	3.66	272.46		0.9082	0.9124	7.299
67	536	1.195		275.00		0.9167	0.9294	7.435
68	544	1.184	4.5	282.65		0.9422	0.9687	7.733
69	552	1.193		297.35		0.9912	1.0034	8.027
70	560	1.199	5.76	304.71	1698	1.0157	1.0029	8.024
71	568	1.205		297.06		0.9902	0.9760	7.808
72	576	1.213	6.13	288.53		0.9618	0.9627	7.702
73	584	1.224		289.12		0.9637	0.9917	7.933
74	592	1.225	6.32	305.88		1.0196	1.0108	8.086
75	600	1.227		300.59	1989	1.0020	1.0034	8.027
76	608	1.235	6.45	301.47		1.0049	1.0054	8.043
77	616	1.236		301.76		1.0059	1.0123	8.098
78	624	1.239	6.56	305.59		1.0186	1.0113	8.090
79	632	1.242		301.18		1.0039	1.0044	8.035
76	608	1.235	6.45	301.47		1.0049	1.0054	8.043
77	616	1.236		301.76		1.0059	1.0123	8.098
78	624	1.239	6.56	305.59		1.0186	0.5093	4.075
SUM(RATIO OF NI. IN TO NI. OUT TOTAL)								383.54
TOTAL EXCHANGE NICKEL (mg / l.resin)								72138.50

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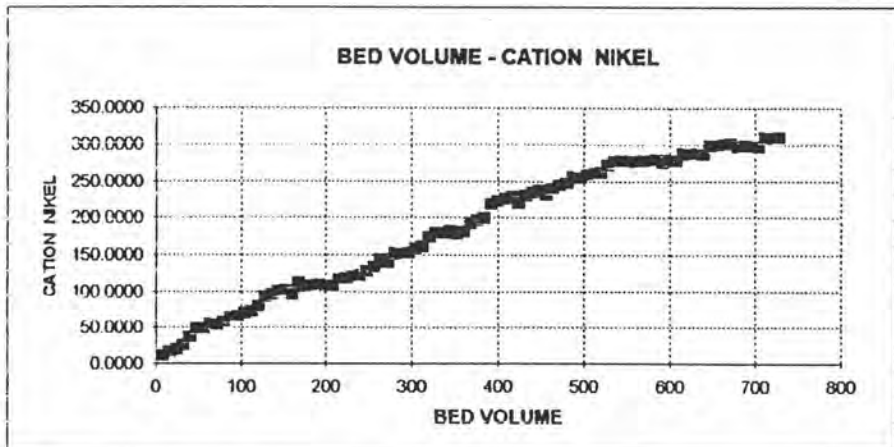
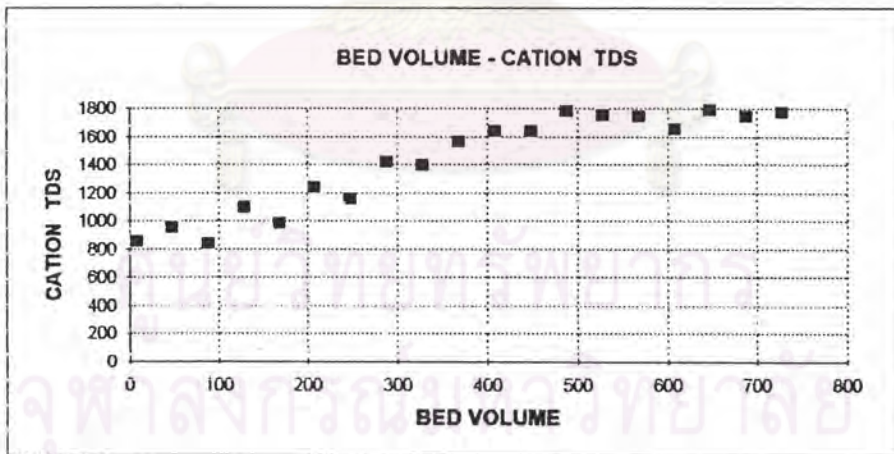
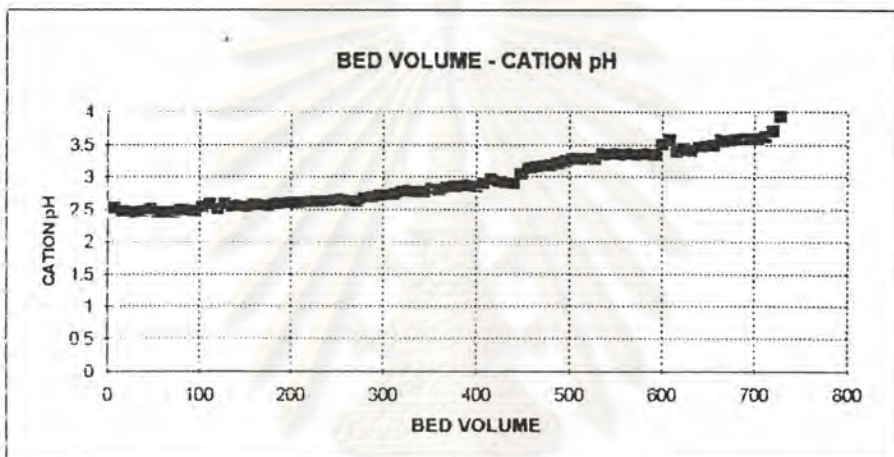
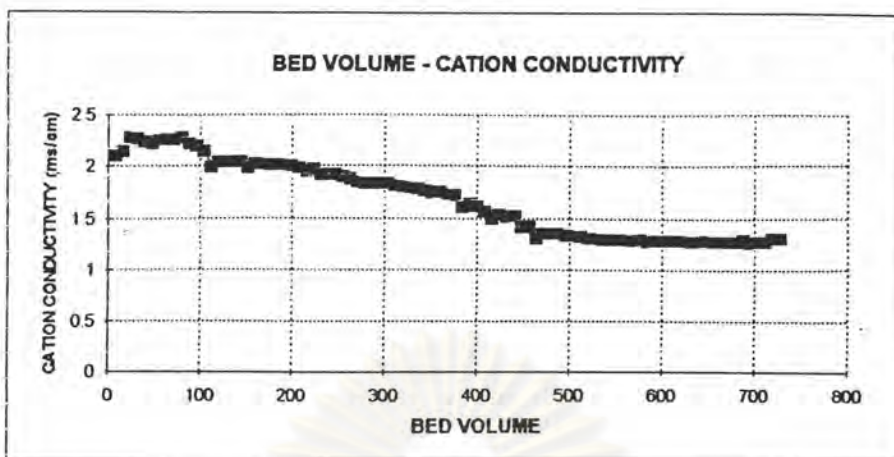


RAW WATER: INFLUENT NI = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMUNODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 12% flowrate 4.5 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
1	8	2.100	2.53	10.96		0.0365	0.0468	0.375
2	16	2.150	2.48	17.13		0.0571	0.0625	0.500
3	24	2.280	2.48	20.37		0.0879	0.0782	0.625
4	32	2.270	2.47	26.54		0.0885	0.1071	0.857
5	40	2.240	2.48	37.72		0.1257	0.1449	1.159
6	48	2.220	2.51	49.19	956	0.1640	0.1630	1.304
7	56	2.250	2.47	48.60		0.1620	0.1748	1.398
8	64	2.260	2.47	56.25		0.1875	0.1841	1.473
9	72	2.260	2.47	54.19		0.1806	0.1900	1.520
10	80	2.280	2.49	59.78		0.1993	0.2086	1.668
11	88	2.220	2.49	65.37	846	0.2179	0.2200	1.760
12	96	2.200	2.48	68.60		0.2220	0.2299	1.839
13	104	2.150	2.55	71.31		0.2377	0.2410	1.928
14	112	1.990	2.59	73.31		0.2444	0.2558	2.047
15	120	2.040	2.51	80.19		0.2673	0.2905	2.324
16	128	2.040	2.59	94.09	1100	0.3136	0.3172	2.538
17	136	2.040	2.55	96.25		0.3208	0.3277	2.622
18	144	2.040	2.56	100.37		0.3346	0.3381	2.704
19	152	1.982	2.55	102.46		0.3415	0.3324	2.659
20	160	2.020	2.58	98.96		0.3232	0.3485	2.788
21	168	2.020	2.58	112.13	987	0.3738	0.3654	2.924
22	176	2.015	2.57	107.13		0.3571	0.3596	2.876
23	184	2.011	2.59	108.60		0.3620	0.3650	2.920
24	192	2.010	2.6	110.37		0.3679	0.3659	2.927
25	200	2.000	2.61	109.19		0.3640	0.3630	2.904
26	208	1.984	2.61	108.60	1240	0.3620	0.3757	3.006
27	216	1.954	2.61	116.82		0.3894	0.3927	3.142
28	224	1.975	2.62	118.81		0.3960	0.4009	3.207
29	232	1.923	2.63	121.73		0.4058	0.4064	3.251
30	240	1.918	2.63	122.13		0.4071	0.4169	3.335
31	248	1.914	2.64	128.01	1156	0.4267	0.4380	3.504
32	256	1.901	2.66	134.78		0.4493	0.4654	3.724
33	264	1.873	2.65	144.49		0.4816	0.4752	3.802
34	272	1.842	2.63	140.66		0.4689	0.4885	3.908
35	280	1.840	2.68	152.43		0.5081	0.5096	4.076
36	288	1.839	2.7	151.84	1423	0.5110	0.5199	4.159
37	296	1.837	2.72	153.31		0.5287	0.5350	4.280
38	304	1.836	2.73	158.60		0.5414	0.5625	4.500
39	312	1.819	2.75	162.43		0.5836	0.5919	4.735
40	320	1.802	2.78	175.07		0.6002	0.6002	4.802
41	328	1.795	2.79	180.07	1400	0.6002	0.6002	4.802
42	336	1.788	2.78	180.07		0.6002	0.6061	4.849
43	344	1.762	2.77	183.60		0.6120	0.6037	4.829
44	352	1.740	2.82	178.60		0.5953	0.6012	4.810
45	360	1.751	2.81	182.13		0.6071	0.6257	5.006
46	368	1.735	2.84	193.31	1554	0.6444	0.6522	5.218
47	376	1.724	2.85	198.01		0.6600	0.6640	5.312
48	384	1.612	2.86	200.37		0.6679	0.7002	5.602
49	392	1.638	2.87	219.78		0.7326	0.7394	5.915
50	400	1.621	2.86	223.85		0.7482	0.7513	6.011
51	408	1.571	2.91	226.98	1645	0.7585	0.7612	6.090
52	416	1.498	2.97	229.78		0.7565	0.7679	6.143
53	424	1.537	2.94	221.25		0.7659	0.7767	6.214
54	432	1.519	2.93	230.96		0.7699	0.7767	6.214
55	440	1.522	2.91	235.07		0.7836	0.7895	6.316

RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 12% flowrate 4.5 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
56	448	1.420	3.06	238.60	1639	0.7953	0.7850	6.280
57	456	1.425	3.13	232.43		0.7748	0.7890	6.312
58	464	1.315	3.15	240.96		0.8032	0.8100	6.480
59	472	1.362	3.16	245.07		0.8169	0.8223	6.578
60	480	1.361	3.18	248.31		0.8277	0.8419	6.735
61	488	1.357	3.22	256.84	1782	0.8561	0.8551	6.841
62	496	1.342	3.25	256.25		0.8542	0.8605	6.884
63	504	1.338	3.29	260.07		0.8669	0.8684	6.947
64	512	1.329	3.28	260.96		0.8699	0.8738	6.990
65	520	1.314	3.28	263.31		0.8777	0.8944	7.155
66	528	1.311	3.28	273.31	1758	0.9110	0.9184	7.347
67	536	1.304	3.36	277.72		0.9257	0.9274	7.419
68	544	1.299	3.35	278.73		0.9291	0.9299	7.439
69	552	1.296	3.37	279.19		0.9306	0.9277	7.422
70	560	1.297	3.34	277.43		0.9248	0.9267	7.414
71	568	1.293	3.36	278.60	1745	0.9287	0.9292	7.433
72	576	1.297	3.34	278.90		0.9297	0.9306	7.445
73	584	1.281	3.37	279.49		0.9316	0.9257	7.406
74	592	1.290	3.35	275.96		0.9199	0.9262	7.410
75	600	1.287	3.51	279.78		0.9326	0.9306	7.445
76	608	1.289	3.57	278.60	1655	0.9287	0.9453	7.563
77	616	1.286	3.4	288.60		0.9620	0.9600	7.680
78	624	1.285	3.45	287.43		0.9581	0.9600	7.680
79	632	1.283	3.41	288.60		0.9620	0.9605	7.684
80	640	1.284	3.47	287.72		0.9591	0.9777	7.822
81	648	1.287	3.48	298.90	1789	0.9963	0.9973	7.978
82	656	1.281	3.5	299.49		0.9983	0.9998	7.998
83	664	1.282	3.57	300.37		1.0012	1.0032	8.025
84	672	1.275	3.56	301.54		1.0051	0.9988	7.990
85	680	1.274	3.58	297.72		0.9924	0.9939	7.951
86	688	1.300	3.59	298.60	1747	0.9953	0.9958	7.967
87	696	1.272	3.6	298.90		0.9963	0.9939	7.951
88	704	1.275	3.6	297.43		0.9914	1.0120	8.096
89	712	1.283	3.63	309.78		1.0326	1.0306	8.245
90	720	1.307	3.7	308.60		1.0287	1.0316	8.253
91	728	1.313	3.94	310.37	1777	1.0346	0.5173	4.138
						SUM(RATIO OF NI. IN TO NI. OUT TOTAL)		453.80
						TOTAL EXCHANGE NICKEL (mg / l.resin)		82258.64

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3-R2-12.XLS

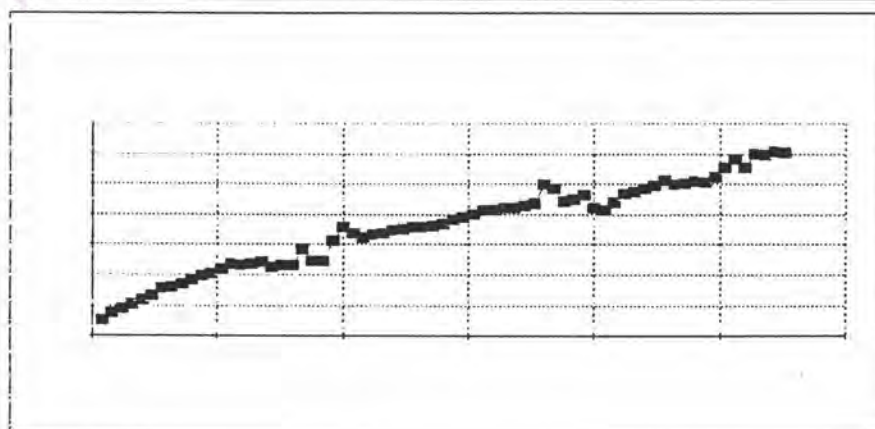
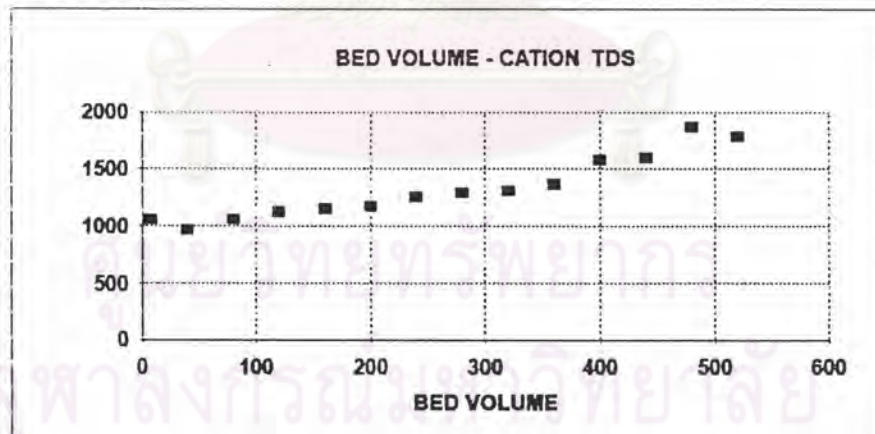
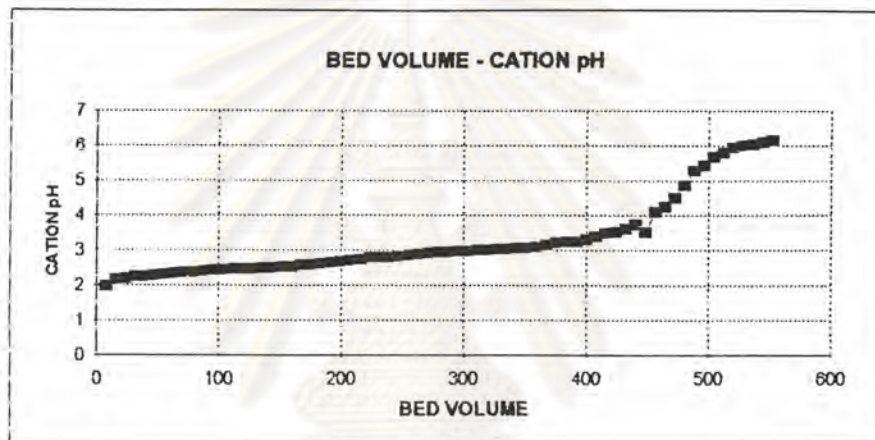
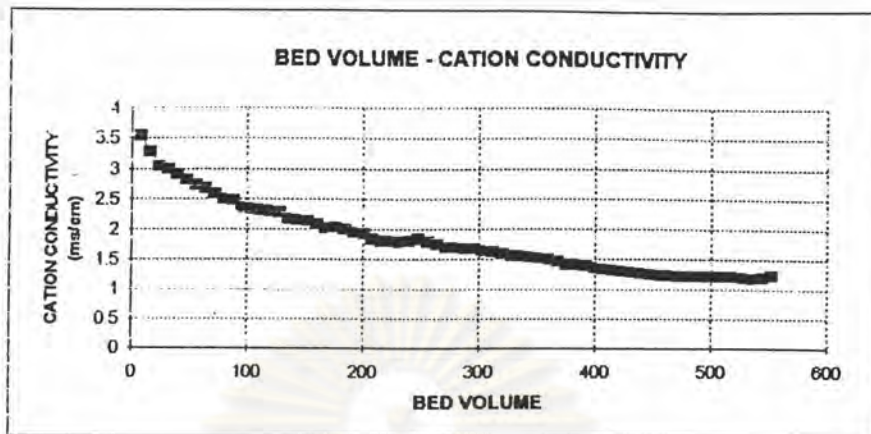


RAW WATER: INFLUENT NI. = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 12%, flowrate 6 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
1	8	3.550	1.96	24.71		0.0824	0.1029	0.824
2	16	3.270	2.15	37.06		0.1235	0.1368	1.094
3	24	3.040	2.19	45.00		0.1500	0.1588	1.271
4	32	3.000	2.24	50.29		0.1676	0.1819	1.455
5	40	2.910	2.23	58.82	966	0.1961	0.2078	1.663
6	48	2.820	2.28	65.88		0.2196	0.2373	1.898
7	56	2.730	2.3	76.47		0.2549	0.2588	2.071
8	64	2.670	2.32	78.82		0.2627	0.2706	2.165
9	72	2.580	2.36	83.53		0.2784	0.2922	2.337
10	80	2.500	2.37	91.76	1057	0.3059	0.3172	2.537
11	88	2.470	2.4	98.53		0.3284	0.3343	2.675
12	96	2.350	2.42	102.06		0.3402	0.3505	2.804
13	104	2.330	2.43	108.24		0.3608	0.3750	3.000
14	112	2.320	2.45	116.76		0.3892	0.3882	3.106
15	120	2.290	2.44	116.18	1125	0.3873	0.3897	3.118
16	128	2.280	2.46	117.65		0.3922	0.3980	3.184
17	136	2.170	2.47	121.18		0.4039	0.3882	3.106
18	144	2.160	2.48	111.76		0.3725	0.3784	3.027
19	152	2.130	2.5	115.29		0.3843	0.3858	3.086
20	160	2.090	2.52	116.18	1154	0.3873	0.4289	3.431
21	168	2.010	2.58	141.18		0.4706	0.4387	3.510
22	176	2.038	2.57	122.06		0.4069	0.4093	3.275
23	184	1.990	2.62	123.53		0.4118	0.4657	3.725
24	192	1.950	2.65	155.88		0.5196	0.5588	4.471
25	200	1.920	2.67	179.41	1169	0.5980	0.5784	4.627
26	208	1.840	2.7	167.65		0.5588	0.5490	4.392
27	216	1.810	2.74	161.76		0.5392	0.5481	4.369
28	224	1.805	2.78	166.88		0.5529	0.5574	4.459
29	232	1.790	2.79	168.53		0.5618	0.5686	4.549
30	240	1.800	2.8	172.55	1256	0.5755	0.5789	4.631
31	248	1.840	2.82	174.71		0.5824	0.5887	4.710
32	256	1.790	2.85	178.53		0.5951	0.5941	4.753
33	264	1.753	2.88	177.94		0.5931	0.5980	4.784
34	272	1.702	2.9	180.88		0.6029	0.6074	4.859
35	280	1.701	2.93	183.53	1289	0.6118	0.6314	5.051
36	288	1.680	2.95	191.76		0.6510	0.6588	5.271
37	296	1.670	2.96	195.29		0.6667	0.6789	5.431
38	304	1.660	2.98	200.00		0.6912	0.6902	5.522
39	312	1.624	3	207.35		0.6892	0.6951	5.561
40	320	1.582	3.01	206.76	1305	0.7010	0.7010	5.608
41	328	1.559	3.02	210.29		0.7010	0.7010	5.608
42	336	1.551	3.04	210.29		0.7010	0.7059	5.647
43	344	1.528	3.05	213.24		0.7108	0.7172	5.737
44	352	1.517	3.07	217.06		0.7235	0.7765	6.212
45	360	1.502	3.09	248.82	1369	0.8294	0.8167	6.533
46	368	1.457	3.14	241.18		0.8039	0.7696	6.157
47	376	1.417	3.21	220.59		0.7353	0.7402	5.922
48	384	1.402	3.23	223.53		0.7451	0.7588	6.071
49	392	1.388	3.25	231.76		0.7725	0.7353	5.882
50	400	1.354	3.31	209.41	1578	0.6980	0.6946	5.557
51	408	1.344	3.38	207.35		0.6912	0.7093	5.675
52	416	1.325	3.47	218.24		0.6912	0.7569	6.055
53	424	1.310	3.53	232.94		0.7275	0.7946	6.357
54	432	1.284	3.62	235.88		0.7863	0.7946	6.357
55	440	1.271	3.73	240.88	1599	0.8029	0.8132	6.506

RAW WATER: INFLUENT NI = 300 mg/l & OTHER SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP: After this service, Regen with sulfuric acid 12% flowrate 6 BV/hr								
SAMPLE No.	BED VOLUME (BV.)	CONDUCTIVITY (ms/cm.)	CATION pH	NIKEL (mg/l)	TDS (mg/l)	RATIO NI. IN/ NI. OUT		
						VALUE	AVERAGE	TOTAL
56	448	1.247	3.5	247.06		0.8235	0.8373	6.898
57	456	1.238	4.09	255.29		0.8510	0.8407	6.725
58	464	1.224	4.25	249.12		0.8304	0.8338	6.671
59	472	1.223	4.5	251.18		0.8373	0.8420	0.003
60	480	1.221	4.86	254.00	1863	0.8467	0.8429	6.744
61	488	1.218	5.27	251.76		0.8392	0.8539	6.831
62	496	1.220	5.43	260.59		0.8686	0.8961	7.169
63	504	1.221	5.68	277.06		0.9235	0.9456	7.565
64	512	1.215	5.78	290.29		0.9676	0.9441	7.553
65	520	1.212	5.93	276.18	1785	0.9206	0.9803	7.682
66	528	1.189	6.01	300.00		1.0000	0.9964	7.971
67	536	1.184	6.03	297.85		0.9928	1.0013	8.011
68	544	1.195	6.1	302.94		1.0098	1.0053	8.043
69	552	1.233	6.16	300.25		1.0008	0.5004	4.003
SUM(RATIO OF NI. IN TO NI. OUT TOTAL)								323.35
TOTAL EXCHANGE NICKEL (mg / l.resin)								68594.83

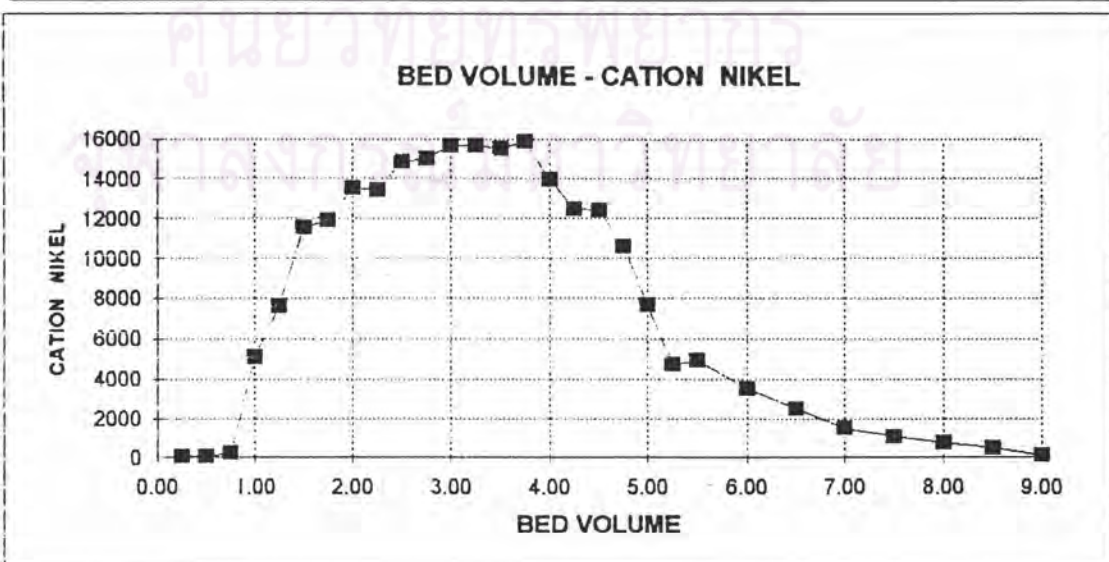
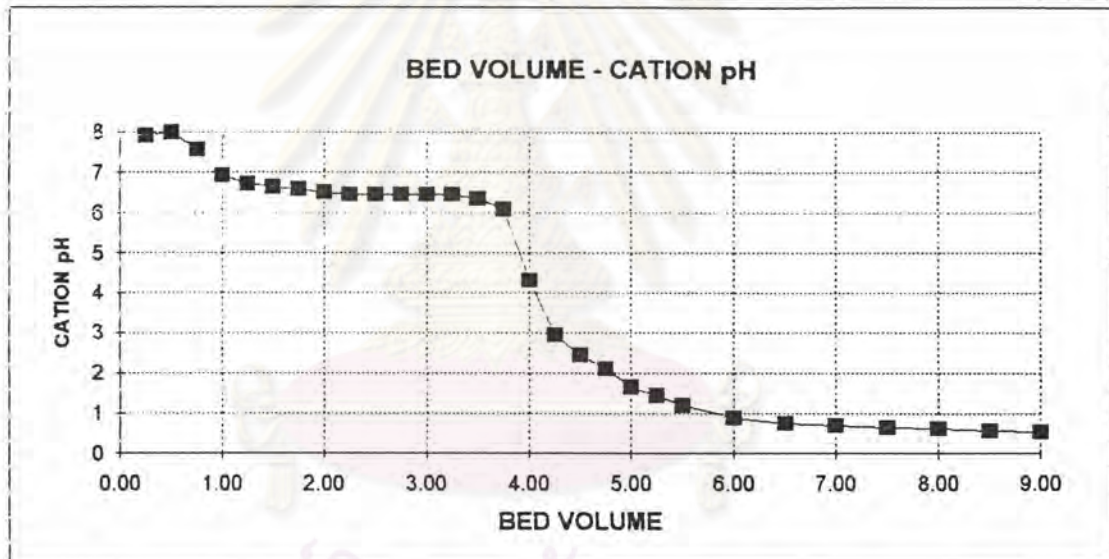
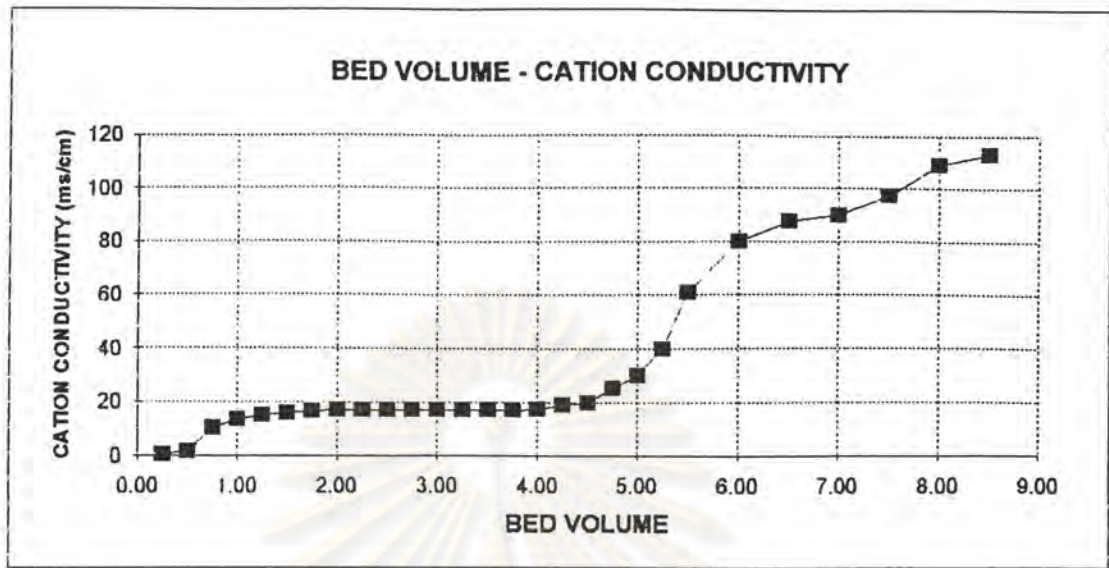
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3-R2-12H.XLS



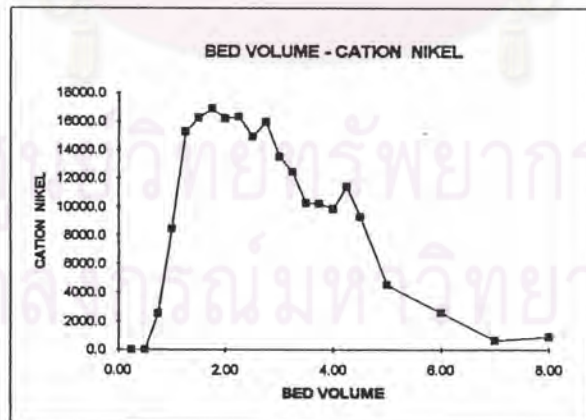
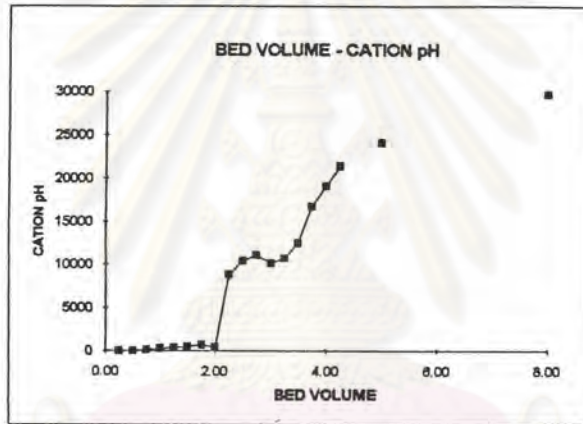
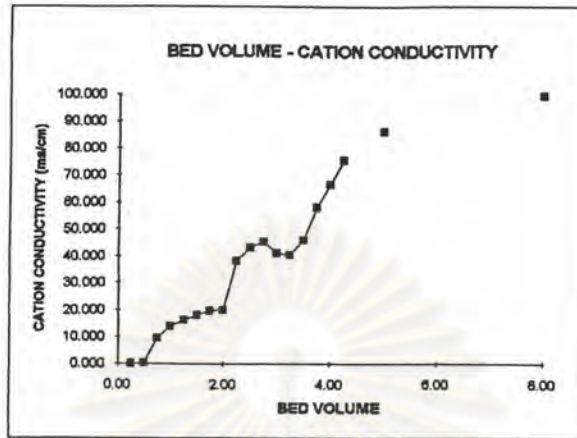
REGENERATION WITH SULFURIC ACID 3%							
ACID INTRODUCE FLOWRATE 3 BV./hr							
AFTER SERVICE BY INFLUENT RINSE WASTE (NI. 300 mg/l & OTHERS); RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	0.368	7.9	63.1	15.78	15.78	63.10
2	0.50	0.320	7.98	51.8	12.95	28.73	57.45
3	0.75	1.660	7.56	224.0	56.00	84.73	112.97
4	1.00	10.540	6.92	5080.0	1270.00	1354.73	1354.73
5	1.25	13.680	6.71	7650.0	1912.50	3267.23	2613.78
6	1.50	15.210	6.64	11550.0	2887.50	6154.73	4103.15
7	1.75	16.090	6.58	11900.0	2975.00	9129.73	5216.99
8	2.00	16.770	6.51	13550.0	3387.50	12517.23	6258.61
9	2.25	17.190	6.46	13450.0	3362.50	15879.73	7057.66
10	2.50	17.230	6.46	14875.0	3718.75	19598.48	7839.39
11	2.75	17.110	6.47	15050.0	3762.50	23360.98	8494.90
12	3.00	17.200	6.46	15650.0	3912.50	27273.48	9091.16
13	3.25	17.140	6.45	15650.0	3912.50	31185.98	9595.68
14	3.50	17.040	6.35	15525.0	3881.25	35067.23	10019.21
15	3.75	17.050	6.09	15900.0	3975.00	39042.23	10411.26
16	4.00	17.210	4.33	13975.0	3493.75	42535.98	10633.99
17	4.25	17.590	2.94	12500.0	3125.00	45660.98	10743.76
18	4.50	19.050	2.45	12450.0	3112.50	48773.48	10838.55
19	4.75	20.050	2.09	10600.0	2650.00	51423.48	10825.99
20	5.00	25.600	1.64	7660.0	1915.00	53338.48	10667.70
21	5.25	30.200	1.44	4720.0	1180.00	54518.48	10384.47
22	5.50	40.000	1.19	4960.0	1240.00	55758.48	10137.90
23	6.00	61.000	0.89	3500.0	1750.00	57508.48	9584.75
24	6.50	80.000	0.75	2525.0	1262.50	58770.98	9041.69
25	7.00	87.800	0.7	1520.0	760.00	59530.98	8504.43
26	7.50	89.900	0.65	1055.0	527.50	60058.48	8007.80
27	8.00	97.200	0.63	740.0	370.00	60428.48	7553.56
28	8.50	109.400	0.56	500.0	250.00	60678.48	7138.64
29	9.00	113.100	0.55	110.0	55.00	60733.48	6748.18

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REGENERATION WITH SULFURIC ACID 3%							
ACID INTRODUCE FLOWRATE 4.5 BV./hr							
AFTER SERVICE BY INFLUENT RINSE WASTE (Ni. 300 mg/l & OTHERS); RESIN TYPE : IMMUNODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI. CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	0.000	0	0.3	0.08	0.08	0.30
2	0.50	0.300	0	6.8	1.70	1.78	3.55
3	0.75	9.390	150	2550.0	637.50	639.28	952.37
4	1.00	13.830	300	8475.0	2118.75	2758.03	2758.03
5	1.25	16.160	350	15250.0	3812.50	6570.53	5256.42
6	1.50	17.960	500	16250.0	4062.50	10633.03	7088.68
7	1.75	19.480	660	16900.0	4225.00	14858.03	8490.30
8	2.00	19.750	450	16220.0	4055.00	18913.03	9456.51
9	2.25	38.000	8810	16325.0	4081.25	22994.28	10219.68
10	2.50	43.000	10400	14925.0	3731.25	26725.53	10690.21
11	2.75	45.000	11100	19950.0	3987.50	30713.03	11168.37
12	3.00	40.900	10100	13500.0	3375.00	34088.03	11362.68
13	3.25	40.400	10700	12475.0	3118.75	37206.78	11448.24
14	3.50	45.600	12500	10275.0	2568.75	39775.53	11364.44
15	3.75	57.900	16770	10250.0	2562.50	42338.03	11290.14
16	4.00	66.600	19112	9650.0	2462.50	44800.53	11200.13
17	4.25	75.500	21400	11420.0	2855.00	47655.53	11213.06
18	4.50			9320.0	3495.00	51150.53	11366.78
19	5.00	86.100	24100	4500.0	3375.00	54525.53	10905.11
20	6.00			2580.0	2580.00	57105.53	9517.59
21	7.00			655.0	655.00	57760.53	8251.50
22	8.00	99.300	29750	925.0	925.00	58685.53	7335.69

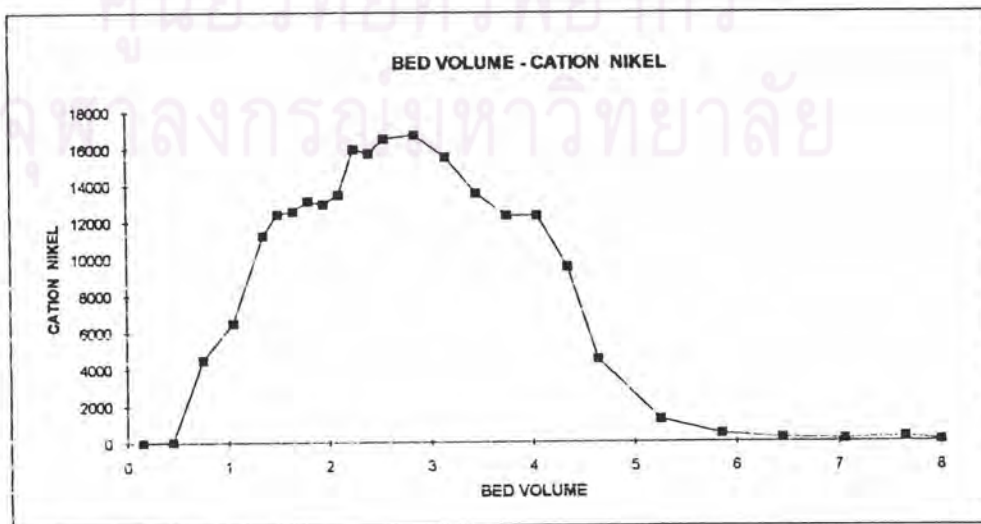
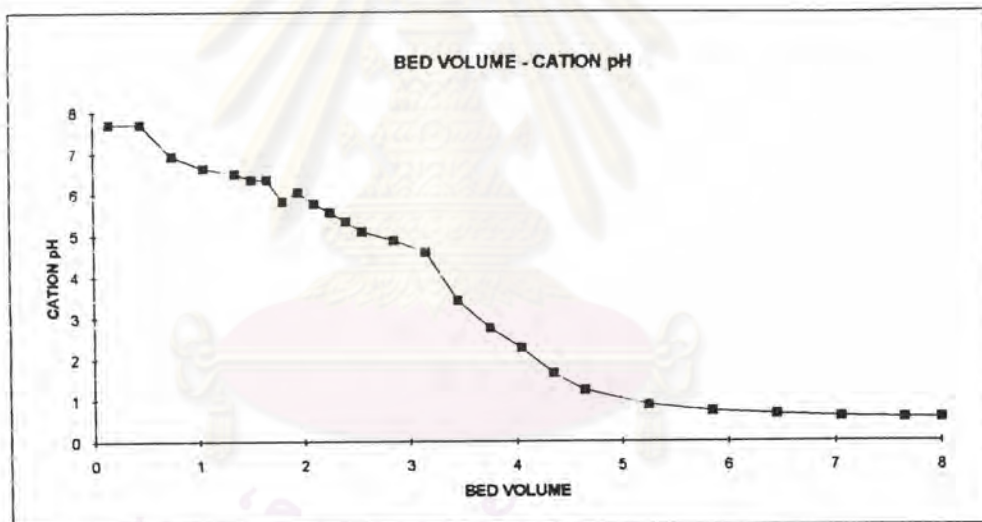
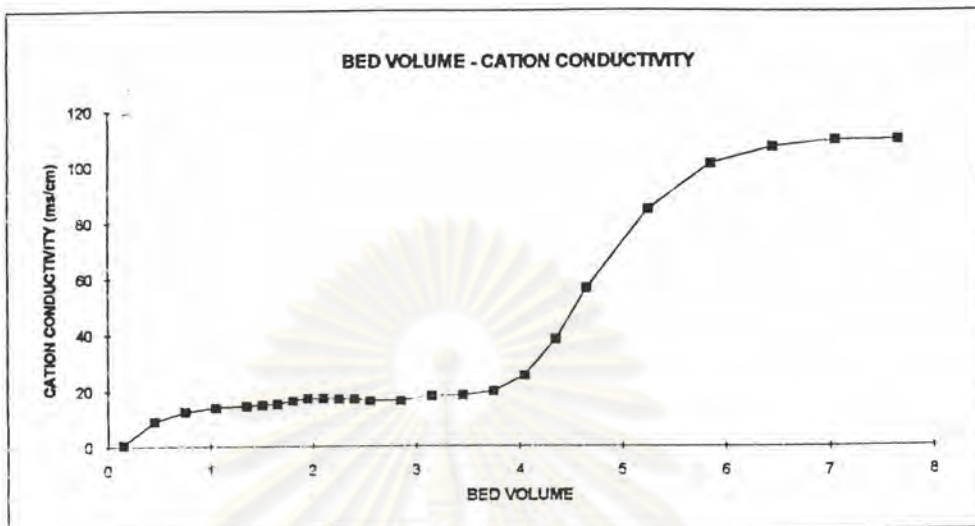
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REGENERATION WITH SULFURIC ACID 3% ACID INTRODUCE FLOWRATE 6 BV./hr AFTER SERVICE BY INFLUENT RINSE WASTE (Ni, 300 mg/l & OTHERS); RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI. CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.15	0.227	7.71	28.4	4.26	4.26	28.40
2	0.45	0.449	7.71	49.0	14.70	18.96	42.13
3	0.75	9.150	6.93	4500.0	1350.00	1368.96	1825.28
4	1.05	12.420	6.63	6500.0	1950.00	3318.96	3160.91
5	1.35	14.050	6.5	11250.0	3375.00	6693.96	4958.49
6	1.50	14.640	6.36	12450.0	1867.50	8561.46	5707.64
7	1.65	14.960	6.36	12575.0	1886.25	10447.71	6331.95
8	1.80	15.370	5.83	13125.0	1968.75	12416.46	6898.03
9	1.95	16.540	6.04	12950.0	1942.50	14358.96	7363.57
10	2.10	17.220	5.77	13480.0	2022.00	16380.96	7800.46
11	2.25	17.250	5.55	15960.0	2394.00	18774.96	8344.43
12	2.40	17.140	5.34	15720.0	2358.00	21132.96	8805.40
13	2.55	17.030	5.09	16530.0	2479.50	23612.46	9259.79
14	2.85	16.530	4.87	16750.0	5025.00	28637.46	10048.23
15	3.15	16.580	4.59	15530.0	4659.00	33296.46	10570.30
16	3.45	18.050	3.42	13560.0	4068.00	37364.46	10830.28
17	3.75	18.420	2.75	12360.0	3708.00	41072.46	10952.66
18	4.05	19.800	2.27	12350.0	3705.00	44777.46	11056.16
19	4.35	25.600	1.64	9560.0	2868.00	47645.46	10952.98
20	4.65	38.300	1.24	4530.0	1359.00	49004.46	10538.59
21	5.25	56.700	0.89	1250.0	750.00	49754.46	9477.04
22	5.85	84.500	0.73	440.0	264.00	50018.46	8550.16
23	6.45	100.800	0.65	200.0	120.00	50138.46	7773.40
24	7.05	106.800	0.59	150.0	90.00	50228.46	7124.60
25	7.65	109.400	0.56	250.0	150.00	50378.46	6585.42
26	8.00	109.800	0.57	90.0	31.50	50409.96	6301.25

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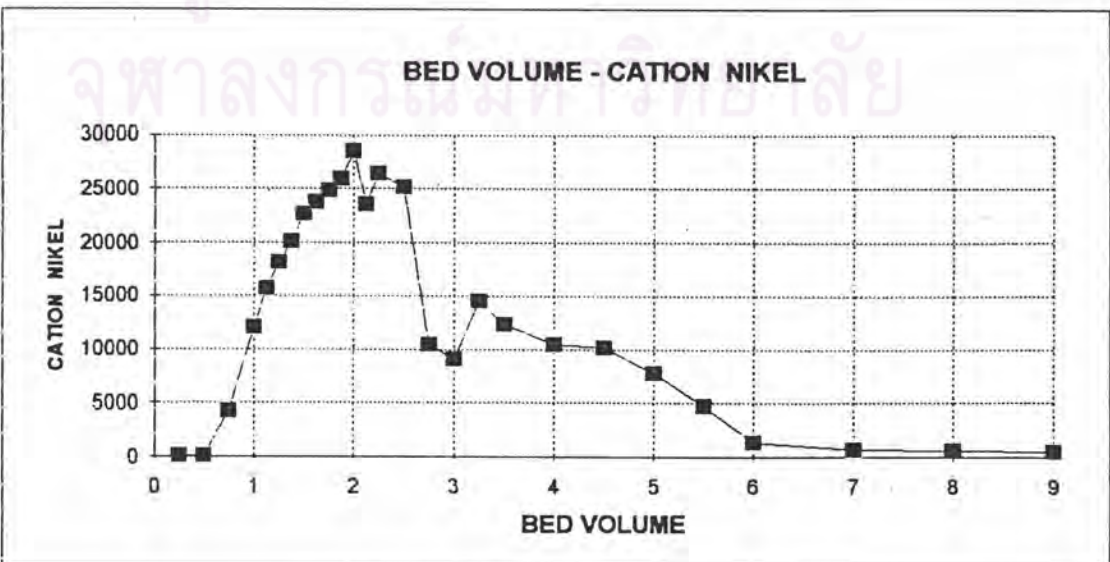
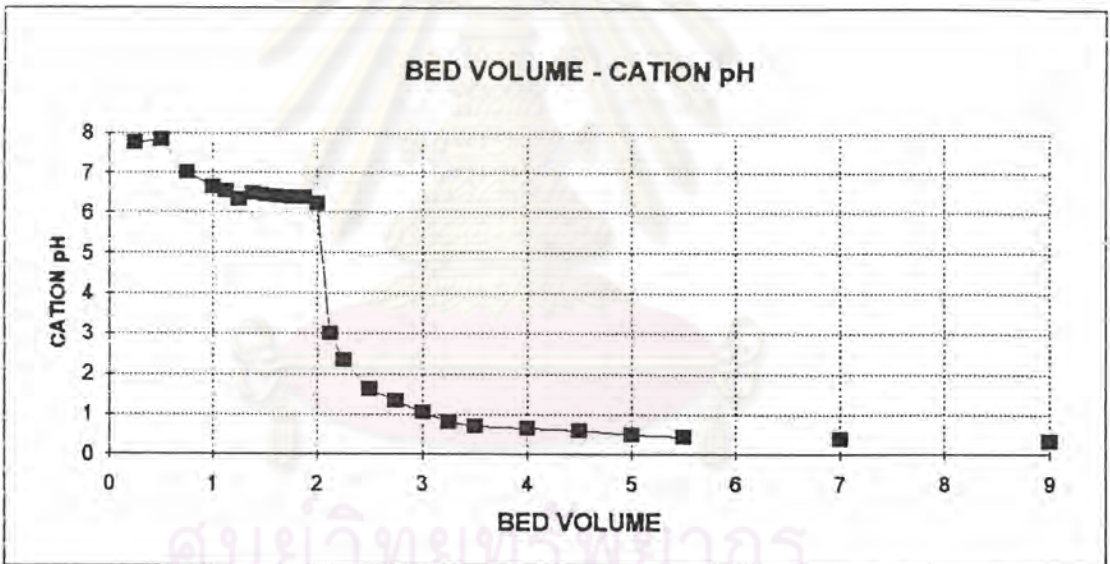
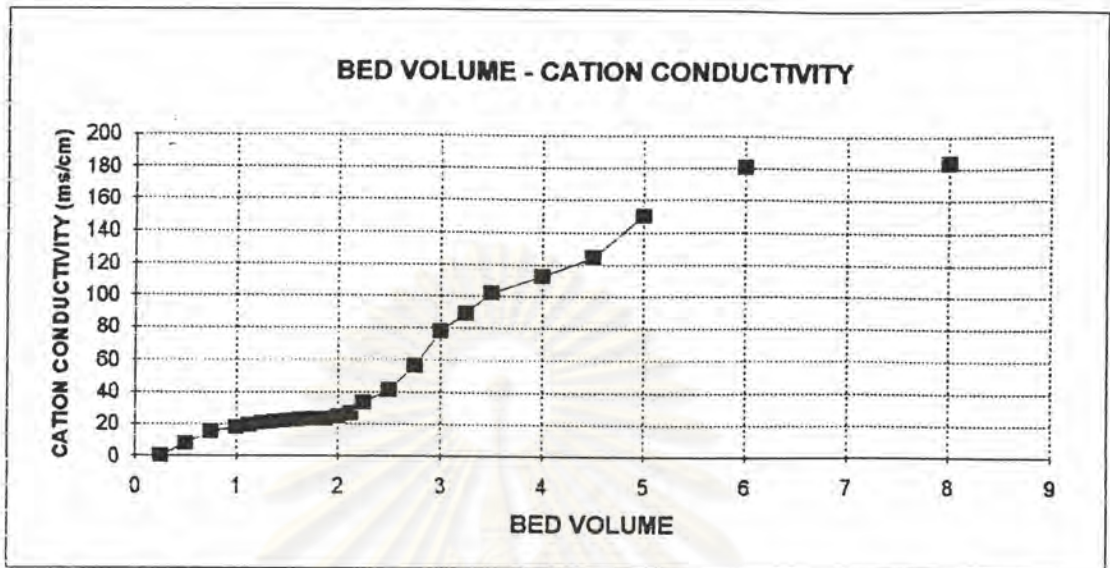
R2-3-3H.XLS



REGENERATION WITH SULFURIC ACID 5% ACID INTRODUCE FLOWRATE 3 BV./hr AFTER SERVICE BY INFLUENT RINSE WASTE (NI. 300 mg/l & OTHERS); RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI. CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	0.928	7.76	115.0	28.75	28.75	115.00
2	0.50	0.475	7.84	107.3	26.83	55.58	111.15
3	0.75	8.400	7.02	4300.0	1075.00	1130.58	1507.43
4	1.00	15.160	6.63	12000.0	3000.00	4130.58	4130.58
5	1.13	18.280	6.53	15700.0	1962.50	6093.08	5416.07
6	1.25	19.560	6.32	18150.0	2268.75	8361.83	6689.46
7	1.38	20.700	6.48	20150.0	2518.75	10880.58	7913.15
8	1.50	21.500	6.43	22650.0	2831.25	13711.83	9141.22
9	1.63	22.100	6.4	23725.0	2965.63	16677.45	10263.05
10	1.75	22.500	6.39	24375.0	3109.38	19786.83	11306.76
11	1.88	22.900	6.39	25900.0	3237.50	23024.33	12279.64
12	2.00	23.200	6.21	28500.0	3562.50	26586.83	13293.41
13	2.13	24.600	2.99	23525.0	2940.63	29527.45	13895.27
14	2.25	26.300	2.33	26450.0	3306.25	32833.70	14592.76
15	2.50	33.100	1.63	25100.0	6275.00	39108.70	15643.48
16	2.75	40.700	1.33	10475.0	2618.75	41727.45	15173.62
17	3.00	56.400	1.03	9050.0	2262.50	43989.95	14663.32
18	3.25	77.700	0.8	14475.0	3618.75	47608.70	14648.83
19	3.50	89.400	0.71	12300.0	3075.00	50683.70	14481.06
20	4.00	102.300	0.64	10475.0	5237.50	55921.20	13980.30
21	4.50	112.500	0.58	10150.0	5075.00	60996.20	13554.71
22	5.00	124.800	0.49	7830.0	3915.00	64911.20	12992.24
23	5.50	150.500	0.42	4740.0	2370.00	67281.20	12232.95
24	6.00			1415.0	707.50	67988.70	11331.45
25	7.00	180.800	0.37	755.0	755.00	68743.70	9820.53
26	8.00			591.0	591.00	69334.70	8666.84
27	9.00	183.500	0.33	564.0	564.00	69898.70	7766.52

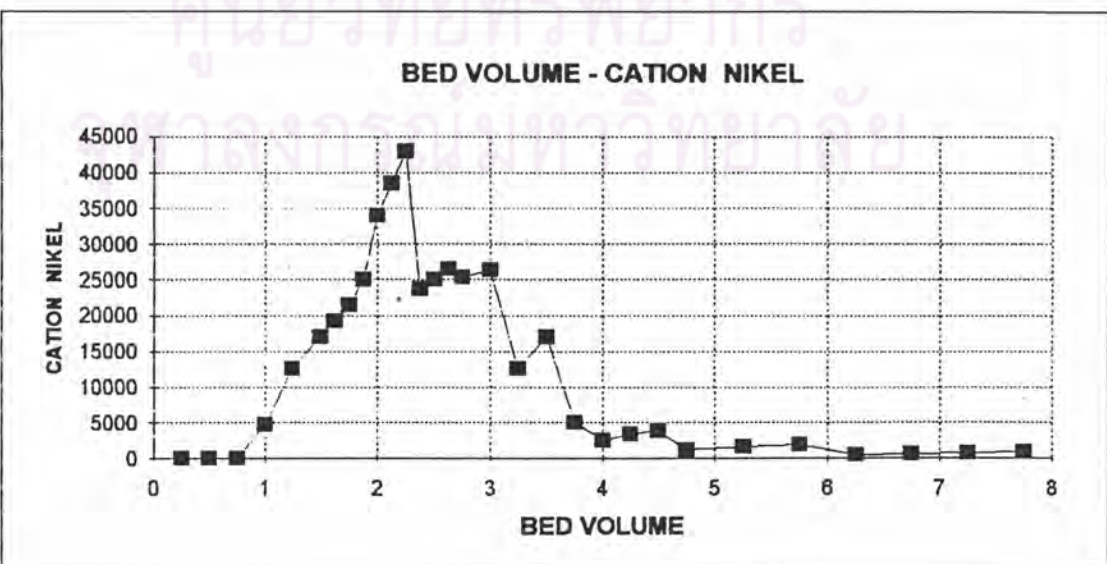
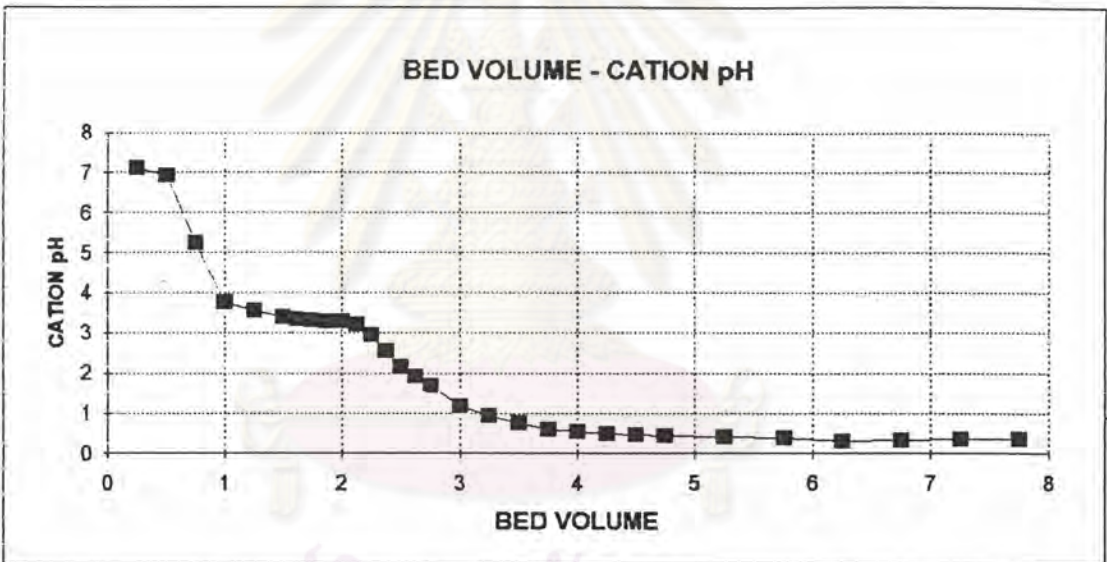
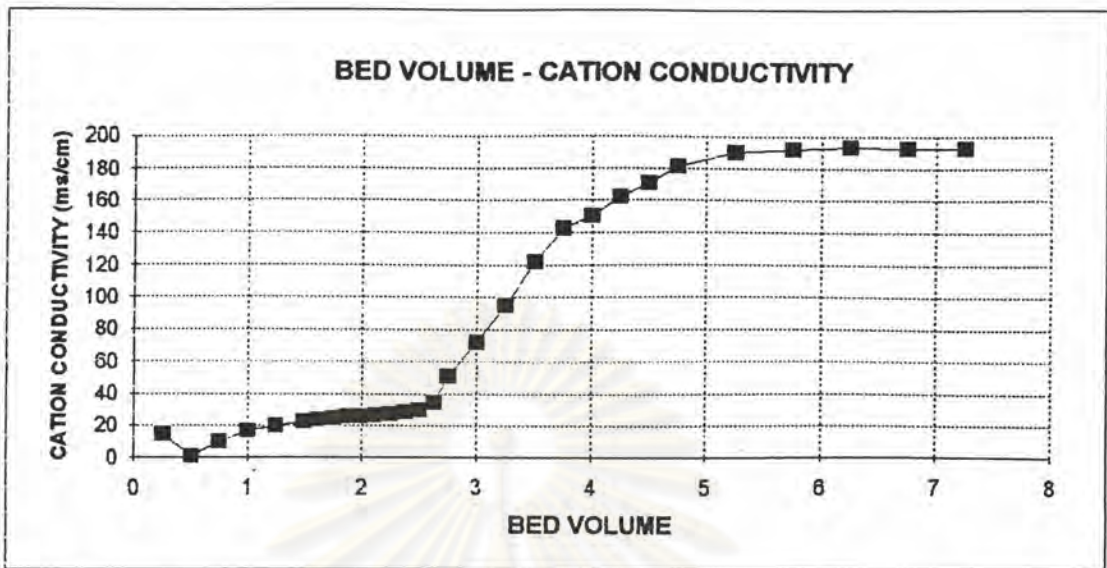
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R2-3-5L.XLS



REGENERATION WITH SULFURIC ACID 5% ACID INTRODUCE FLOWRATE 4.5 BV./hr AFTER SERVICE BY INFLUENT RINSE WASTE (NI. 300 mg/l & OTHERS); RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI CONC. x BEDVOLUME (mg/l.resin)	CUMULATIVE NICKEL (mg/l.resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	15.600	7.13	2.3	0.58	0.58	2.30
2	0.50	14.980	6.94	2.2	0.55	1.13	2.25
3	0.75	0.636	5.23	94.1	23.53	24.65	32.87
4	1.00	10.050	3.75	4790.0	1197.50	1222.15	1222.15
5	1.25	16.880	3.55	12525.0	3131.25	4353.40	3482.72
6	1.50	20.200	3.39	17000.0	4250.00	8603.40	5735.60
7	1.63	22.400	3.33	19250.0	2406.25	11009.65	6775.17
8	1.75	23.700	3.3	21450.0	2681.25	13690.90	7923.37
9	1.88	24.600	3.29	25030.0	3131.25	16822.15	8971.81
10	2.00	25.800	3.29	34000.0	4250.00	21072.15	10536.08
11	2.13	25.900	3.2	38500.0	4812.50	25884.65	12181.01
12	2.25	26.400	2.94	42900.0	5362.50	31247.15	13887.62
13	2.38	27.500	2.55	23650.0	2956.25	34203.40	14401.43
14	2.50	28.800	2.16	25000.0	3125.00	37328.40	14931.36
15	2.63	30.000	1.92	26450.0	3306.25	40634.65	15479.87
16	2.75	34.400	1.67	25300.0	3162.50	43797.15	15926.24
17	3.00	51.100	1.17	26400.0	6600.00	50397.15	16799.05
18	3.25	71.800	0.93	12525.0	3131.25	53528.40	16470.28
19	3.50	94.900	0.75	17000.0	4250.00	57778.40	16508.11
20	3.75	122.300	0.58	5010.0	1252.50	59030.90	15741.57
21	4.00	142.500	0.55	2505.0	626.25	59657.15	14914.29
22	4.25	150.500	0.48	3400.0	850.00	60507.15	14236.98
23	4.50	162.300	0.46	3850.0	962.50	61469.65	13659.92
24	4.75	171.100	0.43	1252.5	313.13	61782.78	13006.90
25	5.25	181.100	0.4	1700.0	850.00	62632.78	11930.05
26	5.75	190.000	0.38	1925.0	962.50	63595.28	11060.05
27	6.25	192.200	0.3	501.0	250.50	63845.78	10215.32
28	6.75	193.300	0.34	680.0	340.00	64185.78	9509.00
29	7.25	192.400	0.35	770.0	385.00	64570.78	8906.31
30	7.75	192.700	0.35	858.0	429.00	64999.78	8387.07

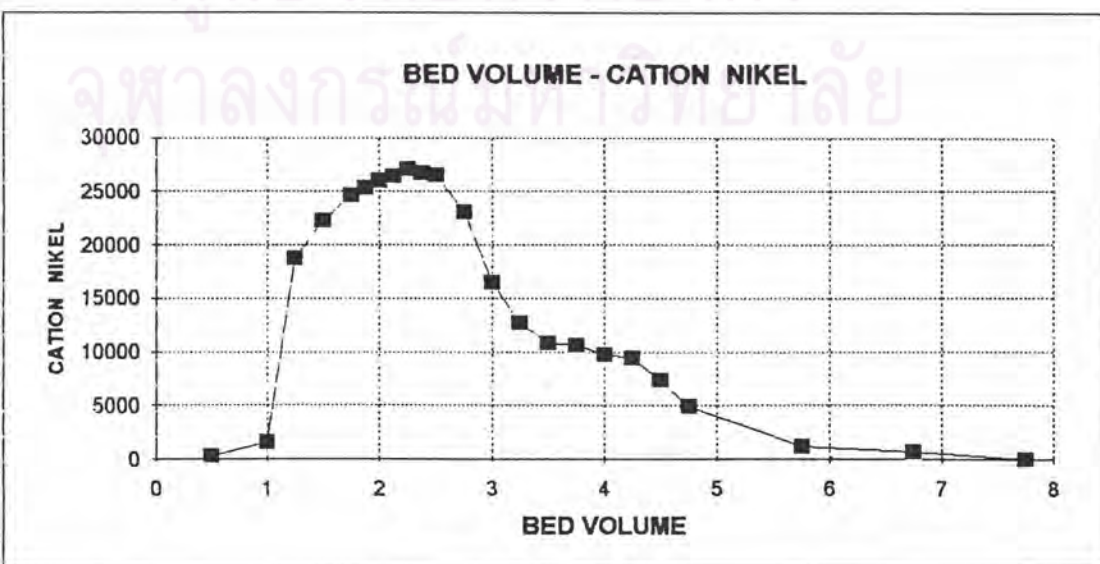
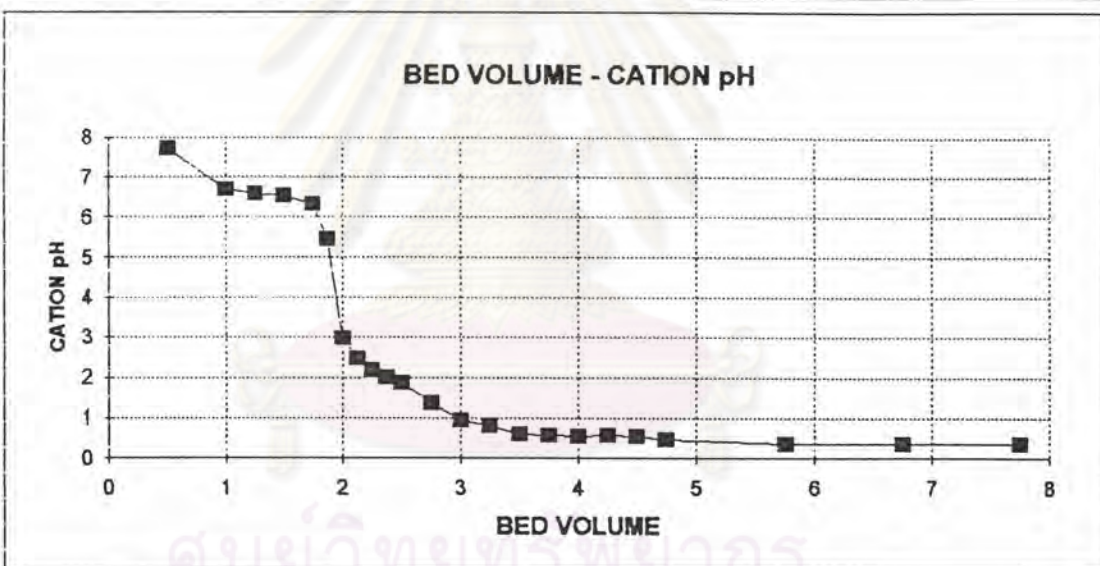
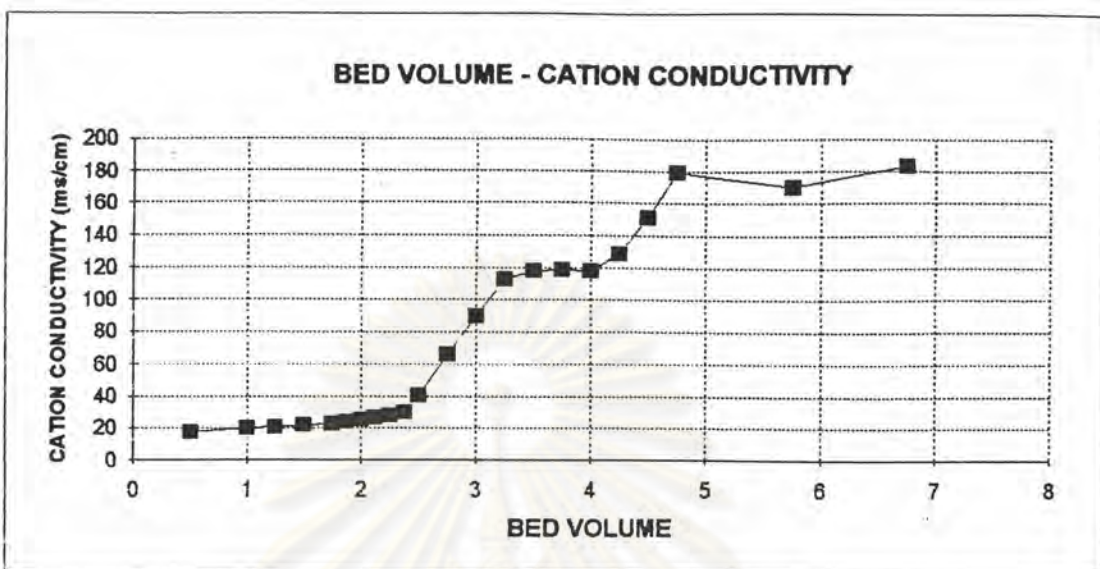
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REGENERATION WITH SULFURIC ACID 6%							
ACID INTRODUCE FLOWRATE 6 BV./hr							
AFTER SERVICE BY INFLUENT RINSE WASTE (Ni. 300 mg/l & OTHERS); RESIN TYPE : IMMUNODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI. CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.50	1.145	7.72	271.0	135.50	135.50	271.00
2	1.00	17.210	6.7	1650.0	825.00	960.50	960.50
3	1.25	19.810	6.6	18725.0	4681.25	5641.75	4513.40
4	1.50	20.900	6.53	22325.0	5581.25	11223.00	7482.00
5	1.75	21.900	6.32	24625.0	6156.25	17379.25	9931.00
6	1.88	22.300	5.46	25375.0	3171.88	20551.13	10960.60
7	2.00	24.000	2.96	26075.0	3259.38	23810.50	11905.25
8	2.13	25.300	2.48	26475.0	3309.38	27119.88	12762.29
9	2.25	26.600	2.17	27150.0	3393.75	30513.63	13561.61
10	2.38	28.100	2	26750.0	3343.75	33857.38	14255.74
11	2.50	29.500	1.87	26500.0	3312.50	37169.88	14867.95
12	2.75	40.100	1.36	23050.0	5762.50	42932.38	15611.77
13	3.00	65.800	0.93	16475.0	4118.75	47051.13	15683.71
14	3.25	89.700	0.81	12775.0	3193.75	50244.88	15459.96
15	3.50	113.000	0.6	10875.0	2718.75	52963.63	15132.46
16	3.75	118.400	0.57	10690.0	2672.50	55636.13	14836.30
17	4.00	118.600	0.54	9750.0	2437.50	58073.63	14518.41
18	4.25	117.900	0.56	9480.0	2370.00	60443.63	14222.03
19	4.50	128.600	0.53	7450.0	1862.50	62306.13	13845.81
20	4.75	150.800	0.46	4940.0	1235.00	63541.13	13377.08
21	5.75	179.400	0.35	1182.0	1182.00	64723.13	11256.20
22	6.75	170.000	0.36	717.0	717.00	65440.13	9694.83
23	7.75	183.400	0.35	41.0	41.00	65481.13	8449.18
24	8.00	182.600	0.34	40.0	10.00	65491.13	8186.39

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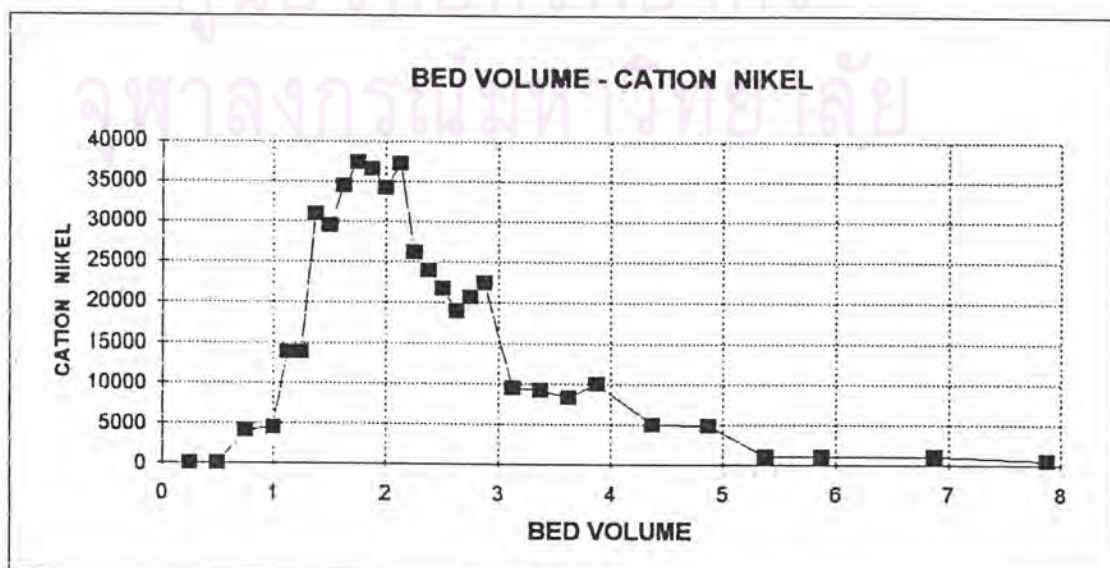
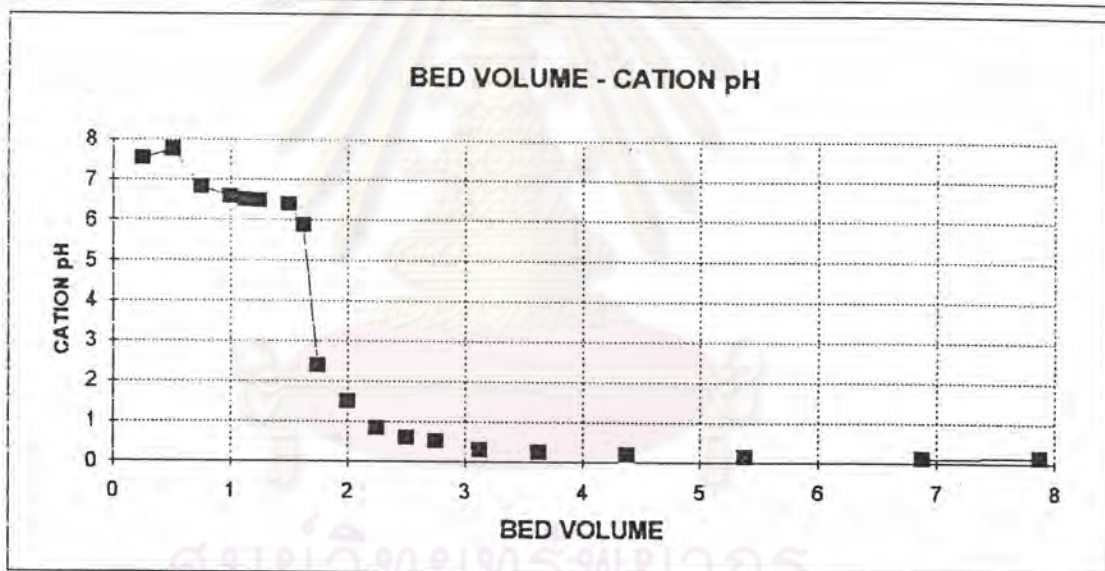
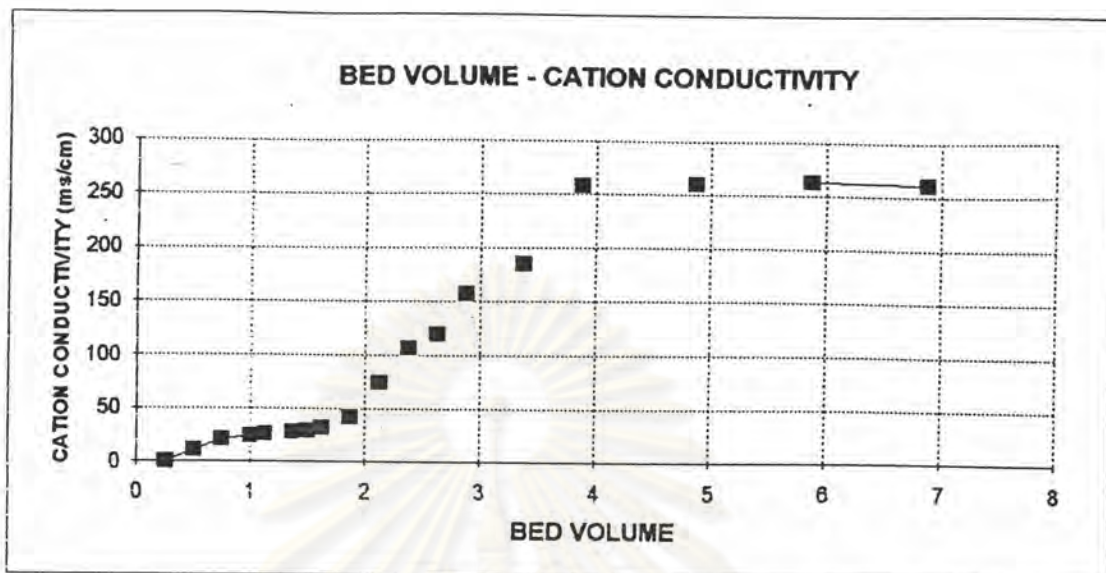
R2-3-5H.XLS



REGENERATION WITH SULFURIC ACID 7%							
ACID INTRODUCE FLOWRATE 3 BV./Hr							
AFTER SERVICE BY INFLUENT RINSE WASTE (NI. 300 mg/l & OTHERS); RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI. CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	0.259	7.53	8.1	2.03	2.03	8.10
2	0.50	0.623	7.74	11.6	2.90	4.93	9.85
3	0.75	11.330	6.83	4060.0	1015.00	1019.93	1359.90
4	1.00	21.300	6.59	6540.0	1635.00	2654.93	2654.93
5	1.13	24.200	6.52	13875.0	1734.38	4389.30	3901.60
6	1.25	25.600	6.48	16780.0	2097.50	6486.80	5189.44
7	1.38			30950.0	3868.75	10355.55	7531.31
8	1.50	27.600	6.41	29400.0	3675.00	14030.55	9353.70
9	1.63	29.000	5.88	34450.0	4306.25	18336.80	11284.18
10	1.75	31.700	2.38	37350.0	4668.75	23005.55	13146.03
11	1.88			36600.0	4575.00	27580.55	14709.63
12	2.00	41.600	1.49	34150.0	4268.75	31849.30	15924.65
13	2.13			37200.0	4650.00	36499.30	17176.14
14	2.25	73.900	0.83	26200.0	3275.00	39774.30	17677.47
15	2.38			24000.0	3000.00	42774.30	18010.23
16	2.50	107.300	0.6	25600.0	3200.00	45974.30	18369.72
17	2.63			24780.0	3097.50	49071.80	18694.02
18	2.75	120.100	0.51	20675.0	2584.38	51656.18	18784.06
19	2.88			19500.0	2437.50	54093.68	18815.19
20	3.13	157.300	0.31	15220.0	3805.00	57898.68	18527.58
21	3.38			11250.0	2812.50	60711.18	17988.50
22	3.63	185.200	0.25	8330.0	2082.50	62793.68	17322.39
23	3.88			10080.0	2520.00	65313.68	16855.14
24	4.38	257.800	0.2	4995.0	2497.50	67811.18	15499.70
25	4.88			4860.0	2430.00	70241.18	14408.45
26	5.38	260.400	0.15	1046.0	523.00	70764.18	13165.43
27	5.88			1053.0	526.50	71290.68	12134.58
28	6.88	263.200	0.12	1059.0	1059.00	72349.68	10523.59
29	7.88	261.400	0.13	527.5	527.50	72877.18	9254.24
30	8.00	263.400	0.13	236.0	29.50	72906.68	9113.33

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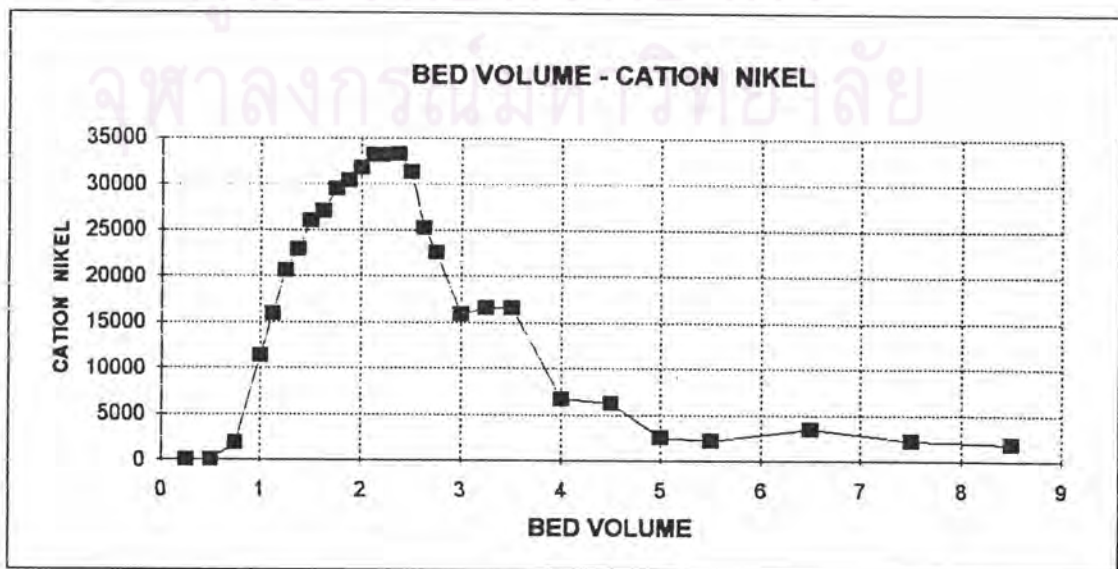
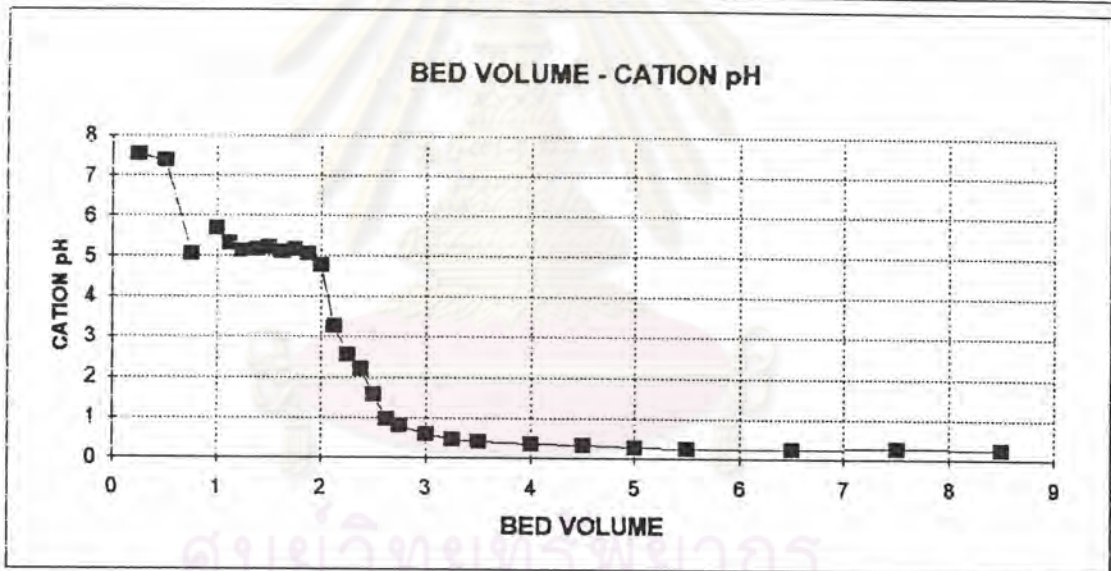
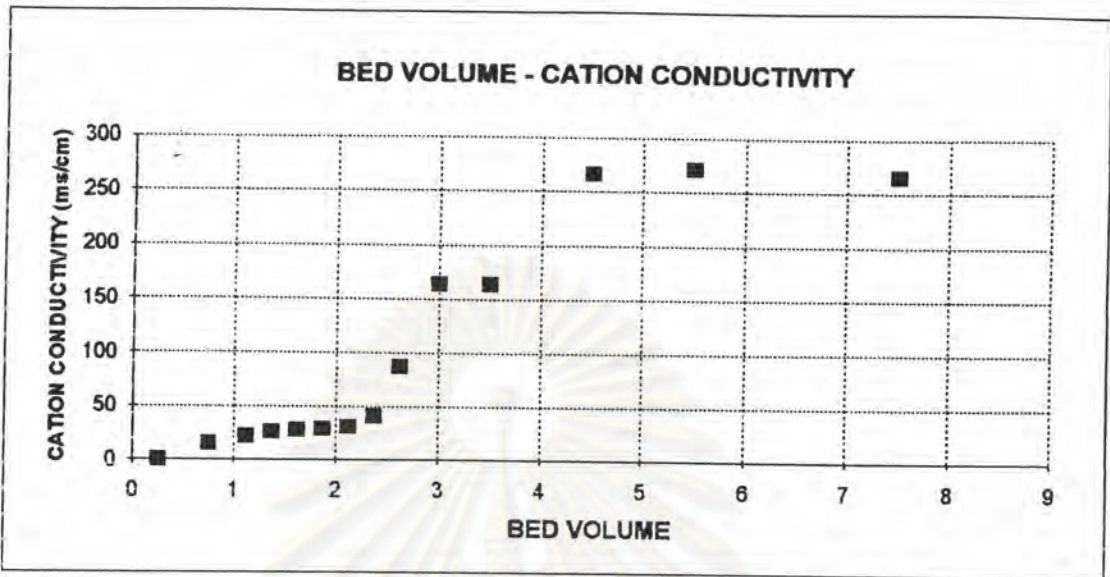
R2-3-7L.XLS



REGENERATION WITH SULFURIC ACID 7% ACID INTRODUCE FLOWRATE 4.5 BV./hr AFTER SERVICE BY INFLUENT RINSE WASTE (NI. 300 mg/l & OTHERS); RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI. CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25		7.53	44.6	11.15	11.15	44.60
2	0.50	0.154	7.37	23.3	5.83	16.98	33.95
3	0.75		5.05	1820.0	455.00	471.98	629.30
4	1.00	14.740	5.69	11325.0	2831.25	3303.23	3303.23
5	1.13		5.33	15925.0	1990.63	5293.85	4705.64
6	1.25	22.200	5.14	20625.0	2578.13	7871.98	6297.58
7	1.38		5.16	22950.0	2868.75	10740.73	7811.44
8	1.50	26.100	5.22	26050.0	3256.25	13996.98	9331.32
9	1.63		5.1	27000.0	3375.00	17371.98	10690.45
10	1.75	27.700	5.15	29500.0	3687.50	21059.48	12033.99
11	1.88		5.05	30350.0	3793.75	24853.23	13255.05
12	2.00	28.500	4.76	31800.0	3975.00	28828.23	14414.11
13	2.13		3.25	33150.0	4143.75	32971.98	15516.22
14	2.25	31.300	2.55	33100.0	4137.50	37109.48	16493.10
15	2.38		2.2	33250.0	4156.25	41265.73	17375.04
16	2.50	40.300	1.58	31350.0	3918.75	45184.48	18073.79
17	2.63		0.97	25200.0	3150.00	48334.48	18413.13
18	2.75	87.000	0.79	22550.0	2818.75	51153.23	18601.17
19	3.00		0.6	15900.0	3975.00	55128.23	18376.08
20	3.25	164.500	0.45	16575.0	4143.75	59271.98	18237.53
21	3.50		0.41	16550.0	4137.50	63409.48	18116.99
22	4.00	164.500	0.36	6650.0	3325.00	66734.48	16683.62
23	4.50		0.33	6270.0	3135.00	69869.48	15526.55
24	5.00	266.400	0.28	2520.0	1260.00	71129.48	14225.90
25	5.50		0.26	2255.0	1127.50	72256.98	13137.63
26	6.50	271.000	0.24	3480.0	3480.00	75736.98	11651.84
27	7.50		0.27	2240.0	2240.00	77976.98	10396.93
28	8.00	265.000	0.25	520.0	260.00	78236.98	9779.62

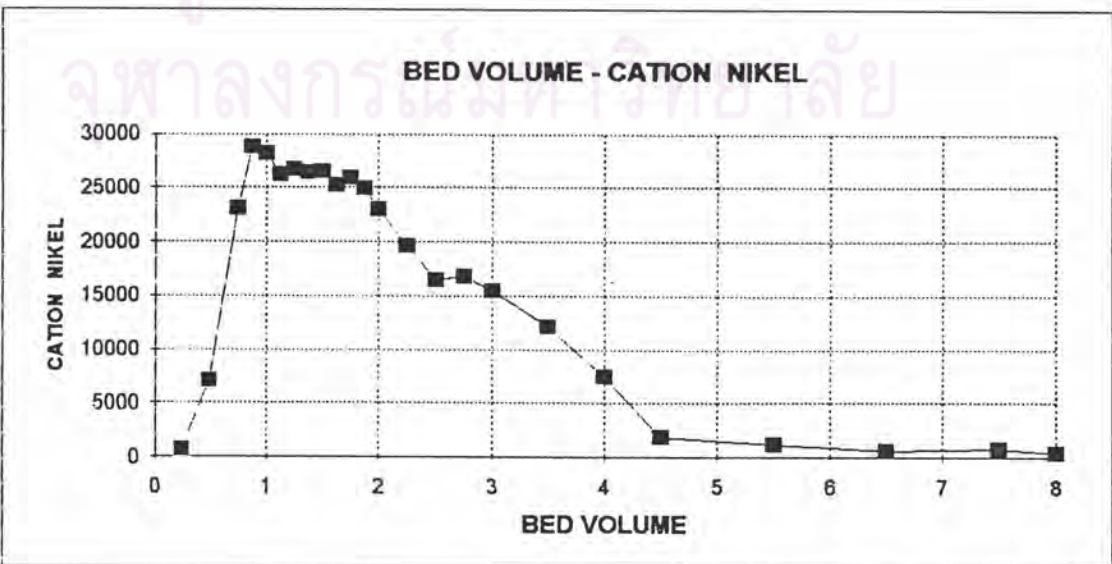
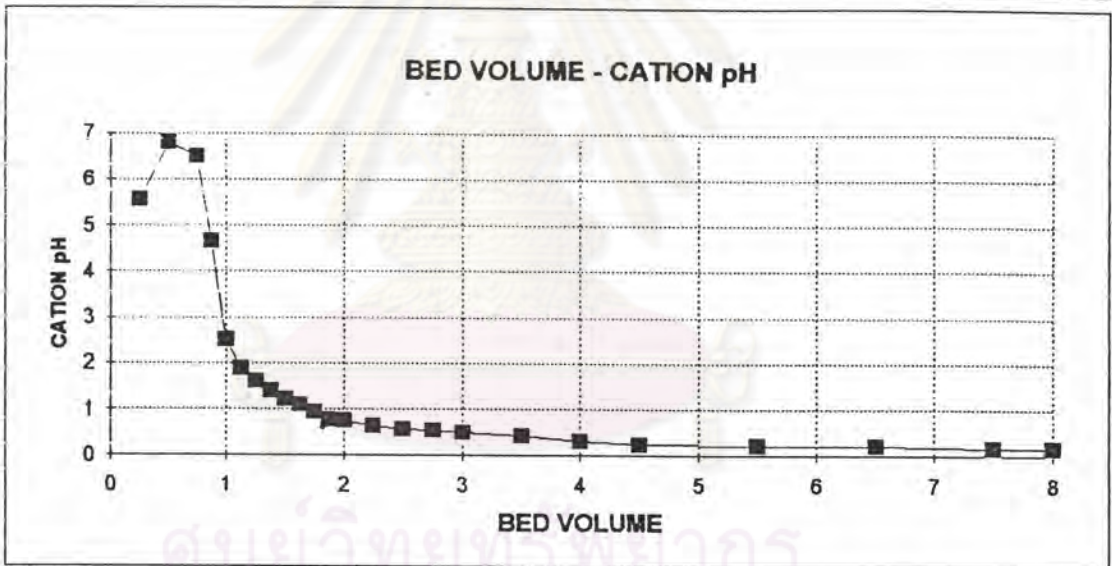
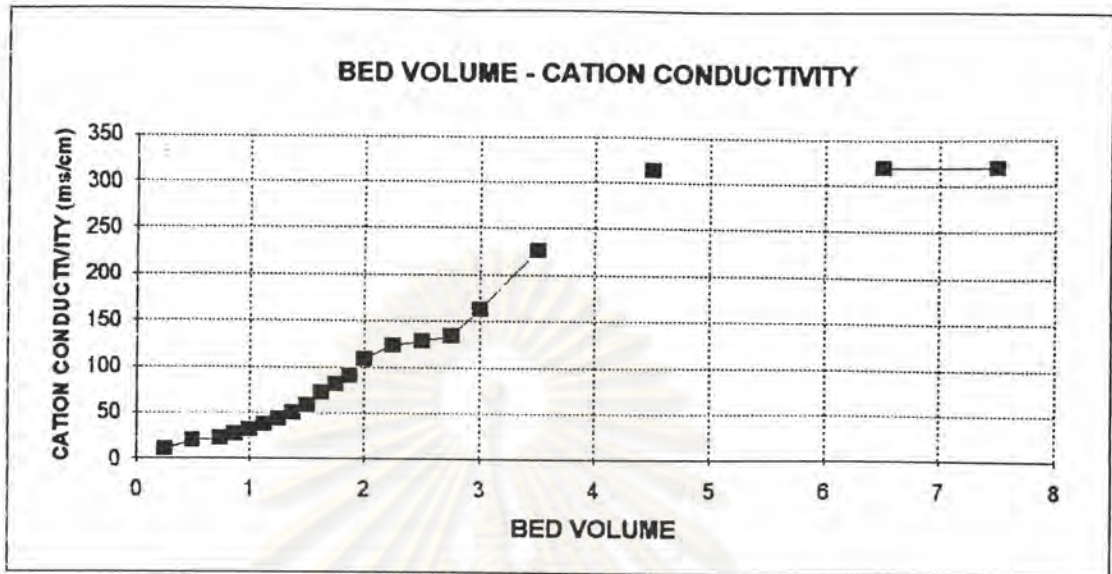
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R2-3-7.XLS



REGENERATION WITH SULFURIC ACID 7%							
ACID INTRODUCE FLOWRATE 6 BV./hr							
AFTER SERVICE BY INFLUENT RINSE WASTE (NI. 300 mg/l & OTHERS); RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI. CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	1.431	5.55	723.0	180.75	180.75	723.00
2	0.50	10.290	6.8	7110.0	1777.50	1958.25	3916.50
3	0.75	19.460	6.5	23100.0	5775.00	7733.25	10311.00
4	0.88	22.400	4.65	28750.0	3593.75	11327.00	12945.14
5	1.00	26.500	2.51	28250.0	3531.25	14858.25	14858.25
6	1.13	31.300	1.89	26250.0	3281.25	18139.50	16124.00
7	1.25	36.700	1.6	26700.0	3337.50	21477.00	17181.60
8	1.38	42.900	1.39	26450.0	3306.25	24783.25	18024.18
9	1.50	50.400	1.2	26500.0	3312.50	28095.75	18730.50
10	1.63	58.300	1.1	25250.0	3156.25	31252.00	19232.00
11	1.75	71.500	0.93	25900.0	3237.50	34489.50	19708.29
12	1.88	80.600	0.78	24925.0	3115.63	37605.13	20056.07
13	2.00	90.300	0.75	22975.0	2871.88	40477.00	20238.50
14	2.25	108.700	0.64	19675.0	4918.75	45395.75	20175.99
15	2.50	123.600	0.56	16500.0	4125.00	49520.75	19808.30
16	2.75	128.500	0.53	16725.0	4181.25	53702.00	19528.00
17	3.00	134.400	0.5	15525.0	3881.25	57583.25	19194.42
18	3.50	162.500	0.42	12100.0	6050.00	63633.25	18180.93
19	4.00	226.000	0.32	7490.0	3745.00	67378.25	16844.56
20	4.50		0.23	1915.0	957.50	68335.75	15185.72
21	5.50	314.400	0.22	1235.0	1235.00	69570.75	12649.23
22	6.50		0.21	614.0	614.00	70184.75	10797.65
23	7.50	320.000	0.18	773.0	773.00	70957.75	9461.03
24	8.00	320.000	0.18	450.0	225.00	71182.75	8897.64

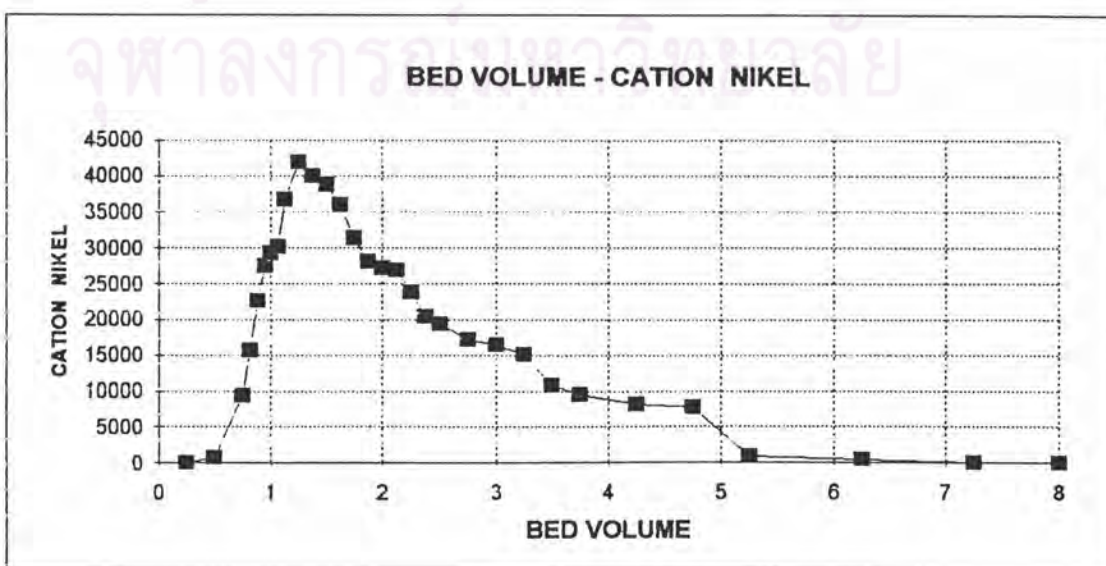
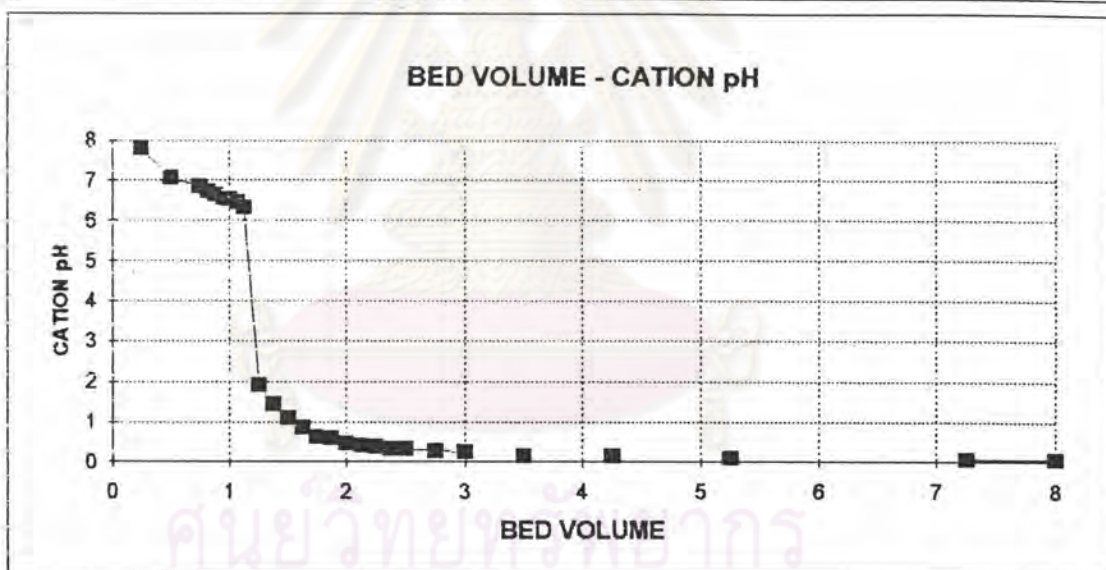
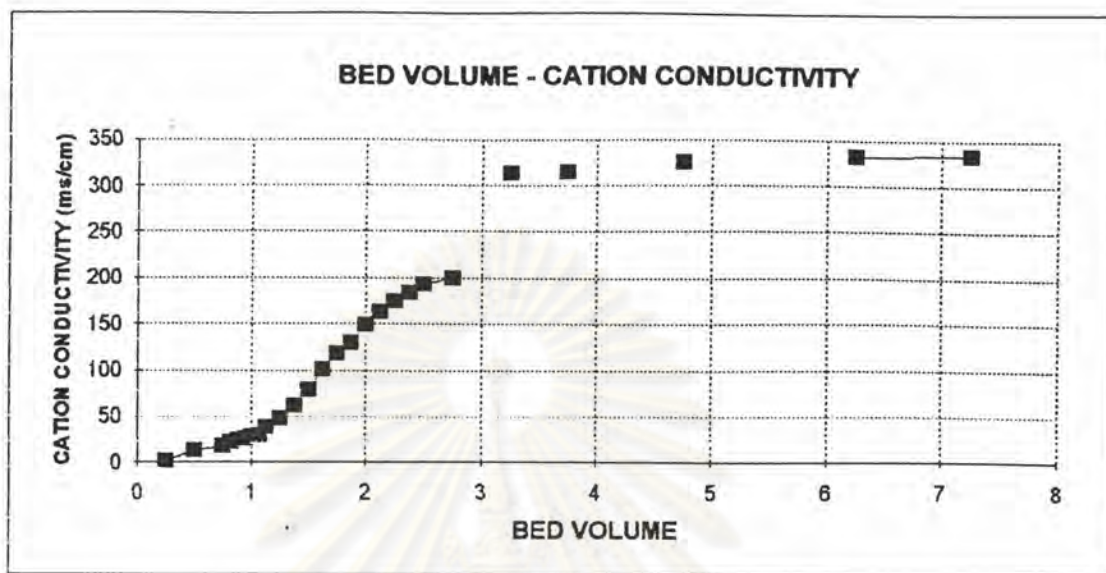
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REGENERATION WITH SULFURIC ACID 9% ACID INTRODUCE FLOWRATE 3 BV./hr AFTER SERVICE BY INFLUENT RINSE WASTE (NI. 300 mg/l & OTHERS); RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI. CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	0.048	7.81	2.6	0.65	0.65	2.60
2	0.50	1.622	7.07	793.0	198.25	198.90	397.80
3	0.75	12.800	6.85	9370.0	2342.50	2541.40	3388.53
4	0.82	17.960	6.71	15700.0	1059.75	3601.15	4405.08
5	0.89	22.300	6.63	22600.0	1525.50	5126.65	5792.82
6	0.95	24.400	6.57	27500.0	1856.25	6982.90	7331.13
7	1.00	26.100	6.53	29250.0	1969.38	8372.28	8372.28
8	1.07	27.700	6.47	30250.0	2041.88	10414.15	9755.64
9	1.13	29.500	6.32	36650.0	2107.38	12521.53	11130.24
10	1.25	38.000	1.9	41800.0	5225.00	17746.53	14197.22
11	1.38	47.700	1.43	40000.0	5000.00	22746.53	16542.93
12	1.50	61.100	1.1	38750.0	4843.75	27590.28	18393.52
13	1.63	78.500	0.86	35950.0	4493.75	32084.03	19744.02
14	1.75	100.200	0.61	31300.0	3912.50	35996.53	20569.44
15	1.88	117.400	0.58	28150.0	3518.75	39515.28	21074.81
16	2.00	129.200	0.47	27300.0	3412.50	42927.78	21463.89
17	2.13	149.500	0.41	27000.0	3375.00	46302.78	21789.54
18	2.25	162.900	0.38	23825.0	2978.13	49280.90	21902.62
19	2.38	173.900	0.33	20500.0	2562.50	51843.40	21828.80
20	2.50	183.100	0.32	19400.0	2425.00	54268.40	21707.36
21	2.75	193.300	0.28	17125.0	4281.25	58549.65	21290.78
22	3.00	199.400	0.26	16500.0	4125.00	62674.65	20891.55
23	3.25			15050.0	3762.50	66437.15	20442.20
24	3.50	314.500	0.13	10800.0	2700.00	69137.15	19753.47
25	3.75			9530.0	2382.50	71519.65	19071.91
26	4.25	314.800	0.13	8200.0	4100.00	75619.65	17792.86
27	4.75			7760.0	3880.00	79499.65	16736.77
28	5.25	325.200	0.08	863.0	431.50	79931.15	15224.98
29	6.25			484.0	484.00	80415.15	12866.42
30	7.25	332.600	0.07	30.4	30.40	80445.55	11095.84
30	8.00	334.000	0.06	15.0	11.25	80456.80	10057.10

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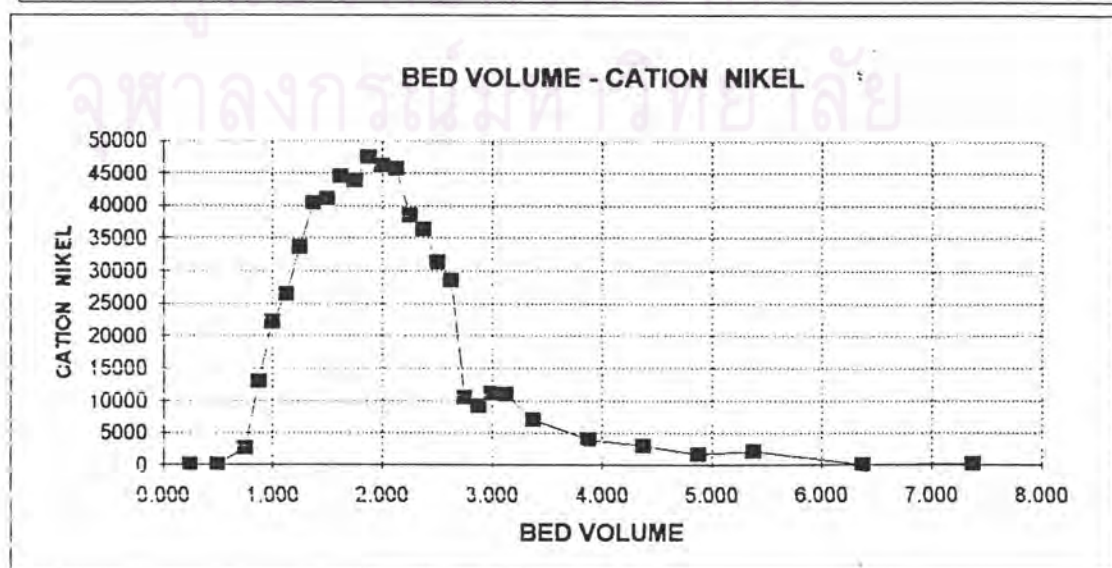
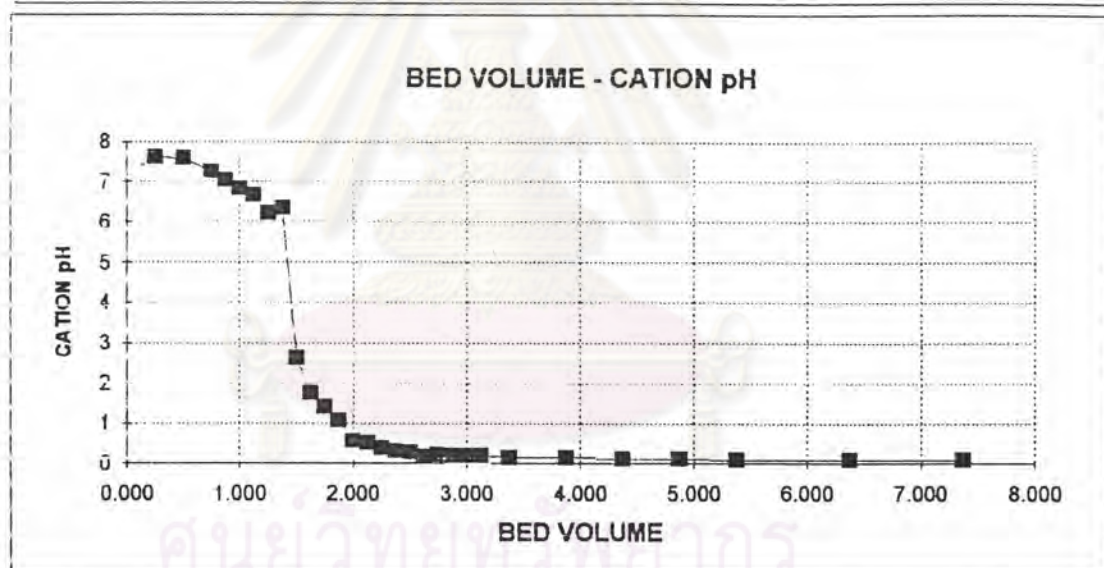
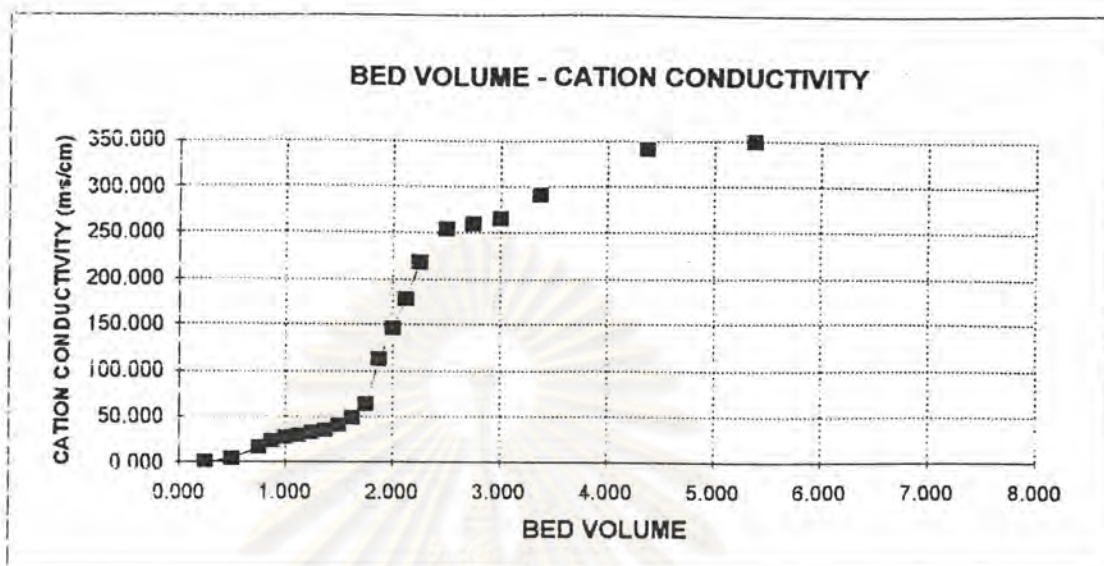
R2-3-9L.XLS



REGENERATION WITH SULFURIC ACID 9% ACID INTRODUCE FLOWRATE 4.5 BV./hr AFTER SERVICE BY INFLUENT RINSE WASTE (NI. 300 mg/l & OTHERS); RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI. CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	0.008	7.63	12.6	3.15	3.15	12.60
2	0.50	0.067	7.59	11.1	2.78	5.93	11.85
3	0.75	3.980	7.24	2582.5	645.63	651.55	868.73
4	0.88	15.890	7.04	12950.0	1618.75	2270.30	2594.63
5	1.00	29.600	6.82	22150.0	2768.75	5039.05	5039.05
6	1.13	26.400	6.68	26400.0	3300.00	8339.05	7412.49
7	1.25	29.100	6.23	39650.0	4206.25	12545.30	10036.24
8	1.38	32.400	6.34	40500.0	5062.50	17607.80	12805.67
9	1.50	34.700	2.62	41200.0	5150.00	22757.80	15171.87
10	1.63	40.700	1.75	44650.0	5581.25	28339.05	17439.42
11	1.75	48.900	1.42	43900.0	5487.50	33826.55	19329.46
12	1.88	63.500	1.07	47500.0	5937.50	39764.05	21207.49
13	2.00	111.800	0.56	46230.0	5778.75	45542.80	22771.40
14	2.13	145.200	0.5	45670.0	5708.75	51251.55	24118.38
15	2.25	178.300	0.37	38450.0	4806.25	56057.80	24914.58
16	2.38	218.400	0.31	36420.0	4552.50	60610.30	25520.13
17	2.50		0.28	31240.0	3905.00	64515.30	25806.12
18	2.63	253.600	0.17	20560.0	3570.00	68085.30	25937.26
19	2.75		0.21	10575.0	1321.88	69407.18	25238.97
20	2.88	260.000	0.2	9150.0	1143.75	70550.93	24539.45
21	3.00		0.2	11175.0	1396.88	71947.80	23982.60
22	3.13	266.000	0.2	11000.0	1375.00	73322.80	23463.30
23	3.38		0.14	7080.0	1770.00	75092.80	22249.72
24	3.68	290.600	0.13	4050.0	2025.00	77117.80	19901.37
25	4.38		0.12	3050.0	1525.00	78642.80	17975.50
26	4.88	340.200	0.11	1620.0	810.00	79452.80	16298.01
27	5.38		0.09	2130.0	1065.00	80517.80	14980.06
28	6.38	348.400	0.08	100.0	100.00	80617.80	12645.93
29	7.38		0.09	275.0	275.00	80892.80	10968.52

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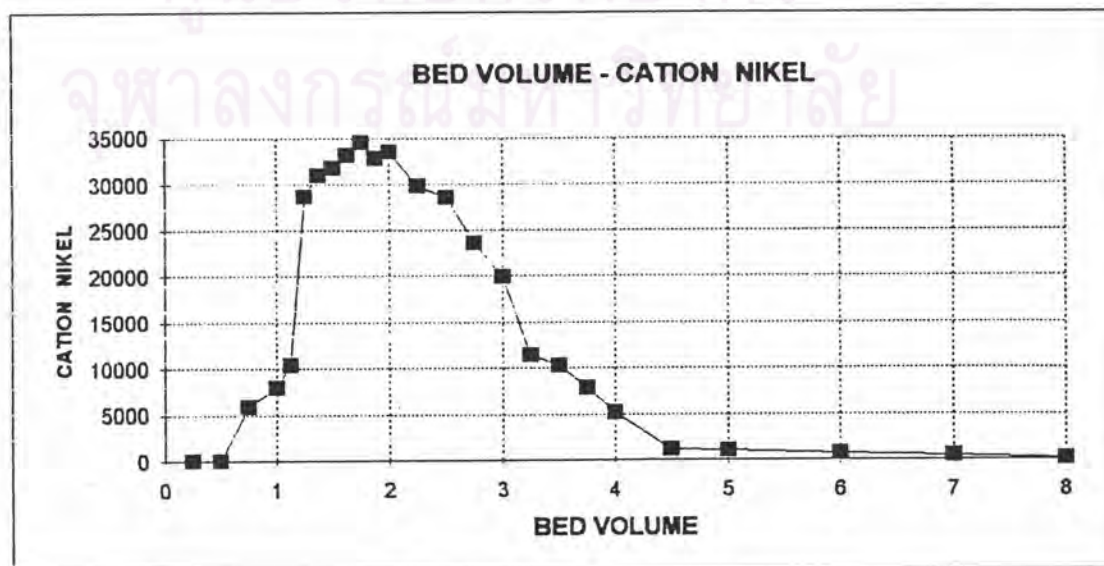
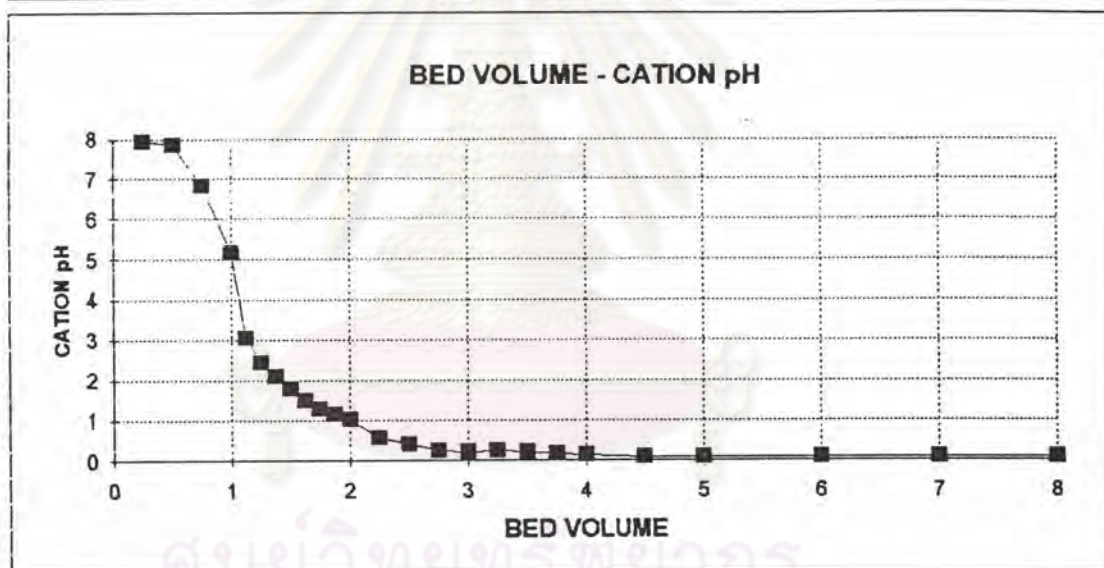
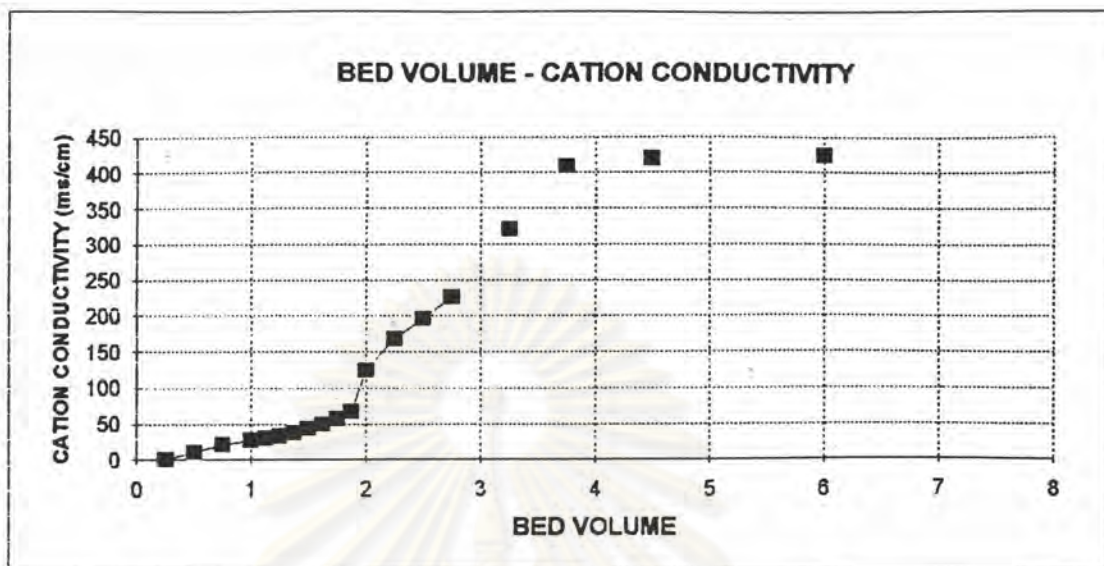
R2-3-9.XLS



REGENERATION WITH SULFURIC ACID 9% ACID INTRODUCE FLOWRATE 8 BV./Hr AFTER SERVICE BY INFLUENT RINSE WASTE (Ni. 300 mg/l & OTHERS); RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI. CONC. x BEDVOLUME (mg/l.resin)	CUMULATIVE NICKEL (mg/l.resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	0.344	7.93	58.2	14.55	14.55	58.20
2	0.50	0.367	7.86	83.5	20.88	35.43	70.85
3	0.75	11.060	6.82	5900.0	1475.00	1510.43	2013.90
4	1.00	21.800	5.16	7970.0	1992.50	3502.93	3502.93
5	1.13	26.400	3.04	10430.0	1303.75	4806.68	4272.60
6	1.25	29.800	2.43	28600.0	3575.00	8381.68	6705.34
7	1.38	32.800	2.09	30900.0	3862.50	12244.18	8904.85
8	1.50	37.600	1.77	31750.0	3968.75	16212.93	10808.62
9	1.63	43.800	1.49	33150.0	4143.75	20356.68	12527.18
10	1.75	49.600	1.29	34500.0	4312.50	24669.18	14096.67
11	1.88	56.700	1.14	32800.0	4100.00	28769.18	15343.56
12	2.00	66.600	1.01	33500.0	4187.50	32956.68	16478.34
13	2.25	124.400	0.57	29850.0	7462.50	40419.18	17964.08
14	2.50	167.400	0.4	28500.0	7125.00	47544.18	19017.67
15	2.75	196.600	0.26	23570.0	5892.50	53436.68	19431.52
16	3.00	226.000	0.22	19870.0	4967.50	58404.18	19468.06
17	3.25		0.24	11375.0	2843.75	61247.93	18845.52
18	3.50	320.800	0.21	10300.0	2575.00	63822.39	18235.12
19	3.75		0.18	7890.0	1972.50	65795.43	17545.45
20	4.00	410.000	0.14	5250.0	1312.50	67107.93	16776.98
21	4.50		0.09	1146.0	573.00	67680.93	15040.21
22	5.00	420.000	0.09	1020.0	510.00	68190.93	13639.19
23	6.00		0.09	760.0	760.00	68950.93	11491.82
24	7.00	425.000	0.09	500.0	500.00	69450.93	9921.56
25	8.00		0.09	120.0	120.00	69570.93	8696.37

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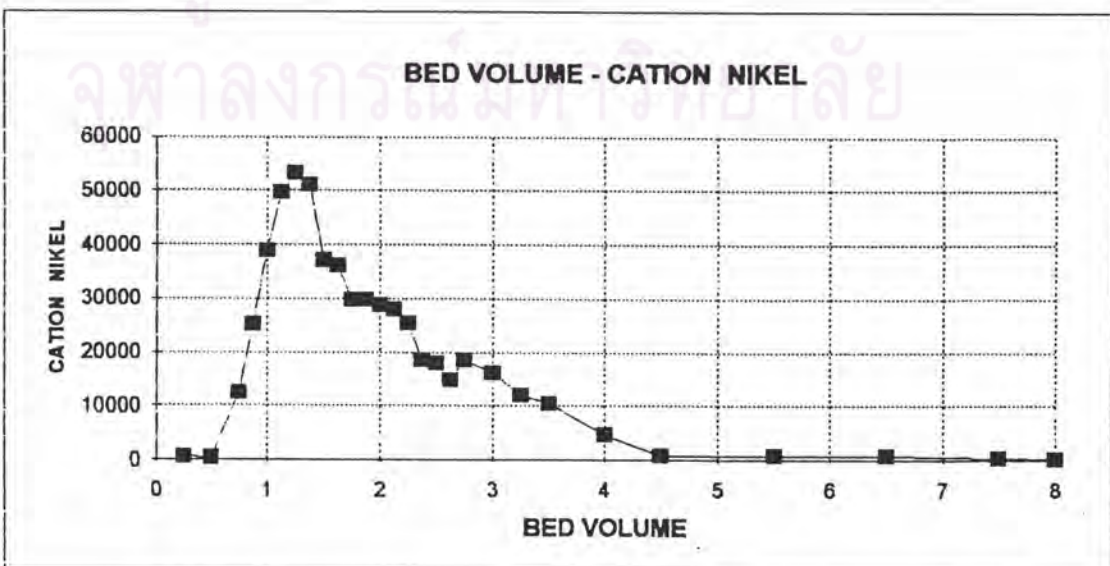
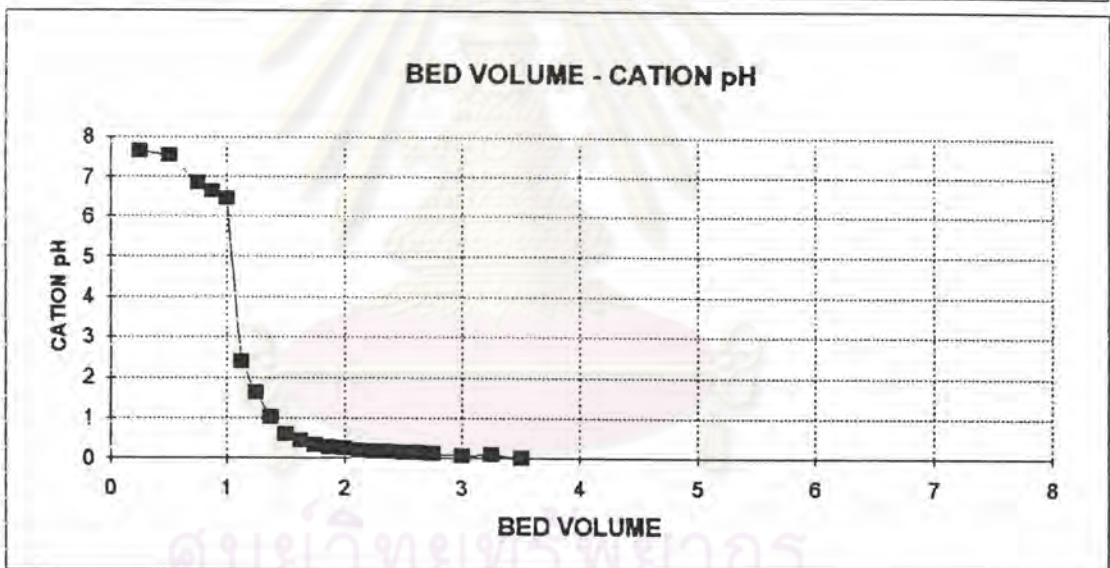
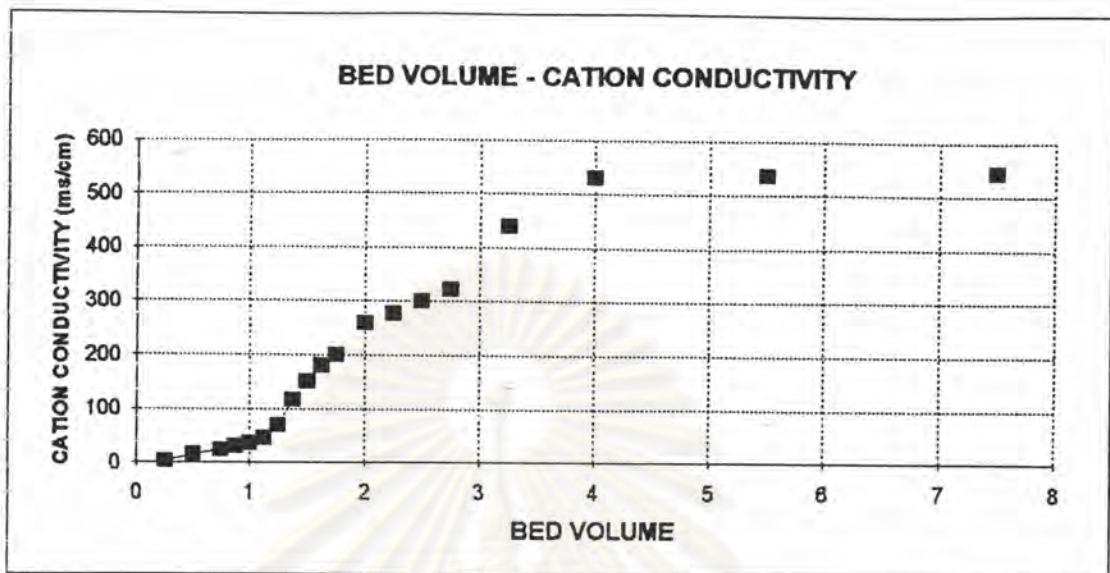
R2-3-9H.XLS



REGENNERATION WITH SULFURIC ACID 12% ACID INTRODUCE FLOWRATE 3 BV./hr AFTER SERVICE BY INFLUENT RINSE WASTE (NI. 300 mg/l & OTHERS); RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI. CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	2.370	7.64	703.0	175.75	175.75	703.00
2	0.50	1.674	7.53	491.0	122.75	298.50	597.00
3	0.75	16.480	6.86	12475.0	3118.75	3417.25	4566.33
4	0.88	25.100	6.65	25250.0	3156.25	6573.50	7512.57
5	1.00	30.400	6.45	38850.0	4856.25	11429.75	11429.75
6	1.13	37.000	2.39	49750.0	6218.75	17648.50	15687.56
7	1.25	45.400	1.63	53300.0	6662.50	24311.00	19448.80
8	1.38	69.900	1.01	51100.0	6387.50	30698.50	22326.18
9	1.50	116.600	0.59	37150.0	4643.75	35342.25	23561.50
10	1.63	151.600	0.43	36050.0	4506.25	39848.50	24522.15
11	1.75	181.300	0.33	29800.0	3725.00	43573.50	24899.14
12	1.88	199.700	0.28	29750.0	3718.75	47292.25	25222.53
13	2.00		0.25	28750.0	3593.75	50886.00	25443.00
14	2.13	259.200	0.19	27950.0	3493.75	54379.75	25590.47
15	2.25		0.18	25550.0	3193.75	57573.50	25588.22
16	2.38	277.000	0.16	18575.0	2321.88	59895.38	25219.11
17	2.50		0.15	18025.0	2253.13	62148.50	24859.40
18	2.63	300.400	0.13	14900.0	1862.50	64011.00	24385.14
19	2.75		0.12	18500.0	2312.50	66323.50	24117.64
20	3.00	322.400	0.07	16175.0	4043.75	70367.25	23455.75
21	3.25		0.09	12000.0	3000.00	73367.25	22574.54
22	3.50	439.500	0.02	10510.0	2627.50	75994.75	21712.79
23	4.00			4775.0	2387.50	78382.25	19595.56
24	4.50	530.500		849.0	424.50	78806.75	17512.61
25	5.50			796.0	796.00	79602.75	14473.23
26	6.50	535.500		740.0	740.00	80342.75	12380.42
27	7.50			519.0	519.00	80861.75	10781.57
28	8.00	545.000		218.0	109.00	80970.75	10121.34

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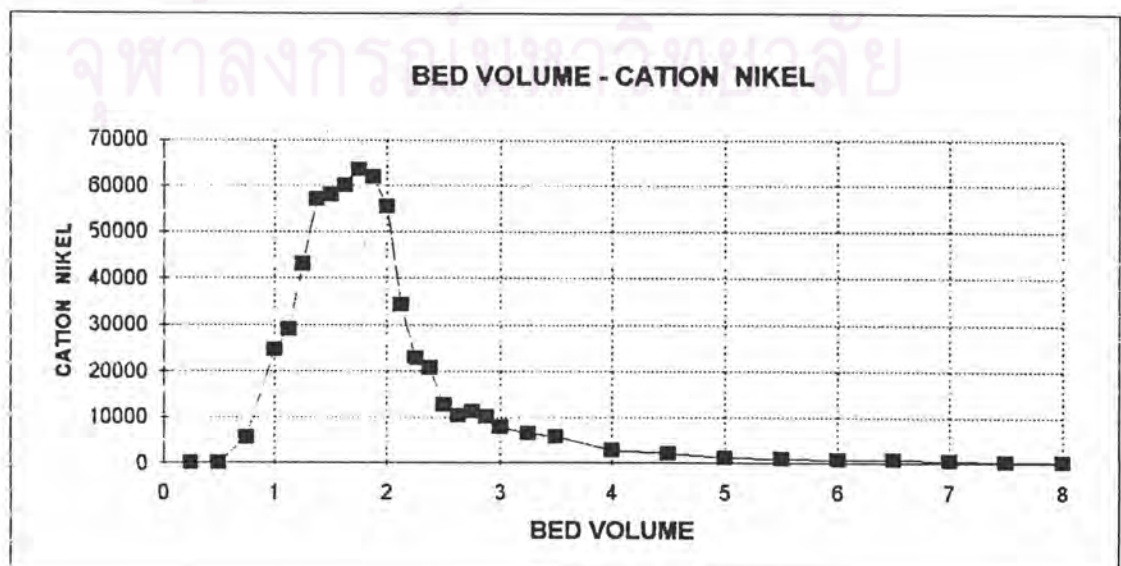
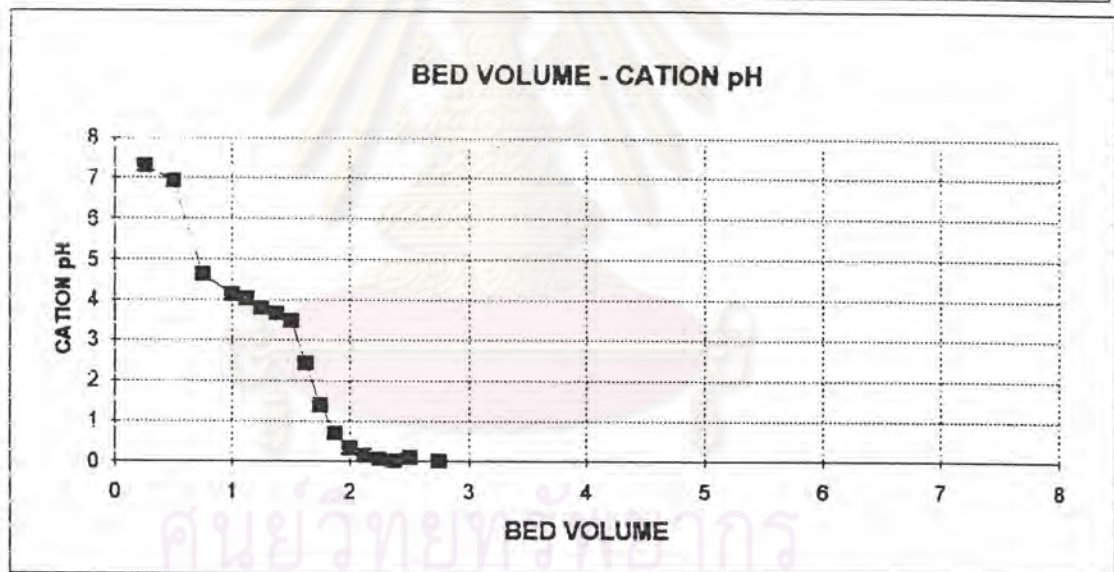
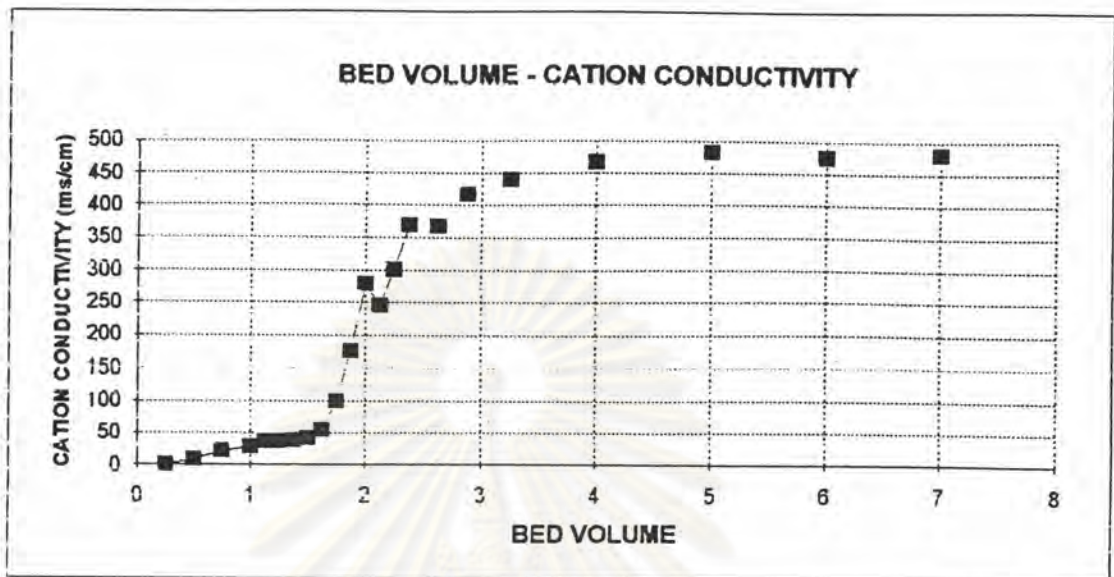
R2-3-12L.XLS



REGENERATION WITH SULFURIC ACID 12% ACID INTRODUCE FLOWRATE 4.5 BV./hr AFTER SERVICE BY INFLUENT RINSE WASTE (Ni. 300 mg/l & OTHERS); RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI CONC. x BEDVOLUME (mg/l.resin)	CUMULATIVE NICKEL (mg/l.resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	0.240	7.3	17.5	4.38	4.38	17.50
2	0.50	0.185	6.94	16.7	4.18	8.55	17.10
3	0.75	8.620	4.63	5550.0	1387.50	1396.05	1861.40
4	1.00	21.600	4.14	24550.0	6137.50	7533.55	7533.55
5	1.13	28.600	4.03	29100.0	3637.50	11171.05	9929.82
6	1.25	35.900	3.79	43150.0	5393.75	16564.80	13251.84
7	1.38	36.900	3.65	57000.0	7125.00	23689.80	17228.95
8	1.50	38.300	3.48	58000.0	7250.00	30939.80	20626.53
9	1.63	41.000	2.42	60000.0	7500.00	38439.80	23655.26
10	1.75	54.500	1.39	63500.0	7937.50	46377.30	26501.31
11	1.88	98.700	0.69	62000.0	7750.00	54127.30	28867.89
12	2.00	177.300	0.32	55500.0	6937.50	61064.80	30532.40
13	2.13	278.400	0.15	34400.0	4300.00	65364.80	30759.91
14	2.25	246.000	0.07	22800.0	2850.00	68214.80	30317.69
15	2.38	299.600	0.02	20850.0	2606.25	70821.05	29819.39
16	2.50	369.600	0.08	12650.0	1581.25	72402.30	28960.92
17	2.63			10425.0	1303.13	73705.43	28078.26
18	2.75	367.200	0	11300.0	1412.50	75117.93	27315.61
19	2.88			10220.0	1277.50	76395.43	26572.32
20	3.00	417.600		7880.0	985.00	77380.43	25793.48
21	3.25			6500.0	1625.00	79005.43	24309.36
22	3.50	441.000		5700.0	1425.00	80430.43	22980.12
23	4.00			2875.0	1437.50	81867.93	20466.98
24	4.50	465.900		2142.5	1071.25	82939.18	18430.93
25	5.00			1125.0	562.50	83501.68	16700.34
26	5.50	481.800		1049.0	524.50	84026.18	15277.49
27	6.00			656.0	328.00	84354.18	14059.03
28	6.50	475.500		636.0	318.00	84672.18	13026.49

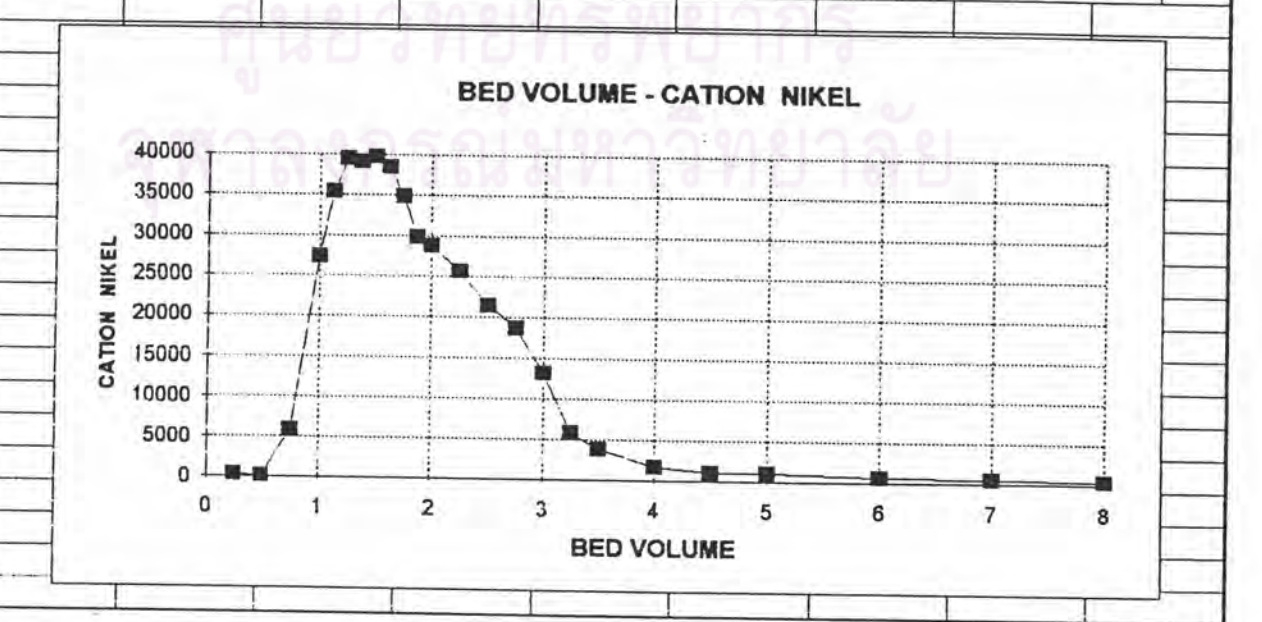
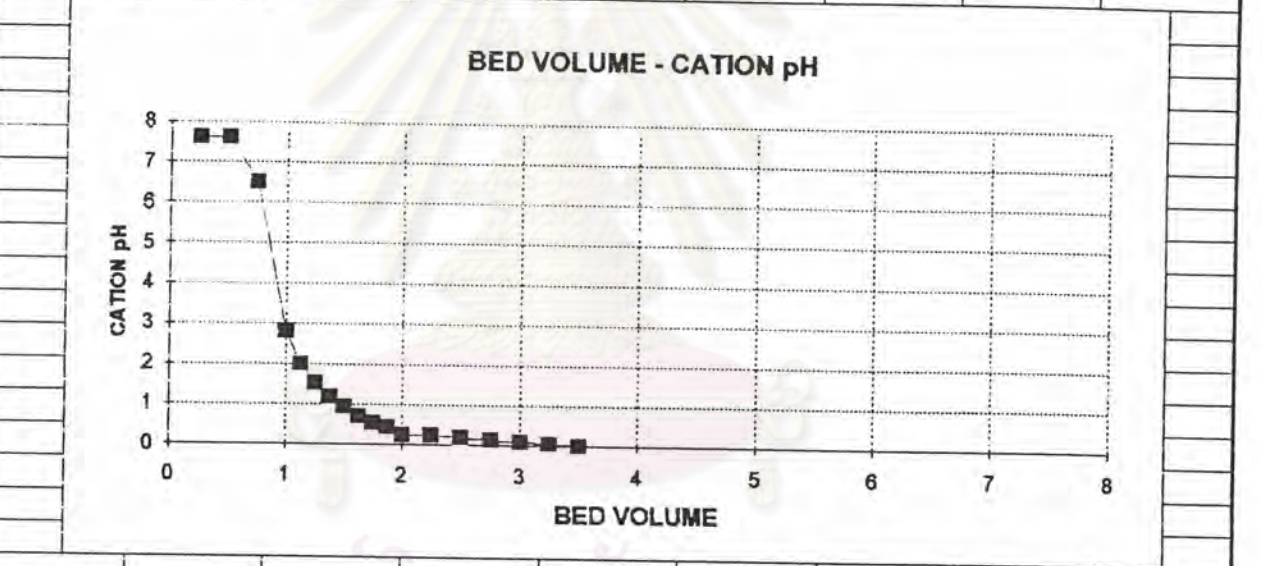
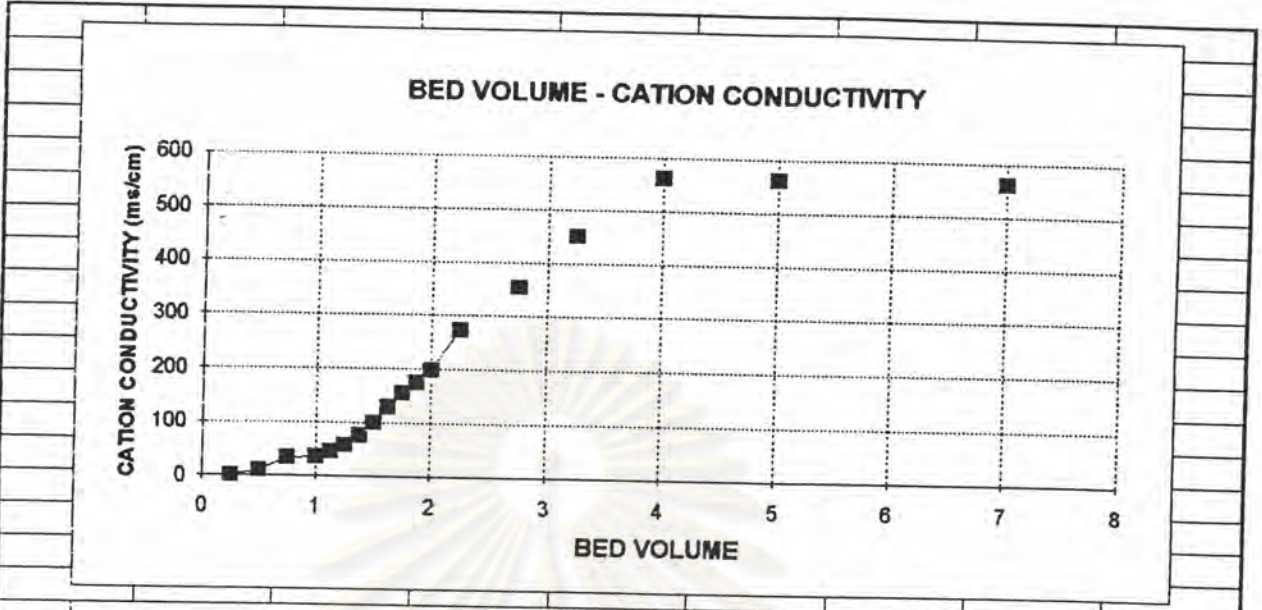
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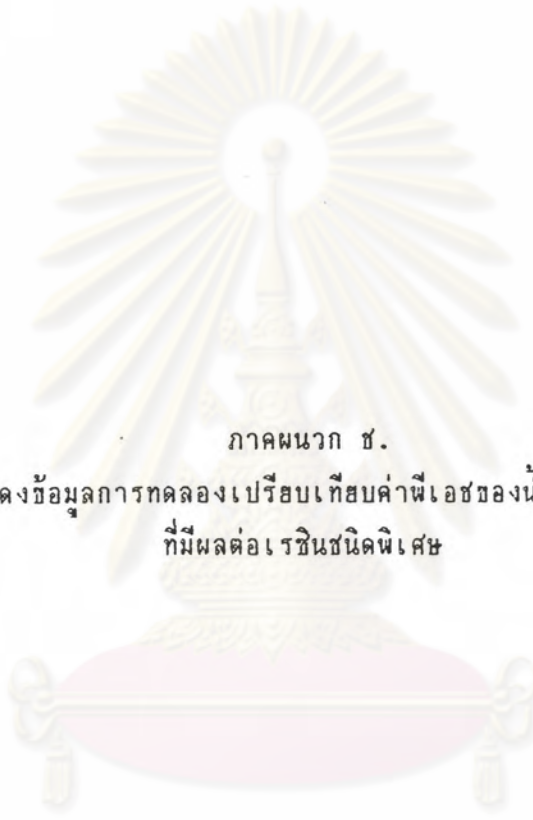
R2-3-12.XLS



REGENNERATION WITH SULFURIC ACID 12%							
ACID INTRODUCE FLOWRATE 6 BV./hr							
AFTER SERVICE BY (INFLUENT RINSE WASTE (NI. 300 mg/l & OTHERS)); RESIN TYPE : IMMINODIACETIC FUNCTIONAL GROUP							
SAMPLE No.	BED VOLUME (BV.)	CONDUCT. (ms/cm.)	CATION ACIDITY (mg/l)	NI CONC. (mg/l)	NI. CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	CUMULATIVE NI CONC. (mg/l)
1	0.25	1.186	7.63	254.5	63.63	63.63	254.50
2	0.50	1.087	7.62	197.5	49.38	113.00	226.00
3	0.75	11.060	6.5	5760.0	1440.00	1553.00	2070.67
4	1.00	33.200	2.81	27300.0	6825.00	8378.00	8378.00
5	1.13	35.400	2	35350.0	4418.75	12796.75	11374.89
6	1.25	45.400	1.51	39400.0	4925.00	17721.75	14177.40
7	1.38	58.000	1.18	39100.0	4887.50	22609.25	16443.09
8	1.50	75.600	0.93	39700.0	4962.50	27571.75	18381.17
9	1.63	99.800	0.7	38400.0	4800.00	32371.75	19921.08
10	1.75	128.600	0.53	34800.0	4350.00	36721.75	20983.86
11	1.88	154.000	0.43	29850.0	3731.25	40453.00	21574.93
12	2.00	174.000	0.26	28800.0	3600.00	44053.00	22026.50
13	2.25	198.700	0.25	25600.0	6400.00	50453.00	22423.56
14	2.50	274.200	0.19	21450.0	5362.50	55815.50	22326.20
15	2.75		0.14	18700.0	4675.00	60490.50	21996.55
16	3.00	354.800	0.08	13125.0	3281.25	63771.75	21257.25
17	3.25		0.06	5750.0	1437.50	65209.25	20064.38
18	3.50	451.000	0	3845.0	961.25	66170.50	18905.86
19	4.00			1722.5	861.25	67031.75	16757.94
20	4.50	561.000		1140.0	570.00	67601.75	15022.61
21	5.00			1048.0	524.00	68125.75	13625.15
22	6.00	562.500		707.0	707.00	68832.75	11472.13
23	7.00			503.0	503.00	69335.75	9905.11
24	8.00	562.500		387.0	387.00	69722.75	8715.34

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย





ภาคผนวก ช.

ตารางแสดงข้อมูลการทดลองเปรียบเทียบค่าพีเอชของน้ำเสียสังเคราะห์
ที่มีผลต่อเรซินชนิดพิเศษ

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

RAW WASTE : NI - 300 mg/l														
SERVICE FLOWRATE ~20 BV/H														
RESIN TYPE IMMINDIACETIC ACID GROUP														
SAMPLE No	BED VOLUME	pH 2				pH 3			pH 5			pH 7		
		NICKEL CONC. (mg/l)	NICKEL CONC. (mg/l)	NICKEL CONC. (mg/l)	NICKEL CONC. (mg/l)	VALUE	AVERAGE	TOTAL	VALUE	AVERAGE	TOTAL	VALUE	AVERAGE	TOTAL
1	15	80.40	79.20	57.60	*	0.2690	0.2660	4.5760	0.2640	0.2723	4.3573	0.1920	0.2500	4.0000
2	32	91.20	84.20	92.40	*	0.3040	0.3425	5.4800	0.2807	0.3057	4.8907	0.3060	0.3370	5.3920
3	48	114.30	93.20	103.80	*	0.3910	0.4170	6.6720	0.3307	0.3542	5.6667	0.3660	0.3800	6.0800
4	64	135.30	113.30	118.20	*	0.4530	0.4600	7.2000	0.3777	0.3832	6.1307	0.3340	0.3335	6.2960
5	80	134.10	116.60	117.90	*	0.4470	0.5090	8.1290	0.3887	0.4102	6.5627	0.3330	0.4180	6.6880
6	96	170.70	129.50	132.90	*	0.5690	0.6055	9.6880	0.4317	0.4467	7.1467	0.4430	0.4560	7.2560
7	112	192.60	138.50	140.70	*	0.6420	0.6380	11.1680	0.4617	0.4727	7.5627	0.4630	0.4760	7.6160
8	129	226.20	145.10	144.90	*	0.7540	0.7475	11.9600	0.4837	0.4962	7.9387	0.4830	0.4960	7.9360
9	144	222.30	152.60	152.70	*	0.7410	0.7480	11.9630	0.5087	0.5202	8.3227	0.5090	0.5225	8.3600
10	160	226.50	159.50	160.80	*	0.7550	0.7850	12.5600	0.5317	0.5407	8.6507	0.5360	0.5590	8.9440
11	176	244.50	164.90	174.60	*	0.8150	0.9555	13.6880	0.5497	0.5657	9.0507	0.5620	0.5770	9.2320
12	192	268.80	174.50	171.60	*	0.8960	0.9200	14.7200	0.5817	0.5907	9.4507	0.5720	0.5965	9.3840
13	208	263.20	179.90	180.30	*	0.9440	0.9585	15.3360	0.5997	0.6107	9.7707	0.6010	0.6185	9.8880
14	224	291.30	186.50	190.80	*	0.9730	0.9860	15.7750	0.6217	0.6387	10.2187	0.6360	0.6425	10.2800
15	240	293.70	195.70	194.70	*	0.9990	0.9530	15.2480	0.6557	0.6397	10.2347	0.6490	0.6680	10.6880
16	256	272.10	187.10	206.10	*	0.9070	0.9546	15.2731	0.6237	0.6347	10.1547	0.6870	0.6395	11.1280
17	272	300.64	193.70	211.20	*	1.0021	1.0035	16.0565	0.6457	0.6537	10.9547	0.7040	0.7235	11.5760
18	288	301.48	202.10	222.90	*	1.0049	0.9025	8.0395	0.6737	0.7017	11.2267	0.7430	0.7480	11.9680
19	304	*	218.90	225.90	*				0.7297	0.7532	12.0507	0.7530	0.7505	12.0080
20	320	*	233.00	224.40	*				0.7767	0.7977	12.7627	0.7480	0.7676	12.2816
21	336	*	245.60	236.16	*				0.8187	0.8411	13.4579	0.7872	0.7977	12.7625
22	352	*	259.07	242.43	*				0.8636	0.8751	14.0021	0.8061	0.8196	13.0971
23	368	*	265.01	248.71	*				0.8867	0.9092	14.5464	0.8290	0.8395	13.4219
24	384	*	279.48	254.98	*				0.9316	0.9541	15.2648	0.8499	0.8604	13.7664
25	400	*	292.95	261.26	*				0.9765	0.9923	15.8765	0.8709	0.8813	14.1010
26	416	*	302.42	267.53	*				1.0061	0.9040	8.0645	0.8918	0.9022	14.4357
27	432	*	*	273.81	*							0.9127	0.9231	14.7703
28	448	*	*	280.08	*							0.9336	0.9441	15.1049
29	464	*	*	266.35	*							0.9545	0.9650	15.4395
30	480	*	*	292.63	*							0.9754	0.9859	15.7742
31	496	*	*	298.90	*							0.9963	0.9982	15.9707
32	512	*	*	300.00	*							1.0000	0.9000	8.0000
		sum 8-26		203.5371	sum 8-34		253.9163	sum 8-41		343.7038				
		Ni quantity (mg./l. resin)		25338.98	Ni quantity (mg./l. resin)		48626.12	Ni quantity (mg./l. resin)		50486.97				

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย



ภาคผนวก ช.

ตารางแสดงข้อมูลการทดลองโดยใช้น้ำเสียจริงกับเรซินชนิดพิเศษ

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

RAW WASTE NI-300 mg/l SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE IMMUNODIACETIC ACID GROUP															
SAMPLE No.	BED VOLUME	INFLUENT CONDUCT. (ms/cm.)	INFLUENT pH	INFLUENT NIKEL (mg/L)	INFLUENT TDS (mg/L)	CONDUCT. (ms/cm.)	CATION pH	CATION NIKEL (mg/L)	CATION TDS (mg/L)	ANION CONDUCT. (ms/cm.)	ANION pH	ANION NIKEL (mg/L)	IN. (mg/L resin)	NICKEL QUANTITY OUT (mg/L resin)	EXCHANGE (mg/L resin)
1	12	1.391	7.47	345	595	3.040	2.27	29	1535	0.985	11.61	17	4140	348	3792
2	24	1.327	7.73	326		2.830	2.35	31		1.010	11.65	18	8076	720	7356
3	36	1.270	7.80	315		2.590	2.38	35		0.998	11.68	19	11656	1140	10716
4	48	1.221	7.88	299		2.350	2.44	35		0.988	11.65	17	15444	1560	13884
5	60	1.154	7.95	280		2.450	2.42	18		0.988	11.61	15	18804	1776	17028
6	72	1.112	7.88	261		2.150	2.49	22		0.452	10.36	15	21936	2040	19896
7	84	1.055	7.94	254		1.991	2.52	23		0.520	9.09	23	24984	2316	22668
8	96	1.027	7.95	245		1.840	2.55	22		0.608	8.36	36	27924	2580	25344
9	108	0.998	7.98	238		1.745	2.60	25		0.654	6.83	50	30780	2880	27900
10	120	0.985	7.97	232	1495	1.615	2.62	27	955	0.620	6.59	45	33664	3204	30360
11	132	0.976	7.90	227		1.536	2.65	27		0.604	6.00	36	36288	3528	32760
12	144	0.959	7.83	216		1.464	2.70	28		0.620	5.31	32	38880	3864	35016
13	156	0.943	7.73	211		1.401	2.74	28		0.897	3.16	30	41412	4200	37212
14	168	0.947	7.73	202		1.377	2.74	30		1.105	2.91	30	43836	4560	39276
15	180	0.932	7.62	195		1.319	2.75	30		1.232	2.83	30	46176	4920	41256
16	192	0.940	7.88	191		1.358	2.75	30		1.262	2.80	30	48468	5280	43188
17	204	0.931	7.80	186		1.309	2.77	30		1.308	2.77	30	50724	5640	45084
18	216	0.924	7.58	172		1.287	2.77	31		1.322	2.78	31	52788	6012	46776
19	228	0.888	7.55	170		1.265	2.81	34		1.297	2.80	33	54828	6420	48408
20	240	0.890	7.49	162	1193.3	1.251	2.83	34	1030	1.257	2.80	33	56772	6828	49844
21	252	0.899	7.53	156		1.237	2.84	34		1.247	2.82	33	58644	7236	51408
22	264	0.892	7.49	144		1.230	2.86	34		1.237	2.84	33	60372	7644	52728
23	276	0.879	7.45	136		1.212	2.86	34		1.230	2.84	33	62004	8052	53952
24	288	0.872	7.35	136		1.209	2.83	29		1.194	2.87	29	63636	8400	55236
25	300	0.861	7.34	133		1.243	2.85	28		1.290	2.81	28	65232	8736	56496
26	312	0.847	7.24	125		1.221	2.88	29		1.287	2.83	29	66732	9084	57648
27	324	0.857	7.17	118		1.214	2.87	30		1.244	2.86	29	68148	9444	58704
28	336	0.835	7.17	114		1.201	2.90	31		1.228	2.87	30	69516	9816	59700
29	348	0.843	7.12	110		1.211	2.91	32		1.195	2.89	32	70836	10200	60636
30	360	0.815	7.05	110	900	1.159	2.97	34	920	1.206	2.92	33	72156	10608	61548
31	372	0.835	6.89	104		1.137	2.97	37		1.205	2.91	36	73404	11052	62352
32	384	0.827	6.97	100		1.128	2.98	37		1.174	2.94	37	74804	11496	63108
33	396	0.810	6.76	88		1.147	2.97	38		1.132	2.97	38	75860	11952	63708
34	408	0.808	6.56	88		1.118	3.02	40		1.118	2.98	41	76716	12432	64284
35	420	0.823	6.52	89		1.133	2.98	42		1.141	2.97	41	77784	12936	64848
36	432	0.822	6.17	90		1.128	2.98	42		1.134	2.99	42	78884	13440	65424
37	444	0.826	6.19	83		1.128	2.98	41		1.133	2.97	41	79860	13932	65928
38	456	0.831	5.81	82		1.128	2.98	43		1.103	2.98	43	80844	14448	66396
39	468	0.827	5.29	82		1.121	3.00	44		1.108	2.98	44	81828	14976	66852
40	480	0.903	4.84	84	995	1.110	3.01	46	940	1.137	2.99	45	82836	15528	67308
41	492	0.910	4.52	80		1.086	3.05	48		1.133	3.00	47	83796	16104	67892
42	504	0.921	4.26	79		1.072	3.08	49		1.123	3.04	50	84744	16692	68052
43	516	0.842	4.25	80		1.114	3.02	45		1.086	3.05	45	85704	17232	68472
44	528	0.853	4.13	78		1.103	3.03	45		1.096	3.03	47	86640	17772	68888
45	540	0.882	4.00	81		1.099	3.03	46		1.114	3.02	45	87612	18324	69288
46	552	0.874	3.85	74		1.104	3.03	48		1.108	3.03	48	88500	18876	69624
47	564	0.887	3.77	72		1.089	3.04	47		1.107	3.03	48	89364	19440	69924
48	576	0.889	3.71	72		1.072	3.08	49		1.111	3.05	49	90228	20028	70200
49	588	0.896	3.67	71		1.046	3.12	53		1.108	3.06	54	91080	20664	70416
50	600	0.905	3.62	74	880	1.055	3.12	54	910	1.082	3.08	53	91968	21312	70596
51	612	0.910	3.58	70		1.037	3.17	54		1.058	3.13	54	92808	21960	70848
52	624	0.917	3.55	69		1.013	3.18	56		1.051	3.15	56	93636	22632	71004
53	636	0.910	3.54	68		1.003	3.17	56		1.016	3.16	56	94452	23304	71148
54	648	0.905	3.50	69		1.035	3.15	57		1.024	3.18	57	95280	23988	71292
55	660	0.913	3.49	71		1.026	3.17	57		1.022	3.19	56	96132	24672	71460
56	672	0.926	3.51	67		1.021	3.17	57		1.004	3.17	56	96936	25356	71580
57	684	0.932	3.46	66		1.029	3.17	57		1.015	3.16	57	97728	26040	71688
58	696	0.929	3.46	66		1.008	3.17	58		1.027	3.16	58	98520	26736	71784
59	708	0.939	3.42	68		1.029	3.18	60		1.029	3.16	61	99336	27456	71880
60	720	0.948	3.42	68	800	1.031	3.17	59	845	1.010	3.18	58	100152	28164	71988
61	732	0.940	3.41	65		1.031	3.16	59		1.013	3.20	58	100932	28872	72060
62	744	0.946	3.42	65		1.023	3.18	59		1.001	3.19	58	101712	29580	72132
63	756	0.922	3.41	67		1.039	3.14	58		1.021	3.18	57	102516	30276	72240
64	768	0.950	3.38	65		1.039	3.14	58		1.024	3.15	58	103296	30972	72324
65	780	0.952	3.38	67		1.038	3.14	61		1.034	3.14	61	104100	31704	72396
66	792	0.942	3.35	66		1.054	3.14	59		1.030	3.14	59	104892	32412	72480

RAW WASTE NI-300 mg/l SERVICE FLOWRATE = 20 BV/Hr RESIN TYPE IMMINODIACETIC ACID GROUP															
SAMPLE No.	BED VOLUME	CONDUCT. (ms/cm.)	INFLUENT			CATION				ANION			NICKEL QUANTITY		
			pH	NIKEL (mg/L)	TDS (mg/L)	CONDUCT. (ms/cm.)	pH	NIKEL (mg/L)	TDS (mg/L)	CONDUCT. (ms/cm.)	pH	NIKEL (mg/L)	IN. (mg/L resin)	NICKEL OUT (mg/L resin)	EXCHANGE (mg/L resin)
67	804	0.951	3.34	65		1.018	3.12	59		1.019	3.18	58	105672	33120	72552
68	816	0.950	3.35	63		1.029	3.17	58		1.016	3.18	58	108428	33816	72612
69	828	0.947	3.35	63		1.016	3.18	59		1.009	3.17	58	107184	34524	72660
70	840	0.983	3.32	62	880	1.000	3.19	59	880	1.020	3.18	59	107928	35232	72696
71	852	0.950	3.33	61		1.014	3.17	57		0.989	3.19	58	108660	35916	72744



ศูนย์วิทยทรัพยากร
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REGENERATION WITH SULFURIC ACID 9%							
FLOWRATE 4.5 BEDVOLUME /hr							
RAW WASTES = NICKEL WASTES 300 mg/l. (RESIN -IMMINODIACETIC ACID GROUP)							
SAMPLE NO.	BV.	REGENERATION			NICKEL CONC. x BEDVOLUME (mg/l .resin)	CUMULATIVE NICKEL (mg/l .resin)	AVG. CONC. NIKEL (mg/l)
		pH	CONDUCT (ms/cm)	Ni CONC. (mg/l.)			
1	0.00	4.50	0.550	12	3.00	3.00	0.00
2	0.25	3.90	0.556	20	5.00	8.00	32.00
3	0.50	3.80	0.789	59	14.75	22.75	45.50
4	1.00	3.54	0.904	440	110.00	132.75	132.75
5	1.25	2.80	19.300	40100	10025.00	10157.75	8128.20
6	1.50	2.51	26.700	32500	8125.00	18282.75	12188.50
7	1.75	2.36	31.200	33800	8450.00	26732.75	15275.86
8	2.00	2.05	34.700	39100	9775.00	36507.75	18253.88
9	2.25	0.91	71.700	28200	7050.00	43557.75	19359.00
10	2.50	0.39	164.000	17700	4425.00	47982.75	19193.10
11	2.75	0.26	*	11200	2800.00	50782.75	18466.45
12	3.00	0.20	*	8200	2050.00	52832.75	17610.92
13	3.25	0.19	*	6800	1700.00	54532.75	16779.31
14	3.50	0.17	*	3520	880.00	55412.75	15832.21
15	3.75	0.15	*	2810	702.50	56115.25	14964.07
16	4.00	0.13	*	1960	490.00	56605.25	14151.31
17	4.25	0.13	*	1450	362.50	56967.75	13404.18
18	4.50	0.12	*	1120	280.00	57247.75	12721.72
19	4.75	0.11	*	740	185.00	57432.75	12091.11
20	5.00	0.10	*	600	150.00	57582.75	11518.55
21	5.25	0.10	*	550	137.50	57720.25	10994.33
22	5.50	0.10	*	490	122.50	57842.75	10516.86
23	5.75	0.09	*	460	115.00	57957.75	10079.61
24	6.00	0.09	*	430	107.50	58065.25	9677.54

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย



ภาคผนวก ๗

ตารางแสดงคุณสมบัติทางกายภาพของ เรซินชนิดธรรมดาและชนิดพิเศษ

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

รายละเอียดโครงสร้างข้อมูลทั่วไปคุณสมบัติทางกายภาพและทางเคมีของแคต
ไอออนเรซินชนิดขรรคมดาและชนิดพิเศษ

PRODUCT INFORMATION

เรซินชนิดขรรคมดา (LEWATIT S100)

SODIUM FORM FOR - Softening of industrial water, dealkalized water condensate, aqueous solutions of nonionic organic chemical products
- Removal of multivalent cations, e.g. heavy metal ions, from aqueous solutions

HYDROGEN FORM FOR - Dealkalization in the split-stream process or in units with moving resin bed
- Decationization within the deionization of industrial water, rinse water from galvanizing processes, aqueous solutions of nonionic organic chemical products, e.g. glycerine
- Removal of undesirable ions in waste water treatment

- Separation of amino acids
- Conversion of salts into free acids

เรซินชนิดพิเศษ (LEWATIT TP207)

Typical fields of application

- Removal of residual concentrations of heavy metals from neutralized effluent of batch-and continuously operating detoxification plants the metal finishing industry (Final polishing)
- At the source treatment of electroplating rinse water for the recover of industrial useful and environmental relevant heavy metals

Example: Copper recycling

- Elimination of interfering metal ions from galvanizing baths and process solutions

Example : Removal of iron-ions from baths of galvanizing zinc coating lines

- Groundwater purification

Example : Removal of heavy metals from contaminated groundwaters


ตารางแสดงคุณสมบัติทางกายภาพและทางเคมีของเรซินชนิดพิเศษและชนิดธรรมดา

คุณสมบัติทางกายภาพและเคมี	ธรรมดา (LEWATIT S100)	พิเศษ (LEWATIT TP207)
Ionic form as shipped	Na ⁺	Na ⁺
Functional group	Sulfonic acid	Imminodiacetic acid
Matrix	Crosslinked - polystyrene	Crosslinked - polystyrene
Structure	Gel	Macroporous
Appearance	Brown	Beige
Bead size min.90%	0.5 - 1.3 mm.	0.4-1.25 mm.
Effective size	0.47 - 0.60 mm.	0.55 + 0.05 mm.
Uniformity coefficient	1.8	1.8
Bulk weight (+ 5%)	800 g/l.	790 g/l
Density	1.13 approx. g/ml	1.17 approx. g/ml
Water Retention	60-70 %wt	55-60 %wt
Total capacity (H ⁺ form)	2.1 min. eq/l	2.4 min. eq/l
Operating capacity	1.6 min. eq/l	1.7 min. eq/l
Bed depth (min.)	800 mm.	1000 mm.
Volume change (Na ⁺ - H ⁺)	+8%	-40%
Stability temp.	0-100 C	-20 upto 80 C

คุณสมบัติสภาพและเคมี		ธรรมดา (LEWATIT S100)			พิเศษ (LEWATIT TP207)	
Stability pH		0-14			0-14	
Flow rates	loading (max.)	50 m/h			40 m/h	
	regeneration (aprox.)	5 m/h			5 m/h	
	rinsing	5-10 m/h			5 m/h	
	backwash (exhaust resin)	6-10 m/h			10 m/h	
regeneration with		HCl	H ₂ SO ₄	NaCl	HCl	H ₂ SO ₄
concentration(%)		5-10	2-4	8-10	4-10	5-15
quantity (100 % basis (approx g./i.resin))		80	100	100	140	200

ศูนย์วิจัยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

Lewatit


Bayer 

Functional group and selectivity

Functional group	Selectivity sequence	Lewatit type
1. Cation Exchanger 1.1 Strongly acidic $R-SO_3H$ 1.2 Weakly acidic $R-COOH$	$Ba^{2+} > Pb^{2+} > Sr^{2+} > \boxed{Ca^{2+}} > Ni^{2+} > Cd^{2+} > Cu^{2+} > Co^{2+}$ $> Zn^{2+} > Fe^{2+} > Mg^{2+} > Mn^{2+} > \text{Alkalis}$ $Cu^{2+} > Pb^{2+} > Fe^{2+} > Zn^{2+} > Ni^{2+} > Cd^{2+} > \boxed{Ca^{2+}} > Mg^{2+} > Sr^{2+}$ $> Ba^{2+} > \text{Alkalis}^*$	SP 112, S 100 CNP 80
2. Chelating resins 2.1 $R-CH_2-N \begin{cases} CH_2COONa \\ CH_2COOH \end{cases}$ Iminodiacetic acid 2.2 $R-CH_2-NH-CH_2-P \begin{cases} O \\ ONa \\ ONa \end{cases}$ Amino methylphosphonic 2.3 $R-CH_2-NH-C \begin{cases} S \\ NH_2 \end{cases}$ Thiourea	$Cu^{2+} > Hg^{2+} > Pb^{2+} > Ni^{2+} > Zn^{2+} > Cd^{2+} > Co^{2+} > Fe^{2+} > Mn^{2+}$ $> \boxed{Ca^{2+}} > Mg^{2+} > Sr^{2+} > Ba^{2+} > \text{Alkalis}$ $Pb^{2+} > Cu^{2+} > Zn^{2+} > Ni^{2+} > Cd^{2+} > Co^{2+} > \boxed{Ca^{2+}} > Mg^{2+} > Sr^{2+} >$ $Ba^{2+} > \text{Alkalis}$ $Hg^{2+} > Au^{1+2+} > Pd^{2+} > Pt^{2+4+} > Ir^{3+} > Os^{4+} > Rh^{3+}$ (noble metals are fixed both as cation and anionic complexes)	TP 207, TP 208 VP OC 1060 TP 214
3. Anion exchanger Weakly basic $R-CH_2-N \begin{cases} H \\ CH_3 \end{cases}$ Strongly basic $R-CH_2-N \begin{cases} CH_3 \\ CH_3 \end{cases}$	$ClO_4^- > Me(CN)_2^- > PGM^* \text{ Chlorocomplexes} > I^- > CrO_4^{2-} >$ $NO_3^- > Br^- > HSO_4^- > Cl^- > H_2PO_4^- > F^-$ $> CN^- > H_2BO_3^- > HCO_3^- > HSiO_3^-$ The weak anions CN^- , $H_2BO_3^-$, HCO_3^- , $HSiO_3^-$ are only fixed by strongly basic anion exchange resins	MP 62, MP 64 M 500, MP 500

*Platinum group metals

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Lewatit TP 207 Properties and application

– Functional group

Lewatit TP 207 has weakly acidic, chelate-forming iminodiacetate groups with marked selectivity for a number of heavy or transition metals.

The heavy metals are bound by the exchanger as cations, preferably, from a weakly acidic to slightly alkaline solution.

Lewatit TP 207 is used in most cases after preloading (conditioning) with alkali- or alkaline earth ions. In exceptional cases, e.g. with Cu^{2+} , UO_2^{2+} and VO^{2+} , use of the hydrogen-form is also possible (cf. Section 4.2.1 Decomplexing pH).

The amphoteric character of the functional group gives Lewatit TP 207 anion exchange properties, in addition, in highly acidic solution. The so called large anions are bound preferentially in the form of their free acids. These include the following, listed in descending order of base strength: perchlorate (ClO_4^-), vanadate (VO_4^{3-}), molybdate (MoO_4^{2-}), pherrhenate (ReO_4^-) and the chloro-complexes of elements in the platinum group. The latter are adsorbed from hydrochloric acid solution (0.1–2 mol/l HCl). In contrast to anion exchangers with a higher basicity, desorption of the precious metals is possible.


– Selectivity

The stability of complex formation for the individual heavy metals varies and is as follows for divalent cations in descending order:

$\text{Cu}^{2+} > \text{UO}_2^{2+} > \text{VO}^{2+} > \text{Hg}^{2+} > \text{Pb}^{2+} > \text{Ni}^{2+} > \text{Zn}^{2+} > \text{Cd}^{2+} > \text{Co}^{2+} > \text{Fe}^{2+} > \text{Mn}^{2+} > \text{Ca}^{2+} > \text{Mg}^{2+} > \text{Sr}^{2+} > \text{Ba}^{2+} > \text{alkali metals}$

This assumes that these metals do not form complexes with the anions principally present in the solution. If so, this changes the order slightly.

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Lewatit TP 207 Possible application forms

- **Hydrogen-Form**

Regeneration of the form as supplied with 2 bed-volumes (BV) HCl 7.3% or alternatively, with 2 BV H₂SO₄ 10% or 2 BV HNO₃ 12.6%.
Rinse water: 3–4 BV softened – or demin. water
Application: limited to the cations Cu²⁺, UO₂²⁺, VO²⁺
Effluent: acidic (pH < 4)

All of the following conditioning methods require the resin to be in the hydrogen form. The fluid volumes quoted however, refer to the original resin volume in the form as supplied (Na⁺).

- **Mono-Na-Form** (conversion of 50% of the total capacity)

1.0–1.2 BV NaOH 4% are passed into the resin bed downstream. The bed is then vigorously flushed with air (as is done with mixed beds) for 10 min.
Rinse water: not necessary
Application: preferably used when the influent is free of Ca²⁺/Mg²⁺.
Effluent: neutral

When Ca²⁺, Mg²⁺ are present in the influent, the pH of the effluent will drift towards 4–6 and can be neutralized if necessary.

- **Di-Na-Form** (conversion of 100% of the total capacity)

2.0–2.4 BV NaOH 4% are passed into the resin bed upstream.
Rinse water: 1–1.5 BV softened – or demin. water in the same upstream direction.
Application: preferably used for waste water which has been neutralized with calcium hydroxide.
Effluent: first basic (pH > 9)

After the Ca²⁺ of the influent has displaced the Na⁺, usually after 5–10 BV, the effluent will remain in the neutral range.

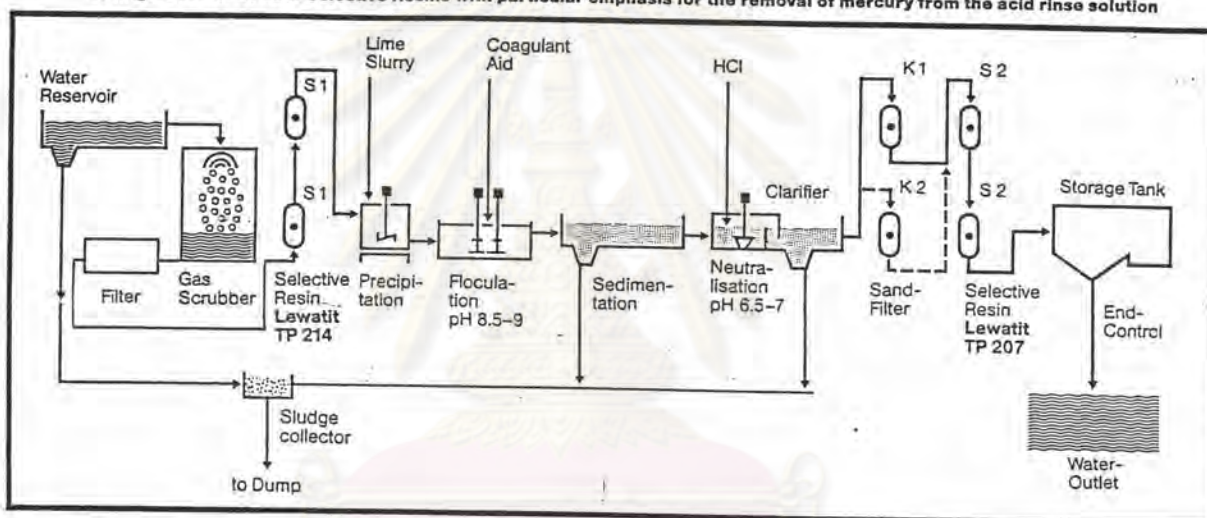
- **Ca-Form** (conversion of 100% of the total capacity)

70–85 g Ca(OH)₂/l resin is circulated for 1 h as a 5% suspension upstream with 50% bed expansion. The resin is then extensively backwashed with raw water until the effluent is clear.
Application: preferably used with waste water which has been neutralized with calcium hydroxide.
Effluent: neutral during the exhaustion run.

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Removal of residual heavy metals from flue gas scrubbing water with Lewatit® selective resins

Configuration of Lewatit Selective Resins with particular emphasis for the removal of mercury from the acid rinse solution

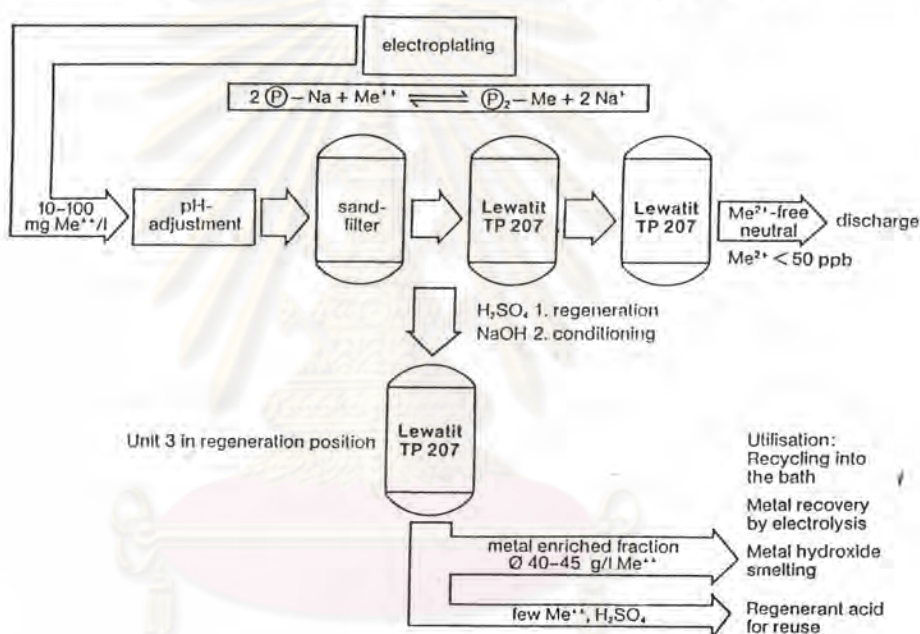


- Recommended selective resins
 Lewatit TP 207 to adsorb: Cu^{2+} , Ni^{2+} , Zn^{2+} , Cd^{2+} , Pb^{2+} , Cr^{3+} , Mn^{2+} , Co^{2+}
 Lewatit TP 214 to adsorb: Hg^{2+}
- Influent conditions:
 pH: 6-7
 Ca content: up to 20 g/l
 Suspended matter and substances causing turbidity should be removed as far as possible
- Arrangement: in each case 2 units alternately in series
- Form of resin used
 Lewatit TP 207: Di-Na form
 Lewatit TP 214: form supplied
- Exhaustion flow rate: up to 20 BV/h per unit
- Obtainable residual values:
 for Cu^{2+} , Ni^{2+} , Zn^{2+} , Co^{2+} , Mn^{2+} , Pb^{2+} : < 50 ppb
 for Cd^{2+} and Hg^{2+} : < 5 ppb possible
- End of exhaustion cycle: (Cd^{2+} > 50 ppb) generally at Cd^{2+} breakthrough after unit 1
- Operating capacity: Lewatit TP 207: 15-25 g heavy metals/l resin
 Lewatit TP 214: up to 40 g Hg/l resin
- Regeneration and conditioning
 Lewatit TP 207:
 2 BV HCl 7.5%
 3-4 BV rinse water
 2.2 BV NaOH 4% upflow through unit
 Conditioning:
 Lewatit TP 214:
 Disposal e.g. by incineration or dumping
 Regeneration possible with sodium sulphide solution c (Na_2S) = 2 mol/l

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Schematic representation of the recovery of bivalent metals from rinse water



Example: Recycling of copper in the electronics industry

- Composition of influent: pH: 1.8-2 (sulphuric acid)
Cu²⁺: 300-700 ppm
sum of Ca²⁺, Zn²⁺, Fe²⁺; 100 ppm
- Selective resin (SR): Lewatit TP 207
- Arrangement: "merry-go-round system" with alternately 2 units in series and a 3rd unit in regeneration position
- Form of resin used: H-form (only possible with Cu²⁺)
- Exhaustion flow rate: 20 BV/h per unit
- Operating capacity: (of 1st unit)
50 g Cu²⁺/l resin in H-form
- Regeneration: 2 BV H₂SO₄ 15%

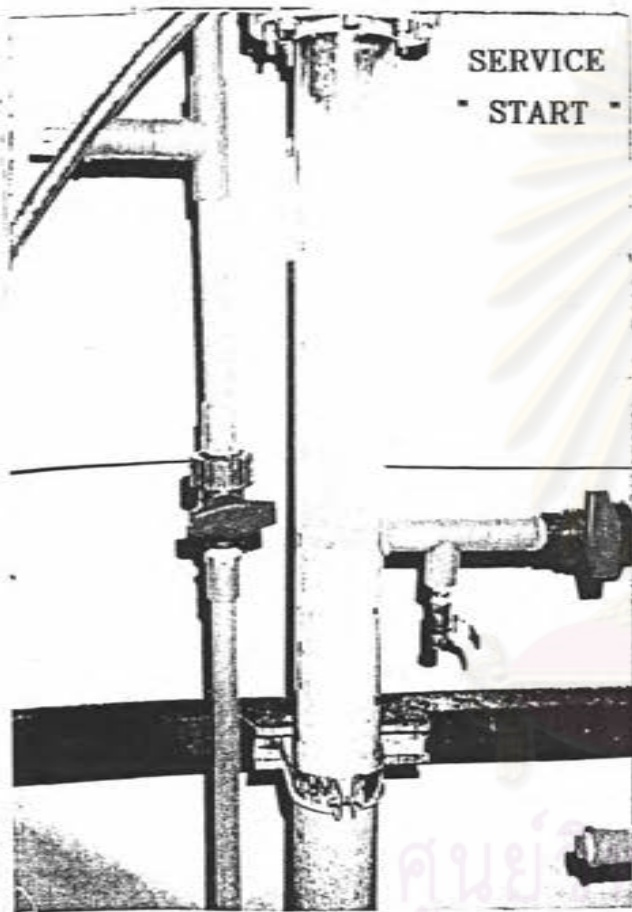
The copper-enriched fraction (0.5-1.5 BV) contains approx. 40-45 g Cu²⁺/l solution and is used directly for electrolysis. The depleted electrolyte circulates through the system and is reused for elution.



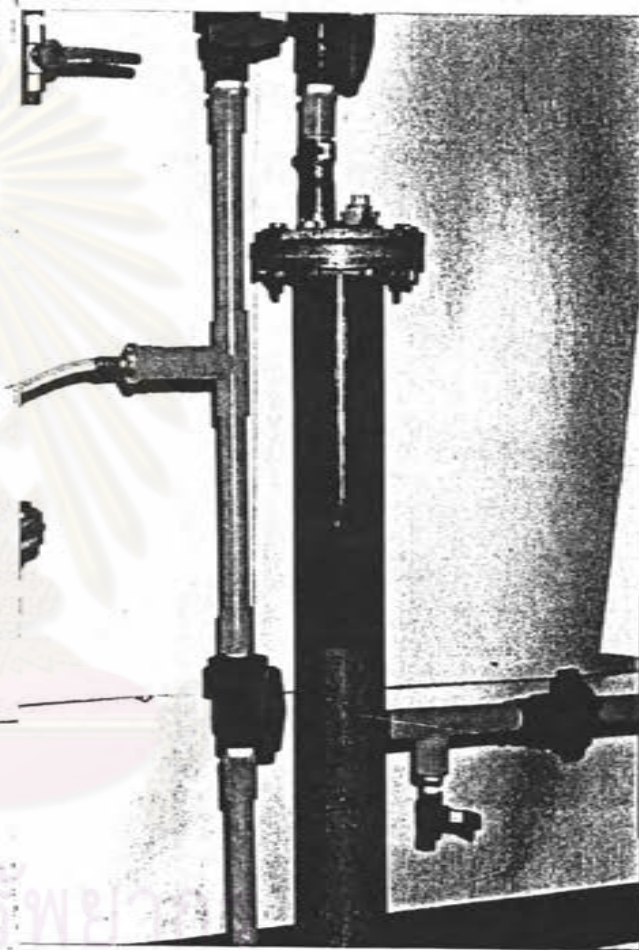
ภาคผนวก ก.

รูปภาพแสดงปรากฏการณ์ของเรซินในถึงปฏิกิริยาจากการทดลองขั้นตอนต่างๆ

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย



รูปที่ 1 แสดงขั้นตอนการแลกเปลี่ยนนิกเกิลไอออน (Service)

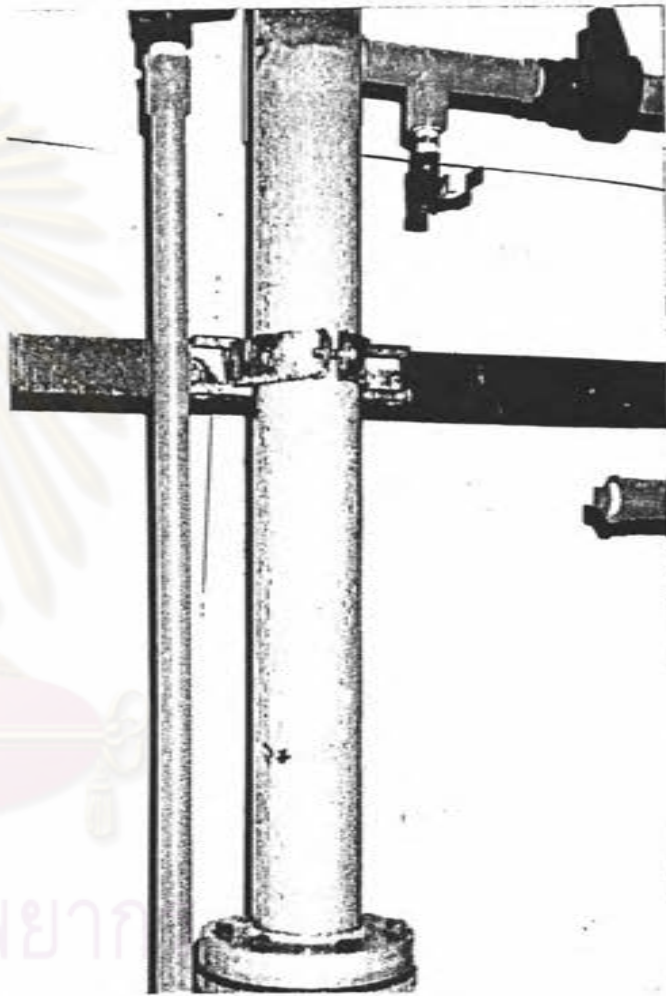


รูปที่ 2 แสดงขั้นตอนการล้างย้อน (Backwash)



REGENERATION :
ACID INTRODUCE STEP

รูปที่ 3 แสดงขั้นตอนการล้างด้วยกรด (Acid Introduce)



REGENERATION :
DEMINERALIZE RINSE STEP

รูปที่ 4 แสดงขั้นตอนการล้างช้า (Slow Rinse)



ภาคผนวก ก.
รายชื่อผู้ผลิตเรซินสีท่อต่างๆ

ศูนย์วิทยทรัพยากร
จุฬาลงกรณ์มหาวิทยาลัย

Table 3-1. Trade names and manufacturers of ion-exchange resins

<i>Trade name</i>	<i>Manufacturer</i>
Amberlite	Rohm & Haas Co., Philadelphia, Pa.
De-Acidite	The Permutit Co., Ltd., London, England
Dowex	Dow Chemical Co., Midland, Mich.
Duolite	Chemical Process Co., Redwood City, Calif.
Imac	Industriële Mij. Activit N.V., Amsterdam, Netherlands
Ionac*	Ionac Co. Ltd., New York, N.Y.
Lewatit	Farbenfabriken Bayer, Leverkusen, Germany (West)
Nalcite†	National Aluminate Corp., Chicago, Ill.
Permutit	Permutit Co., New York, N.Y.
	Permutit A. G., Berlin-Schmargendorf, Germany (West)
Permutite	Phillips & Pain-Vermorel, Paris, France
Resex, Resanex	Jos. Crosfield & Sons Ltd., Warrington, Lancs., England
Wofatit	VEB Farbenfabrik Wolfen, Wolfen, Kr.Bitterfeld, Germany (East)
Zeo-Karb	The Permutit Co. Ltd., London, England
Zerolit‡	United Water Softeners, London, England

* Product of Permutit Co., marketed by Ionac Co.

† Product of Dow Chemical Co., marketed by Nat. Aluminate Corp. There is no difference between corresponding Dowex and Nalcite resins.

‡ Product of Permutit Co. Ltd., marketed by United Water Softeners.

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จุฬาลงกรณ์มหาวิทยาลัย

ประวัติผู้เขียน

นาย ทิพย์ สัยวิธิกุล เกิดเมื่อวันที่ 14 สิงหาคม พ.ศ.2508 จังหวัด
กรุงเทพมหานคร สำเร็จการศึกษา วิศวกรรมศาสตรบัณฑิตสาขาเครื่องกล
จุฬาลงกรณ์มหาวิทยาลัยปีพ.ศ. 2531



ศูนย์วิทยทรัพยากร
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