APPENDIX A

SERIES 100 ION-EXCHANGE BENCH UNIT TESTS

Development of Sodium Chloride Brine Regeneration Cycle
Operation Parameters and Results

SERIES 100 OPERATION PARAMETERS PHASE 1 - BENCH UNIT TESTING
SODIUM CHLORIDE BRINE REGENERATION

SERIES	DATE	RESIN	P. WATER	RUN	HOUR	OTHER
101	841120	C.20.a	marsh	a	8	single cycle; investigate service duration for TH to > 2.0 meq/l; 12 foot column
102	841121	C.20.a	marsh	a	9	single cycle; investigate service duration for TH to > 2.0 meq/l; 12 foot column
103	841124	C.20.a	marsh	a	7	single cycle; investigate service duration for TH to > 2.0 meq/l; 12 foot column
104	841125	C.20.a	marsh	a	12	single cycle; investigate service duration for TH to > 2.0 meq/l; 12 foot column
105	841126	C.20.a	marsh	a	7	single cycle; investigate service duration for TH to > 2.0 meq/l; 12 foot column
106	841127	C.20.a	marsh	a	10	single cycle; investigate service duration for TH to > 2.0 meq/l; 12 foot column
107	841129	C.20.a	marsh	a	9	single cycle; investigate service duration for TH to > 2.0 meq/l; 12 foot column
108	841130	C.20.a	marsh	a	8	single cycle; investigate service duration for TH to > 2.0 meq/l; 12 foot column
109	841204	C.20.a	marsh	a	8	single cycle; investigate service duration for TH to > 2.0 meq/l; 12 foot column
110	841204	C.20.a	marsh	a	12	single cycle; investigate service duration for TH to > 2.0 meq/l; 12 foot column
111	841207	C.20.b	marsh	a	17	single cycle; investigate service duration for TH to > 2.0 meq/l; 12 foot column
112	841209	C.20.b	marsh	a	17	single cycle; investigate service duration for TH to > 2.0 meq/l; 12 foot column
113	841206	C.20.a	marsh	a	13	five consecutive cycles w/o backwash
				b	17	investigate service dur. for TH to > 2.0meq/l
				c	21	unused Duolite C20 resin
	841207			d	2	
				e	6	

BENCH UNIT NOMENCLATURE:

Sampling identification: numbers after event indicate time sample was taken

-instantaneous samples: rega, regb, rina (slow rinse), and rinb (fast rinse). Rina (slow rinse) and rinb (fast rinse) without numbers are batch samples.
-batch samples: feed, fr.brine, recycle brine, combined backwash, combined regeneration, combined rinse and product.
-influent samples: feed, fr.brine and recycle brine.
-effluent samples: combined backwash, combined rinse, combined regeneration (comb.used brine), rega, regb, rina, rinb, service and product.

bv: bed volume of resin
CV: column voids volume or entire column volume minus actual volume of resin.

Resin C.20.a: resin extracted from main units.
Resin C.20.b: new, previously unused resin

LR1: loading rate in gpm/ft2 (cross sectional area of column)
LR2: loading rate in gpm/ft3 of resin

SERIES 100 OPERATION PARAMETERS PHASE 1 - BENCH UNIT TESTING
SODIUM CHLORIDE BRINE REGENERATION

SERIES	DATE	RESIN	P. WATER	RUN	HOUR	OTHER
114	841212	C.20.b	marsh	a	12	five consecutive cycles w/o backwash
				b	17	investigate service dur. for TH to > 2.0meq/l
				c	20	unused Duolite C20 resin
	841213			d	12	
				e	2	
115	841227	C.20.a	marsh	a	9	two consecutive cycles w/o backwash
				b	13	investigate service dur. for TH to > 2.0meq/l
116	841227	C.20.a	marsh	a	20	four consecutine cycles w/o backwash
	851228			b	1	investigate service dur. for TH to > 2.0meq/l
				c	4	
				d	8	
117	850103	C.20.a	marsh	a	12	five consecutive cycles w/o backwash
				b	19	investigate service dur. for TH to > 2.0meq/l
				c	23	
	850104			d	3	
				e	8	
118	850108	C.20.a	marsh	a	8	four consecutine cycles w/o backwash
				b	13	investigate service dur. for TH to > 2.0meq/l
				c	18	
				d	22	
119	850116	C.20.b	marsh	a	8	five consecutive cycles w/o backwash
				b	13	investigate service dur. for TH to > 2.0meq/l
				c	16	unused Duolite C20 resin
				d	21	
	850117			e	1	
120	850123	C.20.b	marsh	a	10	five consecutive cycles w/o backwash
				b	15	investigate service dur. for TH to > 2.0meq/l
				c	19	unused Duolite C20 resin
				d	23	
	850124			e	4	
121	850124	C.20.a	marsh	a	17	ten consecutive cycles w/o backwash
				b	21	verification of developed sodium chloride
	850125			c	1	
				d	4	
				e	7	
				f	11	
				g	15	
				h	18	
				i	22	
	850126			j	1	
122	850204	C.20.a	marsh	a	15	five consecutive cycles w/o backwash
				b	19	investigate service dur. for TH to > 2.0meq/l
				c	22	
	850205			d	1	
				e	5	
123	850206	C.20.b	marsh	a	17	five consecutive cycles w/o backwash
				b	21	investigate service dur. for TH to > 2.0meq/l
	850207			c	1	unused Duolite C20 resin
				d	3	
				e	8	
124	850517	C.20.a	clarifier	a	14	investigate service dur. for TH to > 2.0meq/l
125	850522	C.20.a	clarifier	a	11	investigate service dur. for TH to > 2.0meq/l
						resin stored in 16% NaCl brine previous to run
126	850524	C.20.a	clarifier	a	11	investigate service dur. for TH to > 2.0meq/l

OPERATION PARAMETERS PHASE 1 - BENCH UNIT TESTING

SODIUM CHLORIDE BRINE REGENERATION

		BACKWASH			REGENERATION					SLOW RINSE		FAST RINSE		SERVICE	
SERIES	RUN	LR1	B.E.	Duration	LR1	B.E.	Duration	CONC.	Temp.	LR1	Duration	LR1	Duration	LR2	Duration
		gpm/ft2	%	minutes	gpm/ft2	%	minutes	%	C	gpm/ft2	minutes	gpm/ft2	minutes	gpm/ft3	minutes
101	a	5.1	n.r.	10	3.7	n.r.	50	9.0	13.0	2.8	5	5.9	15	1.02	185
102	a	5.1	30	10	3.6	n.r.	50	9.5	12.0	2.8	5	5.9	15	1.00	170
103	a	5.1	n.r.	10	3.6	n.r.	50	9.8	12.5	2.8	5	5.9	15	0.54	305
104	a	5.1	n.r.	10	3.2	n.r.	50	9.5	17.5	2.8	5	5.9	15	1.04	165
105	a	5.1	n.r.	10	3.1	n.r.	50	9.5	10.0	2.8	5	5.9	15	1.00	172
106	a	5.1	n.r.	10	3.6	28	50	7.0	11.0	2.8	5	5.9	15	1.22	135
107	a	5.1	n.r.	10	3.5	26	50	6.0	10.0	2.8	5	5.9	15	1.20	140
108	a	5.1	28	10	3.3	25	50	7.0	9.0	2.8	5	5.9	15	1.16	135
109	a	5.1	27	10	2.3	25	50	7.0	9.0	2.8	5	5.9	15	1.16	135
110	a	5.1	27	10	2.5	27	50	7.0	9.0	2.8	5	5.9	15	1.18	55
111	a	4.60	n.r.	10	4.02	n.r.	50	9.0	13.0	4.0	5	8.2	15	1.15	152
112	a	3.79	n.r.	10	2.87	n.r.	50	9.5	12.0	8.3	5	5.6	15	1.10	152
113	a	none	none	none	NA	21	50	6.5	11.0	2.80	5	5.90	15	1.14	162
	b	none	none	none	NA	NA	50	6.5	12.0	2.80	5	5.90	15	1.20	137
	c	none	none	none	NA	20	50	6.5	11.5	2.80	5	5.90	15	1.14	122
	d	none	none	none	NA	NA	50	6.5	10.0	2.80	5	5.90	15	1.16	120
	e	none	none	none	NA	NA	50	6.5	10.0	2.80	5	5.90	15	1.14	120
114	a	none	none	none	2.24	NA	50	6.5	12.0	2.24	5	5.68	15	1.09	130
	b	none	none	none	3.18	NA	50	6.5	12.0	8.19	5	8.19	15	1.19	120
	c	none	none	none	2.97	NA	50	6.5	12.0	8.45	5	5.89	15	1.24	110
	d	none	none	none	2.77	NA	50	6.5	12.0	8.51	5	5.99	15	1.04	80
	e	none	none	none	2.95	27	50	6.5	12.0	8.64	5	5.76	15	1.20	100
115	a	none	none	none	2.10	7	50	6.5	7.0	NA	5	5.99	15	1.14	90
	b	none	none	none	2.00	13	50	6.5	7.5	3.00	5	5.65	15	1.20	90
116	a	none	none	none	2.00	18	50	12.0	7.0	3.67	5	6.01	15	1.18	130
	b	none	none	none	1.70	13	50	12.0	7.0	3.54	5	5.76	15	1.16	90
	c	none	none	none	2.00	NA	50	12.0	6.0	NA	5	5.70	15	1.34	117
	d	none	none	none	2.00	NA	50	12.0	6.0	3.46	5	6.41	15	1.22	120
117	a	none	none	none	2.00	13	60	12.0	6.0	3.69	5	5.84	15	1.20	157
	b	none	none	none	2.00	13	60	12.0	6.0	3.26	5	6.31	15	1.24	140
	c	none	none	none	2.10	17	60	12.0	5.5	3.63	5	6.33	15	1.26	140
	d	none	none	none	2.00	20	60	12.0	5.0	3.26	5	6.05	15	1.20	142
	e	none	none	none	1.90	20	60	12.0	5.0	3.20	5	6.21	15	1.28	122

OPERATION PARAMETERS PHASE 1 - BENCH UNIT TESTING
SODIUM CHLORIDE BRINE REGENERATION

		BACKWASH			REGENERATION					SLOW RINSE		FAST RINSE		SERVICE	
SERIES	RUN	LR1	B.E.	Duration	LR1	B.E.	Duration	CONC.	Temp.	LR1	Duration	LR1	Duration	LR2	Duration
		gpm/ft2	%	minutes	gpm/ft2	%	minutes	%	C	gpm/ft2	minutes	gpm/ft2	minutes	gpm/ft3	minutes
118	a	none	none	none	3.90	30	60	6.5	8.5	3.16	5	6.09	10	1.20	160
	b	none	none	none	4.07	30	60	6.0	9.5	3.18	5	5.68	10	1.14	155
	c	none	none	none	4.07	37	61	6.0	NA	3.26	5	5.80	10	1.10	170
	d	none	none	none	4.00	30	60	6.0	12.0	3.25	5	5.80	10	1.22	140
119	a	none	none	none	2.04	NA	50	12.5	5.0	2.93	5	5.96	10	1.18	155
	b	none	none	none	2.04	NA	50	12.5	6.0	2.89	5	6.01	10	1.19	130
	c	none	none	none	2.20	NA	51	12.0	5.0	2.83	5	5.89	10	1.19	145
	d	none	none	none	1.95	14	52	12.0	5.0	1.95	5	5.98	10	1.15	140
	e	none	none	none	1.79	19	57	12.0	5.0	2.85	5	5.62	10	1.16	140
120	a	none	none	none	1.95	NA	60	12.5	7.0	3.06	5	6.13	10	1.26	150
	b	none	none	none	2.04	8	60	12.5	7.0	2.95	5	6.05	10	1.29	145
	c	none	none	none	2.00	13	60	12.5	6.0	2.93	5	5.80	10	1.24	145
	d	none	none	none	1.99	19	60	12.5	6.0	1.99	5	5.93	10	1.26	150
	e	none	none	none	2.09	NA	60	12.5	7.0	1.91	5	5.27	10	1.15	160
121	a	none	none	none	1.83	15	50	12.0	6.5	2.83	5	5.91	15	1.17	122
	b	none	none	none	1.93	15	50	12.0	6.5	2.93	5	5.90	15	1.18	121
	c	none	none	none	1.93	15	50	12.0	7.0	2.71	5	5.78	15	1.18	120
	d	none	none	none	1.93	15	50	12.0	7.0	2.83	5	6.15	15	1.27	105
	e	none	none	none	2.04	15	50	12.0	6.5	3.07	5	6.23	15	1.17	125
	f	none	none	none	2.04	17	50	12.0	7.0	3.13	5	5.93	15	1.21	120
	g	none	none	none	2.04	17	50	12.0	7.0	3.06	5	6.05	15	1.19	120
	h	none	none	none	2.14	17	50	12.0	7.0	2.85	5	5.91	15	1.14	125
	i	none	none	none	2	16	50	12.0	7.0	3.24	5	5.93	15	1.19	120
	j	none	none	none	2	15	50	12.0	7.0	3.21	5	5.91	15	1.18	121
122	a	none	none	none	2	12	50	10.0	7.5	3.26	5	6.07	15	1.19	120
	b	none	none	none	2	13	50	10.0	8.0	3.18	5	6.01	15	1.19	120
	c	none	none	none	2	13	50	10.0	7.5	3.12	5	5.82	15	1.12	120
	d	none	none	none	2	13	50	10.0	7.5	3.97	5	6.19	15	1.19	120
	e	none	none	none	2	14	50	10.0	7.5	3.71	5	5.80	15	1.19	120
123	a	none	none	none	2	17	50	10.0	6.0	4.38	5	6.02	15	1.25	120
	b	none	none	none	2	17	50	10.0	6.0	4.34	5	6.03	15	1.34	110
	c	none	none	none	2	14	50	10.0	6.0	2.85	5	5.89	15	1.34	110
	d	none	none	none	2	13	50	10.0	6.0	3.03	5	6.09	15	1.36	110
	e	none	none	none	2	14	50	10.0	6.0	3.16	5	6.17	15	1.32	110
124	a	none	none	none	2	20	40	16.0	16.0	2.71	5	3.87	10	1.16	140
125	a	none	none	none	2	NA	40	16.0	21.0	3.18	5	4.48	10	1.26	160
126	a	none	none	none	2	NA	40	16.0	21.0	2.64	5	5.40	10	1.23	150

VOLUMES AND FLOW RATES USED IN PHASE 1 TESTING

PHASE 1 - BENCH UNIT TESTING
SODIUM CHLORIDE BRINE REGENERATION

		VOLUME in bed volumes				TOTAL RINSE	SR+FR-CV	FLOW RATE in bv/minute			
		NaCl	SLOW	FAST		bed volumes		NaCl	SLOW	FAST	
SERIES	RUN	BRINE	RINSE	RINSE	SERVICE			BRINE	RINSE	RINSE	SERVICE
101	a	4.95	0.37	2.37	25.23	2.74	1.82	0.099	0.075	0.158	0.136
102	a	4.81	0.37	2.37	22.73	2.74	1.82	0.096	0.075	0.158	0.134
103	a	4.81	0.37	2.37	22.02	2.74	1.82	0.096	0.075	0.158	0.072
104	a	4.28	0.37	2.37	22.95	2.74	1.82	0.085	0.075	0.158	0.139
105	a	4.15	0.37	2.37	23.00	2.74	1.82	0.083	0.075	0.158	0.134
106	a	4.81	0.37	2.37	22.02	2.74	1.82	0.096	0.075	0.158	0.163
107	a	4.68	0.37	2.37	22.46	2.74	1.82	0.093	0.075	0.158	0.160
108	a	4.41	0.37	2.37	20.94	2.74	1.82	0.088	0.075	0.158	0.155
109	a	3.08	0.37	2.37	20.94	2.74	1.82	0.061	0.075	0.158	0.155
110	a	3.34	0.37	2.37	8.68	2.74	1.82	0.067	0.075	0.158	0.158
111	a	5.38	0.54	3.29	23.37	3.83	2.91	0.107	0.107	0.219	0.154
112	a	3.84	1.12	2.25	22.36	3.36	2.44	0.077	0.223	0.150	0.147
113	a	NA	0.37	2.37	24.69	2.74	1.02	NA	0.075	0.158	0.152
	b	NA	0.37	2.37	21.98	2.74	1.02	NA	0.075	0.158	0.160
	c	NA	0.37	2.37	18.60	2.74	1.02	NA	0.075	0.158	0.152
	d	NA	0.37	2.37	18.61	2.74	1.02	NA	0.075	0.158	0.155
	e	NA	0.37	2.37	18.29	2.74	1.02	NA	0.075	0.158	0.152
114	a	3.00	0.30	2.28	18.95	2.58	0.86	0.060	0.060	0.152	0.146
	b	4.25	1.10	3.29	19.09	4.38	2.66	0.085	0.219	0.219	0.159
	c	3.97	1.13	2.36	18.24	3.49	1.77	0.079	0.226	0.157	0.166
	d	3.70	1.14	2.40	11.13	3.54	1.82	0.074	0.227	0.160	0.139
	e	3.94	1.16	2.31	16.05	3.47	1.75	0.079	0.231	0.154	0.160
115	a	2.81	NA	2.40	13.72	NA	NA	0.056	NA	0.160	0.152
	b	2.67	0.40	2.27	14.44	2.67	0.95	0.053	0.080	0.151	0.160
116	a	2.67	0.49	2.41	20.51	2.90	1.18	0.053	0.098	0.160	0.158
	b	2.27	0.47	2.31	13.96	2.78	1.06	0.045	0.095	0.154	0.155
	c	2.67	NA	2.29	20.96	NA	NA	0.053	NA	0.152	0.179
	d	2.67	0.46	2.57	19.58	3.03	1.31	0.053	0.092	0.171	0.163
117	a	3.21	0.49	2.34	25.19	2.84	1.12	0.053	0.099	0.156	0.160
	b	3.21	0.44	2.53	23.21	2.97	1.25	0.053	0.087	0.168	0.166
	c	3.37	0.49	2.54	23.59	3.02	1.30	0.056	0.097	0.169	0.168
	d	3.21	0.44	2.43	22.78	2.86	1.14	0.053	0.087	0.162	0.160
	e	3.05	0.43	2.49	20.88	2.92	1.20	0.051	0.085	0.166	0.171
118	a	0.00	0.00	0.00	0.00	0.00	-1.72	0.000	0.000	0.000	0.000
	b	6.53	0.43	1.52	23.63	1.94	0.22	0.109	0.085	0.152	0.152
	c	6.64	0.44	1.55	25.00	1.99	0.27	0.109	0.087	0.155	0.147
	d	6.42	0.43	1.55	22.84	1.99	0.27	0.107	0.087	0.155	0.163
119	a	2.73	0.39	1.59	24.46	1.99	0.27	0.054	0.078	0.159	0.158
	b	2.73	0.39	1.61	20.69	1.99	0.27	0.054	0.077	0.160	0.159
	c	3.00	0.38	1.58	23.07	1.95	0.23	0.059	0.076	0.157	0.159
	d	2.71	0.26	1.60	21.53	1.86	0.14	0.052	0.052	0.160	0.154
	e	2.73	0.38	1.50	21.72	1.88	0.16	0.048	0.076	0.150	0.155

VOLUMES AND FLOW RATES USED IN PHASE 1 TESTING

PHASE 1 - BENCH UNIT TESTING
SODIUM CHLORIDE BRINE REGENERATION

		VOLUME in bed volumes				TOTAL RINSE	SR+FR-CV	FLOW RATE in bv/minute			
		NaCl	SLOW	FAST		bed volumes		NaCl	SLOW	FAST	
SERIES	RUN	BRINE	RINSE	RINSE	SERVICE			BRINE	RINSE	RINSE	SERVICE
120	a	3.13	0.41	1.64	25.27	2.05	1.13	0.052	0.082	0.164	0.168
	b	3.27	0.39	1.62	25.01	2.01	1.09	0.054	0.079	0.162	0.172
	c	3.21	0.39	1.55	24.04	1.94	1.02	0.053	0.078	0.155	0.166
	d	3.19	0.27	1.59	25.27	1.85	0.93	0.053	0.053	0.158	0.168
	e	3.35	0.26	1.41	24.60	1.66	0.74	0.056	0.051	0.141	0.154
121	a	2.45	0.38	2.37	19.09	2.75	1.83	0.049	0.076	0.158	0.156
	b	2.58	0.39	2.37	19.09	2.76	1.84	0.052	0.078	0.158	0.158
	c	2.58	0.36	2.32	18.93	2.68	1.76	0.052	0.072	0.154	0.158
	d	2.58	0.38	2.47	17.83	2.85	1.93	0.052	0.076	0.164	0.170
	e	2.73	0.41	2.50	19.56	2.91	1.99	0.054	0.082	0.166	0.156
	f	2.73	0.42	2.38	19.42	2.80	1.88	0.054	0.084	0.158	0.162
	g	2.73	0.41	2.43	19.09	2.84	1.92	0.054	0.082	0.162	0.159
	h	2.86	0.38	2.37	19.05	2.75	1.83	0.057	0.076	0.158	0.152
	i	2.73	0.43	2.38	19.09	2.81	1.89	0.054	0.087	0.158	0.159
	j	2.73	0.43	2.37	19.09	2.80	1.88	0.054	0.086	0.158	0.158
122	a	3.16	0.44	2.43	19.09	2.87	1.95	0.063	0.087	0.162	0.159
	b	3.26	0.43	2.41	19.09	2.84	1.92	0.065	0.085	0.160	0.159
	c	2.73	0.42	2.33	17.97	2.75	1.83	0.054	0.083	0.155	0.150
	d	2.86	0.53	2.48	19.09	3.01	2.09	0.057	0.106	0.165	0.159
	e	2.86	0.50	2.33	19.09	2.82	1.90	0.057	0.099	0.155	0.159
123	a	2.85	0.59	2.41	20.06	3.00	2.08	0.057	0.117	0.161	0.167
	b	2.73	0.58	2.42	19.71	3.00	2.08	0.054	0.116	0.161	0.179
	c	3.13	0.38	2.36	19.71	2.74	1.82	0.062	0.076	0.157	0.179
	d	2.58	0.41	2.44	20.00	2.85	1.93	0.052	0.081	0.163	0.182
	e	2.73	0.42	2.48	19.42	2.90	1.98	0.054	0.084	0.165	0.176
124	a	2.20	0.36	1.03	21.81	1.40	0.48	0.055	0.072	0.103	0.156
125	a	2.12	0.42	1.20	27.02	1.62	0.70	0.053	0.085	0.120	0.169
126	a	1.98	0.35	1.44	24.75	1.80	0.88	0.049	0.070	0.144	0.165

CHEMICAL ANALYSES PHASE 1 - BENCH UNIT TESTING

SERIES	Cycle No	Event	Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Chloride	Sulfate
			meq/l			uS/cm	N.T.U.		meq/l	
101	a	feed	25.52	48.00	91.30	11600	1.0	7.8	43.12	87.45
		fr.brine	8.20	14.40	1565.22	126000	2.6	7.7	2016.36	6.25
		bw0	28.00	48.00	95.65	11500	1.1	7.9	56.40	83.28
		bw10	38.00	86.40	173.91	22500	3.7	7.7	183.31	66.63
		reg5	81.00	164.00	613.04	60700	4.0	7.5	789.62	56.21
		reg15	45.20	90.80	465.22	47200	4.2	7.8	479.41	56.21
		reg30	104.00	173.20	1673.91	135000	5.0	7.4	1931.75	10.41
		reg45	61.00	81.20	1743.48	137200	4.6	7.7	1903.55	16.66
		rina5	22.40	34.00	1882.61	136100	2.9	7.8	1931.75	12.49
		rinb5	30.00	44.80	1817.39	135000	2.9	7.8	1833.05	14.57
		rinb10	0.80	1.00	217.39	18600	0.9	7.8	98.70	83.28
		rinb15	0.36	0.48	143.48	18600	1.2	8.3	49.92	93.69
		prod	0.44	0.96	108.70	12800	0.5	8.1	43.71	72.87
102	a	feed	25.20	48.80	95.65	11400	0.8	8.0	42.27	87.45
		fr.brine	10.00	14.80	1689.57	135000	3.6	7.8	1615.06	6.66
		bw8	28.40	50.00	95.65	12400	1.6	8.1	43.68	83.28
		reg5	202.80	480.00	739.13	95600	6.3	7.4	1252.12	41.64
		reg15	120.00	256.00	543.48	67600	5.1	7.6	724.76	60.38
		reg30	160.00	284.00	1382.61	124100	5.2	7.5	1689.23	10.41
		reg45	90.80	145.00	1395.65	135000	4.0	7.7	1689.23	12.49
		rina5	31.60	54.00	1604.35	135000	2.2	7.9	1717.43	12.49
		rinb5	1.44	2.40	213.04	22500	0.6	8.4	120.98	77.04
		prod.	0.60	0.84	113.04	13700	0.5	8.3	39.48	83.28
103	a	feed	27.60	48.00	91.30	12100	6.0	7.7	42.30	74.95
		fr.brine	9.20	14.80	1608.70	133900	7.3	7.9	1782.29	6.04
		bw5	28.80	55.20	100.00	13700	1.2	8.1	45.12	81.20
		bw10	360.00	800.00	482.61	95600	6.6	7.3	1283.14	12.49
		reg5	182.00	348.00	673.91	84400	5.7	7.4	998.31	47.89
		reg15	97.00	190.00	504.35	60700	5.7	7.5	640.16	56.21
		reg30	136.00	236.00	1591.30	129400	3.4	7.5	1717.43	6.87
		reg45	90.00	124.00	1613.04	133900	3.4	7.7	1717.43	7.50
		rina5	31.00	51.00	1734.78	133900	1.8	7.9	1773.83	6.87
		rinb3	28.00	40.40	1347.83	109000	3.2	7.8	1291.60	27.90
		prod.60	0.48	0.80	138.13	13500	1.3	7.7	40.89	70.79
		prod285	0.52	0.80	139.13	12900	1.0	7.7	38.07	83.28
104	a	feed	25.20	45.60	86.96	11800	1.5	7.5	42.30	79.12
		fr.brine	8.40	14.80	1486.96	133900	7.1	7.7	1692.05	6.45
		bw5	25.60	47.60	104.35	12900	1.4	7.5	45.12	81.20
		bw10	25.20	45.60	73.91	12000	2.6	7.6	42.30	83.28
		reg5	36.40	70.40	113.04	15300	16.8	7.5	91.65	83.28
		reg15	38.80	78.00	104.35	16900	7.9	7.5	104.34	ns
		reg30	282.00	525.00	1056.52	123700	5.8	7.2	1658.21	7.08
		reg45	132.00	240.00	1269.57	132700	4.4	7.4	1686.41	7.08
		rina5	32.80	73.00	1291.30	133900	2.8	7.7	1686.41	6.45
		rinb10	1.60	3.40	160.87	19800	1.3	8.0	106.88	89.53
		prod60	0.60	1.12	126.09	13500	1.0	7.7	45.12	79.12
		prod120	0.60	1.12	130.43	13200	0.9	7.6	45.12	83.28

CHEMICAL ANALYSES PHASE 1 - BENCH UNIT TESTING

SERIES	Cycle No.	Event	Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Chloride	Sulfate
			meq/l			uS/cm	N.T.U.		meq/l	
105	a	feed	24.80	47.60	91.30	11800	1.5	7.5	42.30	79.12
		fr.brine	9.60	15.20	1730.43	135000	7.0	7.7	1706.15	5.62
		bw5	24.80	47.60	95.65	12300	2.6	7.7	42.30	81.20
		bw10	27.60	51.60	100.00	12300	2.5	7.6	49.35	81.20
		reg5	170.00	351.00	456.52	67500	6.0	7.2	775.52	56.21
		reg15	118.00	218.00	447.83	49500	4.8	7.3	516.07	64.54
		reg30	212.00	395.00	1330.43	124900	5.1	7.2	1644.11	7.08
		reg45	117.20	188.00	1395.65	132700	4.2	7.5	1692.05	6.25
		rina5	36.00	64.00	1613.04	133900	2.7	7.7	1692.05	6.45
		rinb10	3.20	5.20	317.39	27000	1.2	8.0	181.90	85.36
		prod60	0.60	1.04	121.74	13400	0.9	7.9	42.30	85.36
		prod120	0.60	1.04	160.87	13000	1.1	7.8	42.30	81.20
106	a	feed	25.60	48.00	91.30	11700	1.8	7.6	42.30	83.28
		fr.brine	8.40	13.20	1178.26	99000	4.0	7.6	1201.35	5.41
		bw7	252.00	510.00	330.43	69700	5.9	7.0	803.72	37.48
		reg7	170.00	342.00	760.87	86600	5.0	7.2	1043.43	41.64
		reg18	87.00	176.00	578.26	64100	4.3	7.4	676.82	56.21
		reg30	94.00	192.00	934.78	95600	3.6	7.4	1170.33	20.82
		reg44	68.00	121.00	956.52	99000	3.5	7.5	1192.89	5.41
		rina5	20.40	36.40	1004.35	100100	2.0	7.7	1184.43	5.62
		rinb10	1.20	2.00	160.87	17400	0.9	8.0	81.78	85.36
		prod	0.72	1.12	121.74	13500	0.9	7.8	42.30	83.28
107	a	feed	24.40	48.00	91.30	10900	1.3	7.7	42.30	85.36
		fr.brine	9.20	12.80	1100.00	94800	6.0	7.8	1142.13	5.41
		bw5	190.00	362.00	230.43	51600	5.5	7.2	591.93	39.56
		reg10	92.00	170.00	308.70	46800	4.8	7.5	476.31	49.97
		reg20	102.00	186.00	600.00	62400	4.9	7.4	732.94	31.23
		reg30	150.00	240.00	834.78	91200	4.3	7.3	1166.95	5.62
		reg40	112.00	16.00	921.74	94800	3.8	7.5	1183.87	4.79
		rina5	22.80	34.00	1165.22	96000	1.9	7.7	1183.87	5.83
		rinb10	0.92	2.00	147.83	14200	1.4	8.0	53.58	72.87
		prod.	0.76	1.16	134.78	13000	1.1	7.9	40.89	85.36
108	a	feed	26.00	48.80	91.30	10300	8.0	7.5	40.89	74.95
		fr.brine	8.40	14.40	1147.83	92800	5.0	7.6	1183.87	5.41
		bw5	24.40	52.00	91.30	11700	1.6	7.6	42.30	139.50
		bw10	24.80	51.00	91.30	11000	1.5	7.5	39.48	81.20
		reg10	112.00	217.00	234.78	38800	4.9	7.2	408.63	58.30
		reg20	98.00	184.00	265.22	38800	3.9	7.2	394.81	62.46
		reg30	176.00	296.00	560.87	86900	3.4	7.2	1183.87	16.66
		reg40	134.00	222.00	856.52	82300	3.4	7.3	1183.87	18.74
		reg50	104.00	176.00	986.96	90500	3.8	7.4	1183.87	14.57
		rin0	22.40	42.00	991.30	90500	2.3	7.5	1141.57	20.82
		rin15	0.88	1.60	143.48	13200	2.1	7.9	45.12	74.95
		prod60	0.96	2.28	139.13	12200	1.1	7.6	42.30	72.87

CHEMICAL ANALYSES PHASE 1 - BENCH UNIT TESTING

SERIES	Cycle No.	Event	Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Chloride	Sulfate
			meq/l			uS/cm	N.T.U.		meq/l	
109	a	feed	25.20	48.00	91.30	11700	3.0	7.9	40.89	77.04
		fr.brine	7.20	12.80	1091.30	95000	3.5	7.9	1178.23	5.00
		bw5	24.40	48.40	91.30	11100	2.6	7.6	40.89	102.02
		bw10	94.00	182.00	165.22	29300	5.6	7.3	296.11	64.54
		reg5	158.00	322.00	421.74	58700	6.9	7.2	727.30	45.80
		reg15	80.00	166.00	260.87	40000	5.5	7.4	380.43	60.38
		reg30	152.00	28.00	860.87	92500	2.7	7.3	1183.87	6.25
		reg45	96.00	156.00	1000.00	95000	2.7	7.5	1195.15	5.21
		rina	18.00	36.00	1030.43	95000	1.8	7.7	1183.87	5.83
		rinb	34.00	66.00	978.26	92500	1.7	7.7	1099.27	16.66
		ser60	0.76	1.40	147.83	13500	1.2	7.9	40.89	87.45
110	a	feed	22.40	48.00	91.30	11000	3.0	7.7	40.89	85.36
		fr.brine	9.60	13.60	1152.17	96300	5.7	7.8	1197.97	5.21
		bw5	25.20	48.80	95.65	12000	1.5	7.9	42.30	89.53
		bw10	25.20	48.80	91.30	11300	3.9	7.8	40.89	77.04
		reg5	46.00	80.00	108.70	15400	8.2	7.6	100.11	70.79
		reg15	30.80	62.00	95.65	13700	7.5	7.7	67.68	85.36
		reg30	230.00	434.00	708.70	90000	2.7	7.2	1152.85	6.04
		reg45	136.00	212.00	900.00	94800	3.2	7.5	1169.77	5.62
		rina	16.00	38.00	986.96	97200	1.6	7.8	1166.95	5.83
		rinb	46.00	79.60	1004.35	97200	1.8	7.7	1192.33	5.21
		prod	ns	ns	121.74	13300	1.1	8.1	ns	ns
111	a	feed	24.80	48.00	95.65	11300	1.4	7.7	40.89	81.20
		fr. brine	8.80	12.40	1630.43	126900	2.3	7.8	1615.06	5.62
		bw5	146.00	350.00	491.30	64600	4.6	7.3	718.84	33.31
		reg5	66.40	142.00	734.78	68700	1.9	7.6	794.70	41.64
		reg15	32.40	67.20	543.48	51700	2.0	7.7	507.33	49.97
		reg30	66.40	115.20	1526.09	119900	2.7	7.7	1600.96	5.00
		reg45	42.40	66.00	1239.13	126900	2.7	7.7	1606.88	4.79
		rina5	22.80	35.00	1708.70	126900	1.8	7.8	1634.80	5.00
		rinb10	0.36	0.48	147.83	13900	1.0	8.0	42.30	74.95
		rinb15	0.24	0.44	143.48	12900	0.7	7.8	40.89	79.12
		prod.	0.32	0.44	143.48	12500	0.6	7.8	40.89	83.28
112	a	feed	25.60	48.00	91.30	11000	0.7	7.6	40.89	81.20
		fr. brine	8.00	12.40	1013.04	128000	2.9	7.8	1691.20	5.41
		bw5	28.00	48.40	95.65	11700	1.2	7.9	42.30	83.28
		reg5	150.00	305.00	608.70	69300	2.6	7.3	831.64	49.97
		reg15	118.00	210.00	521.74	58700	2.0	7.4	620.14	49.97
		reg30	192.00	370.00	1230.43	115100	2.6	7.2	1550.48	6.87
		reg45	116.00	164.00	1465.22	126900	2.5	7.5	1691.48	5.83
		rina5	32.40	54.00	2073.91	129300	2.0	7.7	1691.48	4.79
		rinb10	0.64	2.00	143.48	14300	0.7	8.0	56.40	79.12
		rinb15	0.48	0.76	147.83	12900	0.5	7.8	42.30	79.12
		prod.	0.60	1.12	147.83	12600	0.5	7.8	42.30	70.79

CHEMICAL ANALYSES PHASE 1 - BENCH UNIT TESTING

SERIES	Cycle No	Event	Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Chloride	Sulfate
			meq/l			uS/cm	N.T.U.		meq/l	
113	a	feed	25.20	48.20	100.00	10800	0.6	7.5	36.66	79.12
		fr.brine	6.40	11.60	1543.48	94000	2.0	7.6	1169.77	4.37
		reg5	31.20	63.40	143.48	17600	1.5	7.7	109.70	70.79
		reg15	218.00	408.00	743.48	89300	2.1	7.0	1133.11	27.07
		reg33	88.00	140.00	1034.78	94000	2.3	7.4	1161.31	8.33
		reg45	84.00	116.00	1217.39	95200	2.8	7.4	1155.67	4.79
		rina5	9.60	14.80	1230.43	95200	1.3	7.6	1138.75	5.62
		rinb5	14.40	21.60	1178.26	95200	1.3	7.7	1169.77	4.79
		rinb10	19.20	31.20	1204.35	96300	1.0	7.6	1155.67	5.83
		prod.	0.48	0.84	143.48	13600	0.7	7.9	ns	ns
113	b	feed	25.20	47.60	95.65	11500	0.7	7.6	42.30	77.04
		fr.brine	7.20	11.20	1334.78	94000	1.3	7.6	1161.31	4.58
		reg5	25.60	48.00	91.30	11700	0.7	7.8	42.30	74.95
		reg15	54.40	112.40	152.17	21000	6.2	7.4	183.31	93.69
		reg30	184.00	330.00	821.74	88100	1.8	7.2	1155.67	5.00
		reg45	114.00	192.00	1073.91	89300	1.8	7.4	1155.67	4.16
		rina5	12.80	32.00	1230.43	94000	0.9	7.7	1144.39	5.41
		rinb5	21.20	48.00	1143.48	95200	1.0	7.6	1155.67	4.58
		rinb10	28.80	66.80	1030.43	94000	1.2	7.5	1128.03	11.03
		prod.	0.64	1.36	139.13	13400	0.5	7.7	42.30	83.28
113	c	feed	25.60	47.60	100.00	11300	0.7	8.0	40.89	74.95
		fr.brine	7.20	11.60	1282.61	94000	2.5	7.9	1164.13	4.79
		reg5	24.40	47.60	95.65	11700	0.7	8.0	39.48	70.79
		reg15	26.00	50.00	95.65	11200	1.1	8.0	42.30	72.87
		reg30	230.00	444.00	708.70	86900	1.5	7.3	1141.57	4.58
		reg45	146.00	234.00	956.52	89900	1.5	7.5	1155.67	4.79
		rina5	12.00	24.00	1260.87	94000	1.2	7.9	1150.03	5.00
		rinb10	13.20	30.00	604.35	52900	0.8	8.0	543.99	60.38
		rinb15	0.84	2.40	147.83	14100	0.5	8.2	50.76	74.95
		prod.	0.76	1.44	143.48	12600	0.7	7.9	42.30	79.12
113	d	feed	25.00	48.40	95.65	11200	0.7	7.8	42.30	74.95
		fr.brine	7.20	11.20	1282.61	98800	2.5	7.8	1150.03	4.79
		reg5	26.20	48.40	100.00	12000	0.7	7.9	42.30	81.20
		reg15	25.00	48.80	95.65	11200	0.9	7.9	40.89	74.95
		reg35	180.00	335.00	791.30	88100	3.1	7.4	1138.75	5.00
		reg45	142.00	244.00	630.43	92800	2.1	7.5	1155.67	4.58
		rina5	13.20	54.00	804.35	95200	1.2	7.8	1144.39	4.79
		rinb10	10.40	24.40	465.22	48800	0.8	8.0	445.29	70.79
		rinb15	1.20	1.60	143.48	13400	0.8	8.0	45.12	72.87
		prod.	0.80	1.56	130.43	12600	0.6	7.9	40.89	81.20
113	e	feed	23.80	48.00	95.65	11300	0.7	7.8	40.89	72.87
		fr.brine	7.00	11.20	956.52	94000	2.6	7.7	1141.57	4.79
		reg5	24.00	48.00	86.96	14100	0.7	7.9	43.71	79.12
		rge15	23.80	49.20	91.30	11300	1.1	7.8	40.89	77.04
		reg30	220.00	510.00	630.43	86900	4.0	7.3	1124.65	5.41
		reg45	146.00	260.00	639.13	88700	2.3	7.4	1155.67	4.79
		rina5	14.80	31.20	891.30	94000	1.2	7.8	1147.21	10.89
		rinb10	38.00	87.60	1204.35	95200	1.1	7.7	1155.67	4.58
		rinb15	1.04	4.40	178.26	14500	0.6	8.2	56.40	74.95
		prod.	0.88	1.76	147.83	12700	0.5	7.9	40.89	81.20

CHEMICAL ANALYSES PHASE 1 - BENCH UNIT TESTING

SERIES	Cycle No.	Event	Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Chloride	Sulfate
			meq/l			uS/cm	N.T.U.		meq/l	
114	a	feed	23.60	46.40	100.00	11000	0.6	7.7	45.12	7.50
		fr. brine	6.20	10.40	934.78	91700	2.9	7.6	1374.22	3.96
		reg5	25.20	46.80	91.30	12300	0.4	7.7	45.80	85.36
		reg15	86.80	188.00	178.26	30500	1.2	7.2	324.20	56.21
		reg30	213.60	428.00	865.22	109900	4.2	7.0	1691.48	5.21
		reg45	140.00	248.00	1086.96	105700	2.1	7.3	1409.59	4.58
		rina5	25.60	54.00	1013.04	105700	1.2	7.6	1381.39	5.21
		rinb10	0.80	1.60	160.87	15200	0.3	8.1	65.17	83.28
		rinb15	0.64	1.20	147.83	12300	0.4	7.8	69.09	83.28
		prod60	0.64	1.12	139.13	13200	0.3	7.8	56.12	83.28
	b	feed	24.80	47.20	91.30	11500	0.6	7.8	42.27	95.77
		fr. brine	7.20	10.80	1152.17	98100	1.8	7.6	1550.48	4.37
		reg5	24.80	47.20	104.35	12500	0.4	7.9	45.09	81.20
		reg15	77.20	167.00	273.91	34400	4.0	7.3	338.30	60.38
		reg30	196.00	374.00	856.52	94000	2.1	7.2	1268.64	5.21
		reg45	104.00	186.00	1456.52	99900	1.5	7.5	1268.64	5.00
		rinb5	24.00	56.00	1239.13	101100	1.6	7.6	1268.64	4.58
		rinb10	0.84	1.52	160.87	14600	0.5	8.1	56.37	83.28
		rinb15	0.68	1.16	152.17	12900	0.4	7.9	45.09	91.61
		prod60	0.68	1.20	156.52	12700	0.4	7.8	42.27	85.36
	c	feed	25.60	46.80	108.70	11400	0.5	7.6	40.86	95.77
		fr. brine	6.40	11.20	1386.96	99300	1.3	7.7	1155.67	4.79
		reg5	24.80	46.80	113.04	12000	0.5	7.6	42.27	89.53
		reg15	24.80	46.80	100.00	11500	0.6	7.7	42.27	6.66
		reg30	205.20	413.00	852.17	9400	2.8	7.1	1155.67	4.79
		reg45	106.00	187.00	986.96	98700	1.9	7.4	1155.67	4.58
		rinb5	23.20	56.80	1213.04	101100	1.1	7.6	1183.87	4.79
		rinb10	0.78	1.64	313.04	14600	0.5	8.0	59.22	85.36
		rinb15	0.56	1.24	143.48	13000	0.4	7.9	45.12	72.87
		prod60	0.60	1.28	152.17	12700	0.4	7.8	42.27	85.36
	d	feed	24.80	46.00	95.65	11500	0.7	7.6	42.27	74.95
		fr. brine	6.40	11.20	1243.48	99900	1.6	7.6	1155.95	4.79
		reg25	70.00	148.00	200.00	27600	3.5	7.4	225.61	62.46
		reg30	252.00	530.00	482.61	79900	2.9	7.0	958.54	12.49
		reg45	188.00	364.00	813.04	94000	1.6	7.1	1155.95	5.21
		rinb5	39.20	97.00	1117.39	100500	1.2	7.5	1170.05	5.41
		rinb10	0.96	2.12	169.57	14200	0.4	8.0	46.53	83.28
		rinb15	0.80	1.76	143.48	13200	0.4	7.9	42.27	83.28
		prod60	0.80	1.84	134.78	12700	0.5	7.7	42.27	83.28
	e	feed	24.80	46.80	91.30	11500	0.6	7.6	43.71	7.91
		fr. brine	6.40	10.80	1204.35	99900	1.4	7.7	1156.23	5.41
		reg0	24.40	48.40	100.00	11700	0.5	7.6	45.12	83.28
		reg5	25.20	47.20	86.96	11600	0.5	7.5	45.12	91.61
		reg15	24.00	46.40	91.30	11600	0.8	7.5	42.30	85.36
		reg30	216.00	422.00	813.04	92800	1.5	7.0	1156.23	5.41
		reg45	106.40	180.00	1134.78	99900	1.3	7.3	1156.23	5.62
		rina5	20.40	44.00	1291.30	104600	1.7	7.6	1156.23	8.12
		rinb10	0.80	1.44	173.91	14600	0.6	7.9	53.58	81.20
		rinb15	0.72	1.24	156.52	13400	0.4	7.8	42.30	70.79
		ser60	0.68	1.24	152.17	13000	0.4	7.7	42.30	79.12

CHEMICAL ANALYSES PHASE 1 - BENCH UNIT TESTING

			Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Ratio	
SERIES	Cycle No	Event	meq/l			uS/cm	N.T.U.		Na:TH	Ca:TH
115	a	feed	24.80	48.40	91.30	11500	0.5	7.7	1.89	0.51
		fr.brine	7.60	12.00	1017.39	9400	0.5	7.5	84.78	0.63
		reg10	42.40	91.00	130.43	19000	0.1	7.2	1.43	0.47
		reg20	280.00	602.00	391.30	79200	1.3	6.9	0.65	0.47
		reg30	215.40	414.00	695.65	90000	2.5	6.8	1.68	0.52
		reg40	180.00	346.00	765.22	91200	1.9	6.9	2.21	0.52
		rina5	19.20	44.40	1043.48	94800	1.1	7.3	23.50	0.43
		rinb10	13.00	30.00	560.87	55200	0.8	7.4	18.70	0.43
		rinb15	1.20	1.92	143.48	14200	0.2	7.8	74.73	0.63
		prod60	0.80	1.72	147.83	13100	0.3	7.7	85.95	0.47
	b	feed	24.80	48.40	91.30	11500	0.5	7.7	1.89	0.51
		fr.brine	8.00	12.00	1117.39	88800	1.5	7.2	93.12	0.67
		reg12	26.00	47.60	95.65	12200	0.6	7.7	2.01	0.55
		reg20	24.40	28.00	100.00	11800	1.0	7.6	3.57	0.87
		reg30	88.80	174.00	230.43	31200	1.9	7.2	1.32	0.51
		reg42	270.00	520.00	586.96	84000	1.8	6.8	1.13	0.52
		reg50	220.00	410.00	730.43	90000	1.9	6.9	1.78	0.54
		rina5	31.60	74.40	991.30	96000	1.8	7.2	13.32	0.42
		rinb10	2.80	4.40	221.74	16000	0.3	7.8	50.40	0.64
		rinb15	2.00	2.72	147.83	13100	0.4	7.6	54.35	0.74
		prod60	1.36	2.96	147.83	13100	0.3	7.8	49.94	0.46
116	all	feed	25.60	49.20	91.30	11600	0.2	7.6	1.86	0.52
		fr.brine	10.80	18.00	2265.22	16400	1.5	7.6	125.85	0.60
	a	reg10	24.80	48.40	95.65	12100	0.4	7.8	1.98	0.51
		reg20	25.60	47.60	91.30	11500	0.6	7.8	1.92	0.54
		reg30	171.20	354.00	256.52	51600	1.4	7.1	0.72	0.48
		reg40	498.00	904.00	1195.65	14400	1.7	6.8	1.32	0.55
		rina5	30.00	54.40	2378.26	16800	1.4	7.5	43.72	0.55
		rinb10	28.40	46.40	734.78	72000	1.0	7.8	15.84	0.61
		rinb15	1.44	2.28	178.26	16700	0.4	8.0	78.18	0.63
		prod	0.84	1.48	147.83	13100	0.2	8.0	99.88	0.57
	b	reg10	24.80	48.00	100.00	12200	0.3	7.7	2.08	0.52
		reg20	25.20	47.60	95.65	11500	0.5	7.7	2.01	0.53
		reg30	24.40	47.60	100.00	13700	0.7	7.7	2.10	0.51
		reg40	272.80	554.00	352.17	70800	1.8	6.9	0.64	0.49
		rina5	107.00	220.00	2047.83	15600	1.8	7.2	9.31	0.49
		rinb10	10.60	21.60	413.04	40800	0.9	7.7	19.12	0.49
		rinb15	1.16	2.48	152.17	14400	34.0	7.9	61.36	0.47
		prod	0.96	2.00	134.78	13000	0.3	7.9	67.39	0.48
	c	reg10	25.20	48.40	104.35	11800	0.3	7.6	2.16	0.52
		reg20	25.20	47.60	91.30	11500	0.6	7.6	1.92	0.53
		reg40	316.00	526.00	1726.09	15400	1.7	7.0	3.28	0.60
		reg50	282.00	456.00	1856.52	15600	1.9	7.0	4.07	0.62
		rina5	28.80	58.00	2186.96	16200	1.5	7.5	37.71	0.50
		rinb10	4.08	7.20	343.48	30600	0.7	7.9	47.71	0.57
		rinb15	0.88	1.44	160.87	15100	0.3	8.0	111.71	0.61
		prod	0.64	1.24	147.83	13000	0.3	7.8	119.21	0.52
	d	reg10	24.80	49.20	104.35	12100	0.3	7.7	2.12	0.50
		reg20	24.80	48.40	100.00	11600	0.7	7.7	2.07	0.51
		reg30	209.00	458.00	317.39	57600	1.6	7.0	0.69	0.46
		reg40	463.00	856.00	1330.43	14600	1.9	6.8	1.55	0.54
		rina5	26.80	65.20	2239.13	16200	1.3	7.5	34.34	0.41
		rinb10	18.40	36.40	647.83	60000	1.0	7.7	17.80	0.51
		rinb15	1.00	1.84	165.22	15200	0.6	8.0	89.79	0.54
		prod	0.64	1.48	139.13	13200	0.3	7.9	94.01	0.43

CHEMICAL ANALYSES PHASE 1 - BENCH UNIT TESTING

SERIES	Cycle No.	Event	Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Ratio	
			meq/l			uS/cm	N.T.U.		Na:TH	Ca:TH
117	all	feed	25.20	48.00	95.65	10500	0.9	7.8	1.99	0.53
		fr.brine	10.00	17.20	2056.52	150500	2.9	7.7	119.57	0.58
	a	reg10	24.40	48.00	100.00	11800	0.7	7.9	2.08	0.51
		reg20	530.00	984.00	630.43	107600	2.4	6.7	0.64	0.54
		reg30	321.00	580.00	1639.13	143000	3.1	6.9	2.83	0.55
		reg40	188.00	324.00	1860.87	151600	3.4	7.2	5.74	0.58
		reg50	159.00	258.00	1900.00	151600	4.1	7.3	7.36	0.62
		rina5	20.80	36.00	1630.43	150500	2.7	7.6	45.29	0.58
		rinb10	9.00	66.00	1360.87	126900	1.6	7.7	20.62	0.14
		rinb15	0.44	0.68	152.17	14000	0.6	8.3	223.79	0.65
		prod	0.40	0.68	139.13	12500	0.5	8.2	204.60	0.59
	b	reg15	26.00	46.00	91.30	10900	3.2	8.0	1.98	0.57
		reg30	28.00	51.20	108.70	11500	4.0	7.9	2.12	0.55
		reg45	442.00	810.00	1273.91	134400	3.8	6.9	1.57	0.55
		reg55	250.00	428.00	1813.04	147300	2.7	7.2	4.24	0.58
		rina5	20.00	47.20	2369.57	150500	2.8	7.7	50.20	0.42
		rinb10	12.00	22.80	665.22	58100	4.4	7.9	29.18	0.53
		rinb15	0.64	1.16	169.57	14000	0.6	8.2	146.18	0.55
		prod	0.48	1.00	147.83	12400	0.5	8.2	147.83	0.48
	c	reg15	30.00	47.60	91.30	1100	2.5	7.8	1.92	0.63
		reg30	410.00	912.00	456.52	101100	3.1	6.8	0.50	0.45
		reg45	192.00	314.00	1986.96	102100	2.7	7.2	6.33	0.61
		reg55	166.00	260.00	1969.57	150500	2.8	7.3	7.58	0.64
		rina5	20.40	46.80	2317.39	155900	1.8	7.8	49.52	0.44
		rinb10	12.40	24.00	704.35	62300	2.4	8.1	29.35	0.52
		rinb15	0.60	1.04	1569.57	13700	0.6	8.3	1509.20	0.58
		prod	0.68	1.28	152.17	12400	0.5	8.0	118.89	0.53
	d	reg15	26.00	46.80	108.70	11100	1.4	7.8	2.32	0.56
		reg30	162.00	320.00	269.57	44100	4.5	7.3	0.84	0.51
		reg45	325.00	560.00	1647.83	150500	2.6	7.0	2.94	0.58
		reg55	185.00	320.00	1847.83	150500	2.4	7.2	5.77	0.58
		rina5	20.40	48.00	2321.74	19900	2.0	7.6	48.37	0.43
		rinb10	10.00	18.80	656.52	49500	1.9	8.1	34.92	0.53
		rinb15	0.64	1.20	173.91	14300	0.6	8.2	144.93	0.53
		prod	0.72	1.08	152.17	12500	0.8	8.1	140.90	0.67
	e	reg15	26.00	46.80	95.65	11000	2.5	7.9	2.04	0.56
		reg30	85.00	165.00	208.70	27900	4.7	7.5	1.26	0.52
		reg45	418.00	752.00	1326.09	139700	3.4	6.8	1.76	0.56
		reg55	256.00	416.00	1708.70	145100	2.9	7.1	4.11	0.62
		rina5	28.00	62.00	2160.87	150500	2.1	7.6	34.85	0.45
		rinb10	1.88	3.20	265.22	19900	1.7	8.2	82.88	0.59
		rinb15	0.72	1.44	169.57	14000	2.2	8.2	117.75	0.50
		prod	0.52	1.20	156.52	12400	0.7	8.1	130.43	0.43

CHEMICAL ANALYSES PHASE 1 - BENCH UNIT TESTING

SERIES	Cycle No.	Event	Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Ratio	
			meq/l			uS/cm	N.T.U.		Na:TH	Ca:TH
118	all	feed	30.80	46.40	91.30	10500	0.5	7.9	1.97	0.66
		fr.brine	7.60	11.60	1252.17	88000	0.8	7.6	107.95	0.66
		cb.us.br.	91.20	152.00	691.30	62100	1.2	7.2	4.55	0.60
	a	reg15	204.60	358.00	786.96	90300	1.8	7.2	2.20	0.57
		rge25	115.00	158.00	995.65	86300	1.3	7.3	6.30	0.73
		reg35	94.00	132.00	1091.30	86300	1.2	7.4	8.27	0.71
		reg45	82.80	105.20	1039.13	96600	1.3	7.4	9.88	0.79
		reg55	58.00	73.20	1152.17	85700	1.2	7.5	15.74	0.79
		reg60	48.80	67.20	1143.48	85700	1.1	7.5	17.02	0.73
		rina5	13.60	18.80	1126.09	82800	1.1	7.6	59.90	0.72
		rinb5	7.20	9.72	665.22	47700	0.7	7.9	68.44	0.74
		prod	0.44	0.76	139.13	12300	0.4	7.7	183.07	0.58
	b	reg10	27.60	46.00	95.65	10700	0.6	7.7	2.08	0.60
		reg20	186.00	344.00	286.96	48300	1.3	7.1	0.83	0.54
		reg30	168.00	242.00	717.39	74700	1.0	7.2	2.96	0.69
		reg40	102.00	170.00	760.87	76500	1.0	7.3	4.48	0.60
		reg50	87.00	142.00	882.61	76500	1.1	7.3	6.22	0.61
		reg60	62.00	96.00	960.87	78800	1.0	7.3	10.01	0.65
		rina5	9.60	2.00	1017.39	77100	0.8	7.5	508.70	4.80
		rinb5	14.40	31.20	1030.43	78200	0.9	7.4	33.03	0.46
		prod	0.52	1.08	156.52	12300	0.4	7.7	144.93	0.48
	c	reg10	51.20	96.00	130.43	16800	1.1	7.3	1.36	0.53
		reg20	169.00	300.00	686.96	74200	1.1	7.1	2.29	0.56
		reg30	105.60	182.00	769.57	77100	1.0	7.2	4.23	0.58
		reg40	83.20	128.00	882.61	78200	1.1	7.3	6.90	0.65
		reg50	62.00	100.00	939.13	79300	1.0	7.3	9.39	0.62
		reg60	91.60	161.00	647.83	64400	1.1	7.4	4.02	0.57
		rina5	11.20	20.00	1030.43	78800	0.8	7.4	51.52	0.56
		rinb5	13.60	26.40	995.65	79300	0.8	7.5	37.71	0.52
		prod	0.52	0.96	152.17	12400	0.4	7.7	158.51	0.54
	d	reg10	46.80	93.20	147.83	17300	1.2	7.3	1.59	0.50
		reg20	233.00	456.00	517.39	67900	1.0	6.9	1.13	0.51
		reg30	155.00	266.00	782.61	75300	1.0	7.1	2.94	0.58
		reg40	104.00	172.00	908.70	77100	1.0	7.2	5.28	0.60
		reg50	81.00	130.00	943.48	78200	1.0	7.3	7.26	0.62
		reg60	68.00	102.00	978.26	79300	1.0	7.3	9.59	0.67
		rina5	11.20	20.00	1000.00	80500	0.8	7.5	50.00	0.56
		rinb5	15.20	34.80	1000.00	81700	1.0	7.4	28.74	0.44
		prod	0.56	1.12	152.17	12700	0.5	7.5	135.87	0.50

CHEMICAL ANALYSES PHASE 1 - BENCH UNIT TESTING

			Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Ratio	
SERIES	Cycle No.	Event	meq/l			uS/cm	N.T.U.		Na:TH	Ca:TH
119	all	feed	26.00	46.80	91.30	10200	0.8	7.5	1.95	0.56
		fr.brine	11.20	16.80	2282.61	154300	1.2	7.5	135.87	0.67
		cb.us.br.	136.00	234.00	573.91	62400	1.6	7.1	2.45	0.58
	a	reg6	24.80	54.00	95.65	11300	0.6	7.6	1.77	0.46
		reg15	26.00	47.00	104.35	11400	0.9	7.6	2.22	0.55
		reg30	46.00	86.00	943.48	78400	1.9	7.3	10.97	0.53
		reg40	109.60	204.00	1743.48	129900	1.5	7.1	8.55	0.54
		reg50	106.00	164.00	2256.52	150700	1.6	7.2	13.76	0.65
		rina5	30.40	42.00	2373.91	154300	1.4	7.5	56.52	0.72
		rinb5	41.20	76.80	2491.30	156800	1.4	7.4	32.44	0.54
		prod	0.68	1.20	169.57	13400	0.8	7.8	141.30	0.57
	b	reg5	26.00	45.60	104.35	10900	0.7	7.6	2.29	0.57
		reg12	26.00	45.60	100.00	10500	1.1	7.6	2.19	0.57
		reg30	28.00	51.20	108.70	10900	2.6	7.6	2.12	0.55
		reg40	506.00	880.00	852.17	113900	2.5	6.7	0.97	0.58
		reg50	342.00	556.00	1886.96	143300	1.7	6.9	3.39	0.62
		rina5	24.80	48.00	2347.83	151900	1.3	7.3	48.91	0.52
		rinb5	70.00	135.60	2256.52	153100	1.2	7.3	16.64	0.52
		prod	1.28	2.16	156.52	1300	0.6	7.8	72.46	0.59
	c	reg5	26.00	46.80	95.65	10800	0.6	7.6	2.04	0.56
		reg12	28.00	46.40	95.65	10400	1.2	7.6	2.06	0.60
		reg30	206.00	356.00	243.48	47200	2.6	6.9	0.68	0.58
		reg40	396.00	666.00	1534.78	142100	1.5	6.7	2.30	0.59
		reg50	230.00	342.00	2056.52	151900	1.5	6.9	6.01	0.67
		rina5	20.40	40.00	1760.87	132300	3.0	7.5	44.02	0.51
		rinb5	91.00	145.20	2204.35	155600	1.3	7.2	15.18	0.63
		prod	1.12	1.88	160.87	13400	0.7	7.8	85.57	0.60
	d	reg5	28.00	46.40	100.00	11000	0.6	7.6	2.16	0.60
		reg15	28.00	47.20	95.65	10700	1.1	7.6	2.03	0.59
		reg30	27.20	45.20	95.65	10600	1.3	7.6	2.12	0.60
		reg40	500.00	880.00	639.13	105300	1.8	6.4	0.73	0.57
		reg50	354.00	548.00	1673.91	147000	1.5	6.7	3.05	0.65
		rina5	30.00	58.00	821.74	153600	1.4	7.3	14.17	0.52
		rinb5	83.00	148.00	2300.00	154800	1.3	7.2	15.54	0.56
		prod	1.44	2.04	165.22	13600	0.8	7.7	80.99	0.71
	e	reg5	28.40	46.40	86.96	11200	0.8	7.5	1.87	0.61
		reg15	28.00	46.00	82.61	10800	1.1	7.5	1.80	0.61
		reg30	28.80	46.00	91.30	10700	1.3	7.5	1.98	0.63
		reg40	508.00	952.00	708.70	116400	1.7	6.5	0.74	0.53
		reg50	386.00	572.00	1591.30	146400	1.6	6.7	2.78	0.67
		rina5	32.40	50.00	1586.96	156000	1.4	7.3	31.74	0.65
		rinb5	78.00	147.60	1373.91	156000	1.8	7.2	9.31	0.53
		prod	1.32	2.00	152.17	13600	0.9	7.9	76.09	0.66

CHEMICAL ANALYSES PHASE 1 - BENCH UNIT TESTING

SERIES	Cycle No.	Event	Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Ratio	
			meq/l			uS/cm	N.T.U.		Na:TH	Ca:TH
120	all	feed	30.00	46.40	86.96	10200	1.2	7.8	1.9	0.65
	all	fr.brine	11.20	18.00	2108.70	155000	1.8	7.8	117.1	0.62
	a	reg5	30.40	45.20	82.61	10900	0.9	8.0	1.8	0.67
		reg15	27.20	46.00	78.26	10500	1.1	7.9	1.7	0.59
		reg30	48.00	85.00	108.70	15600	2.9	7.7	1.3	0.56
		reg40	444.00	776.00	1160.87	135000	2.2	7.0	1.5	0.57
		reg50	294.00	434.00	1613.04	147500	2.2	7.2	3.7	0.68
		reg60	198.00	248.00	1878.26	151300	1.8	7.4	7.6	0.80
		rina5	26.00	44.00	2082.61	153700	1.8	7.7	47.3	0.59
		rinb10	20.00	30.40	756.52	69400	3.6	7.9	24.9	0.66
		prod	0.64	1.16	134.78	12700	0.8	8.2	116.2	0.55
	b	reg5	27.20	46.40	84.78	10700	1.3	8.0	1.8	0.59
		reg15	26.80	46.40	86.96	10500	1.7	7.7	1.9	0.58
		reg30	134.00	232.00	217.39	33700	2.7	7.3	0.9	0.58
		reg40	472.00	778.00	1260.87	135000	2.3	6.9	1.6	0.61
		reg50	290.00	466.00	1173.91	142500	2.1	7.1	2.5	0.62
		reg60	162.00	282.00	1847.83	150000	1.8	7.3	6.6	0.57
		rina5	27.60	46.00	2152.17	152500	2.0	7.6	46.8	0.60
		rinb10	58.00	112.40	2043.48	152500	1.9	7.5	18.2	0.52
		prod	0.60	1.36	132.61	12700	0.7	8.1	97.5	0.44
	c	reg5	28.00	46.00	82.61	10600	0.7	7.8	1.8	0.61
		reg15	28.00	45.60	86.96	10300	1.3	7.8	1.9	0.61
		reg30	33.00	52.00	913.04	11500	2.8	7.6	17.6	0.63
		reg40	660.00	950.00	978.26	131300	2.1	6.6	1.0	0.69
		reg50	352.00	510.00	1630.43	145000	2.1	6.8	3.2	0.69
		reg60	200.00	258.00	1913.04	150000	1.8	7.1	7.4	0.78
		rina5	22.00	40.00	2304.35	152500	1.5	7.4	57.6	0.55
		rinb5	56.00	105.00	2152.17	152500	1.5	7.3	20.5	0.53
		prod	1.28	2.36	147.83	13500	0.8	7.9	62.6	0.54
	d	reg5	26.00	46.00	93.48	10500	0.9	7.7	2.0	0.57
		reg15	27.60	46.40	84.78	10300	1.8	7.6	1.8	0.59
		reg30	52.40	94.40	123.91	16500	3.6	7.4	1.3	0.56
		reg40	506.00	852.00	1173.91	131300	2.1	6.6	1.4	0.59
		reg50	286.00	442.00	1913.04	145000	2.0	6.9	4.3	0.65
		reg60	158.00	230.00	2086.96	152500	2.3	7.1	9.1	0.69
		rina5	23.60	50.00	2260.87	154300	1.6	7.4	45.2	0.47
		rinb5	67.00	120.00	2108.70	155600	1.8	7.3	17.6	0.56
		prod	0.72	1.40	150.00	13100	1.1	7.9	107.1	0.51
	e	reg5	27.60	46.00	95.65	11100	1.6	7.7	2.1	0.60
		reg15	26.80	45.60	91.30	10500	1.5	7.6	2.0	0.59
		reg30	85.00	150.00	147.83	23900	3.8	7.3	1.0	0.57
		reg40	470.00	824.00	1108.70	134700	2.4	6.7	1.3	0.57
		reg50	278.00	412.00	1739.13	148200	1.9	6.9	4.2	0.67
		reg60	174.00	254.00	1978.26	154300	2.0	7.0	7.8	0.69
		rina5	29.60	48.00	2130.43	156800	1.8	7.4	44.4	0.62
		rinb5	62.00	118.80	2152.17	156800	2.0	7.2	18.1	0.52
		prod	1.24	1.88	132.61	13600	0.8	7.8	70.5	0.66
	all	cb.us.br.	174.00	262.00	608.70	73500	2.5	7.1	2.3	0.66

CHEMICAL ANALYSES PHASE 1 - BENCH UNIT TESTING

			Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Ratio	
SERIES	Cycle No.	Event	meq/l			uS/cm	N.T.U.		Na:TH	Ca:TH
121	all	feed	28.00	46.40	86.96	10100	0.5	7.6	1.87	0.60
		fr.brine	8.40	15.60	2260.87	15300		7.7	144.93	0.54
	a	reg15	29.20	49.20	84.78	11500		7.8	1.72	0.59
		reg50	134.00	224.00	500.00	57400		7.4	2.23	0.60
		prod.	0.60	0.92	123.91	12000	0.4	7.9	134.69	0.65
	b	reg15	27.60	45.20	82.61	10300		7.5	1.83	0.61
		reg50	276.00	420.00	1804.35	146300		7.0	4.30	0.66
		prod.	0.52	0.88	130.43	12100	0.6	7.9	148.22	0.59
	c	reg15	31.20	45.20	84.78	10300		7.6	1.88	0.69
		reg50	344.00	554.00	1630.43	142900		6.9	2.94	0.62
		prod.	0.88	1.44	132.61	11900	0.5	7.9	92.09	0.61
	d	reg15	25.60	45.20	84.78	10500		7.6	1.88	0.57
		reg50	220.00	334.00	1956.52	149500		7.1	5.86	0.66
		prod.	0.64	1.16	1282.61	12200	0.5	7.9	1105.70	0.55
	e	reg15	26.40	44.80	86.96	10600		7.5	1.94	0.59
		reg50	254.00	400.00	1847.83	147200		7.0	4.62	0.64
		prod.	1.16	1.92	139.13	12600	1.5	8.0	72.46	0.60
	f	reg15	26.40	44.80	80.43	10800		7.7	1.80	0.59
		reg50	238.00	382.00	189.13	151200		7.0	0.50	0.62
		prod.	0.60	1.00	134.78	12500	0.3	7.9	134.78	0.60
	g	prod.	0.44	0.76	128.26	11900	0.2	7.8	168.76	0.58
	h	prod.	0.40	0.64	130.43	11900	0.2	7.8	203.80	0.63
	i	reg15	28.00	46.00	82.61	10800		7.6	1.80	0.61
		reg50	276.00	534.00	1717.39	148800		7.0	3.22	0.52
		prod.	0.68	1.08	130.43	12500	0.2	7.9	120.77	0.63
	j	reg15	432.00	660.00	1543.48	144500		6.8	2.34	0.65
		reg50	232.00	384.00	1891.30	151600		7.0	4.93	0.60
		prod.	0.80	1.20	139.13	12300	0.2	8.0	115.94	0.67
122	all	feed	26.40	46.00	89.13	10200	0.4	7.7	1.94	0.57
		fr.brine	9.20	14.40	1760.87	134400	NA	7.6	122.28	0.64
	a	reg15	26.00	46.00	76.09	11200	NA	7.9	1.65	0.57
		reg50	348.00	592.00	1021.74	120000	NA	6.9	1.73	0.59
		prod.	1.00	1.80	139.13	12000	0.5	8.1	77.29	0.56
	b	rge15	26.00	46.00	82.61	10300	NA	7.8	1.80	0.57
		reg50	240.00	348.00	139.13	130800	NA	7.1	0.40	0.69
		prod.	0.96	1.60	132.61	12100	0.4	8.1	82.88	0.60
	c	reg15	26.00	45.60	89.13	10800	NA	7.8	1.95	0.57
		reg50	246.00	344.00	1413.04	133200	NA	7.1	4.11	0.72
		prod.	0.92	1.68	136.96	12500	0.5	8.0	81.52	0.55
	d	reg15	26.40	45.60	84.78	10900	NA	7.7	1.86	0.58
		reg50	157.20	270.00	369.57	55200	NA	7.2	1.37	0.58
		prod.	1.00	2.04	123.91	12000	0.6	8.0	60.74	0.49
	e	reg15	26.00	45.60	76.09	10800	NA	7.7	1.67	0.57
		reg50	300.00	458.00	1152.17	129600	NA	6.9	2.52	0.66
		prod.	1.04	1.84	139.13	12400	0.9	8.0	75.61	0.57

CHEMICAL ANALYSES PHASE 1 - BENCH UNIT TESTING

			Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Ratio	
SERIES	Cycle No	Event	meq/l			uS/cm	N.T.U.		Na:TH	Ca:TH
123	all	feed	26.80	46.00	86.96	10100	0.4	7.8	1.89	0.58
		fr.brine	8.80	13.60	1652.17	129300	1.6	7.8	121.48	0.65
	a	reg15	26.00	45.20	847.83	10200	NA	8.0	18.76	0.58
		reg50	214.00	312.00	1369.57	117500	NA	7.3	4.39	0.69
		prod.	1.04	1.60	126.09	11600	0.5	8.2	78.80	0.65
	b	reg15	26.00	47.20	86.96	10100	NA	7.7	1.84	0.55
		reg50	354.00	552.00	978.26	112800	NA	7.0	1.77	0.64
		prod.	1.28	2.20	123.91	11700	0.4	8.1	56.32	0.58
	c	reg15	26.40	46.00	86.96	10100	NA	7.8	1.89	0.57
		reg50	398.00	434.00	113.04	112800	NA	7.1	0.26	0.92
		prod.	1.24	2.16	84.78	12000	0.4	8.1	39.25	0.57
	d	reg15	29.20	46.00	84.78	10300	NA	7.8	1.84	0.63
		reg50	334.00	492.00	1043.48	114000	NA	7.0	2.12	0.68
		prod.	1.48	2.40	130.43	11500	0.3	8.0	54.35	0.62
	e	reg15	27.60	45.60	82.61	10000	NA	7.8	1.81	0.61
		reg50	286.00	412.00	1217.39	112800	NA	7.1	2.95	0.69
		prod.	1.24	2.28	132.61	11500	0.3	7.9	58.16	0.54
124	a	feed	21.60	51.60	96.96	11400	0.5	7.6	1.88	0.42
		fr.brine	3.80	16.00	3141.30	168700	NA	NA	196.33	0.24
		reg15	56.00	226.00	254.35	37700	NA	NA	1.13	0.25
		reg40	100.00	278.00	2686.96	169400	NA	NA	9.67	0.36
		ser0	0.50	1.80	205.43	18000	NA	NA	114.13	0.28
		prod130	0.50	0.92	153.48	13500	0.7	8.6	166.82	0.54
		used brin	162.00	354.00	1186.96	103800	NA	NA	3.35	0.46
125	a	feed	21.20	50.00	100.00	11100	0.6	7.6	2.00	0.42
		fr.brine	7.80	20.40	1273.91	180100	NA	NA	62.45	0.38
		reg15	198.00	430.00	2641.30	161400	NA	NA	6.14	0.46
		reg40	78.00	122.00	3665.22	179100	NA	NA	30.04	0.64
		rina5	23.00	43.60	3997.83	180000	NA	NA	91.69	0.53
		ser0	0.84	3.40	517.39	36000	1.7	8.9	152.17	0.25
		ser10	<0.5	0.56	203.26	NA	NA	NA	362.97	NA
		ser60	<0.5	0.44	NA	NA	NA	NA	NA	NA
		ser120	<0.5	0.44	177.17	13400	0.4	NA	402.67	NA
		ser140	<0.5	0.64	NA	NA	NA	NA	NA	NA
		ser160	<0.5	5.20	NA	NA	NA	NA	NA	NA
		prod120	<0.5	0.44	177.17	1300	0.3	NA	402.67	NA
		cm.us.br	174.00	384.00	1000.00	165500	NA	NA	2.60	0.45
126	a	feed	21.00	52.40	106.96	11300	3.0	7.7	2.04	0.40
		fr.brine	9.60	19.60	3176.09	175200	NA	NA	162.05	0.49
		reg15	25.40	50.80	101.52	12400	NA	NA	2.00	0.50
		reg40	224.00	420.00	4063.04	181700	NA	NA	9.67	0.53
		rina5	54.00	120.00	3750.00	185100	NA	NA	31.25	0.45
		ser0	0.94	4.40	273.91	23800	NA	NA	62.25	0.21
		ser10	<0.5	1.76	163.70	14500	NA	NA	93.01	NA
		ser60	<0.5	1.48	NA	NA	NA	NA	NA	NA
		ser120	<0.5	2.16	158.04	13700	0.2	NA	73.17	NA
		prod120	<0.5	1.68	182.61	13400	0.1	8.2	108.70	NA
		cm.us.br	244.00	600.00	NA	NA	NA	NA	NA	0.41

APPENDIX B

SERIES 200 ION-EXCHANGE BENCH UNIT TESTS

Development of Desalting Reject Brine Regeneration Cycle
Operation Parameters and Results

SERIES 200 OPERATION PARAMETERS
ROTATING EVAPORATOR DISK BRINE (RED BRINE)

OPERATION INFORMATION:

SERIES	DATE	RESIN*	PROCESS WATER	RUN	HOUR	OTHER
201	850304	C.20.a	marsh	a	12	all regeneration with fresh brine; run to total hardness breakthrough to influent total hardness.
202	850307	C.20.a	marsh	a	10	all regeneration with fresh brine; run to total hardness breakthrough to influent total hardness.
203	850311	C.20.a	marsh	a	10	all regeneration with fresh brine; run to total hardness breakthrough to influent total hardness.
204	850312	C.20.a	marsh	a	10	all regeneration with fresh brine; run to total hardness breakthrough to influent total hardness.
205	850319	C.20.a	marsh	a	9	all regeneration with fresh brine; run to total hardness breakthrough to influent total hardness.
206	850325	C.20.a	marsh	a	10	all regeneration with fresh brine; run to total hardness breakthrough to influent total hardness.
207	850326	C.20.a	marsh	a	9	all regeneration with fresh brine; run to total hardness breakthrough to influent total hardness.
208	850329	C.20.b	marsh	a	9	all regeneration with fresh brine; run to total hardness breakthrough to influent total hardness.
209	850416	C.20.a	clarifier	a	9	sixth run with recycle brine; service run duration for 120 minutes.
210	850424	C.20.a	clarifier	a	11	seventh run with recycle brine; service run duration for 120 minutes

* C.20.a resin taken from main IX columns
C.20.b resin is new C20 resin that was also used in the first series of tests

OPERATION PARAMETERS:

		RECYCLE BRINE REGENERATION				FRESH BRINE REGENERATION				SLOW RINSE		FAST RINSE		SERVICE	
		LR1	B.E.	DUR.	CONC.	LR1	DUR.	CONC.	TEMP.	LR1	DUR.	LR1	DUR.	LR2	DUR.
SERIES	RUN	(gpm/ft2)	(%)	(min.)	(%)	(gpm/ft2)	(min.)	(%)	(C)	(gpm/ft2)	(min.)	(gpm/ft2)	(min.)	(gpm/ft3)	(min.)
201	a	4.89	50	30	7.0	3.77	20	7.0	9.5	2.85	5	6.11	15	1.18	190
202	a	5.00	50	30	7.0	3.77	20	7.0	9.0	2.85	5	6.11	15	1.18	207
203	a	5.68	55	30	7.0	3.65	20	7.0	13.0	3.54	5	5.54	15	1.22	210
204	a	5.41	55	30	5.5	3.70	20	6.5	12.0	2.85	5	5.63	15	1.19	150
205	a	5.93	top	50	5.0	3.89	20	6.5	12.0	5.36	5	5.36	15	1.20	180
206	a	5.89	top	50	5.0	3.81	20	6.5	10.5	2.95	5	5.48	15	1.18	180
207	a	5.43	50	50	5.0	3.71	20	6.5	10.0	3.71	5	5.60	15	1.08	189
208	a	5.76	50	50	5.0	3.69	20	6.5	9.5	4.48	5	5.50	10	1.19	165
209	a	5.37	50	70	5.0	3.71	20	6.5	17.0	3.46	5	5.66	15	1.19	142
210	a	5.31	40	40	NA	3.85	50	6.5	20.0	3.54	5	4.96	15	1.21	120

LR1: loading rate in gpm/ft2 (cross sectional area of column)
LR2: loading rate in gpm/ft3 of resin
B.E.: bed expansion

SERIES 200 BENCH UNIT TEST

RATES AND VOLUMES OF PROCESS WATER AND BRINE USED
ROTATING EVAPORATOR DISK BRINE (RED)

	RATE					VOLUME						
	RECYCLE BRINE	FRESH BRINE	SLOW RISE	FAST RINSE	SERVICE	RECYCLE BRINE	FRESH BRINE	SLOW RISE	FAST RINSE	SERVICE	SR+FR-CV	Calcium at Ser120
SERIES	(bv/minute)					bed volume						(meq/l)
201	0.13	0.10	0.08	0.16	0.16	3.9	2.0	0.4	2.5	30.0	1.9	0.5
202	0.13	0.10	0.08	0.16	0.16	4.0	2.0	0.4	2.5	32.7	1.9	0.6
203	0.15	0.10	0.09	0.15	0.16	4.6	2.0	0.5	2.2	34.3	1.8	0.7
204	0.14	0.10	0.08	0.15	0.16	4.3	2.0	0.4	2.3	23.9	1.7	3.0
206	0.16	0.10	0.08	0.15	0.16	7.9	2.0	0.4	2.2	28.4	1.7	1.7
207	0.14	0.10	0.10	0.15	0.14	7.3	2.0	0.5	2.2	27.2	1.8	1.4
208	0.15	0.10	0.12	0.15	0.16	7.7	2.0	0.6	1.5	26.3	1.1	4.2
209	0.14	0.10	0.09	0.15	0.16	10.0	2.0	0.5	2.3	22.7	1.8	1.3
210	0.14	0.10	0.09	0.13	0.16	5.7	5.1	0.5	2.0	19.4	1.5	1.2

BENCH UNIT NOMENCLATURE:

Sampling identification: numbers after event indicate time sample was taken.

-instantaneous samples: rega, regb, ser , rina (slow rinse) and rinb (fast rinse). Rina (slow rinse) and rinb (fast rinse) without numbers are batch samples.
-batch samples: feed, fr.brine, recycled brine, combined backwash, combined regeneration, combined rinse and product.
-influent samples: feed, fr.brine and recycled brine.
-effluent samples: combined backwash, combined rinse, combined regeneration (comb.used brine), rega, regb, rina, rinb, service and product.

bv: bed volume of resin
CV: column voids volume or entire column volume minus actual volume of resin.
Resin C.20.a: resin extracted from main units
Resin C.20.b: new, previously unused resin.

SERIES 200 BENCH UNIT TESTS CHEMICAL ANALYSES
Analyses for tests 201 through 210

SERIES	RUN	Event	Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Na:TH
			(meq/l)			(uS/cm)	(N.T.U.)		
201	a	feed	27.4	47.2	69.6	9600	0.7	8.1	1.5
		fr.brine	2.0	4.4	804.3	56300	NA	NA	182.8
		rega14	29.2	88.0	565.2	47500	NA	NA	6.4
		regb15	28.4	48.0	782.6	52500	NA	NA	16.3
		usedbr.	31.2	73.6	391.3	26300	NA	NA	5.3
		ser0	0.6	0.9	132.6	11300	0.5	8.6	150.7
		ser10	0.5	0.7	132.6	11900	NA	NA	184.2
		rina5	6.8	14.4	782.6	55000	NA	NA	54.3
		rinb4	9.6	18.0	804.3	55000	1.4	9.0	44.7
		prod125	0.6	0.8	134.8	12300	0.7	8.4	168.5
		prod195	1.4	5.0	128.3	12000	NA	NA	25.7
202	a	feed	29.2	46.8	89.1	10600	0.4	8.0	1.9
		fr.brine	2.4	4.8	869.6	54700	NA	NA	181.2
		rega14	30.0	166.0	413.0	39400	NA	NA	2.5
		regb15	NA	72.0	739.1	50300	NA	NA	10.3
		rina5	14.0	28.0	913.0	53700	NA	NA	32.6
		rinb4	18.0	20.8	804.3	53500	NA	NA	38.7
		ser0	3.0	5.8	232.6	19800	NA	NA	39.8
		ser10	0.7	1.3	260.9	12700	NA	NA	203.8
		comb.reg	31.6	76.8	1521.7	47800	NA	NA	19.8
		combrin	1.8	3.2	189.1	17300	NA	NA	59.1
		combrega	32.8	92.0	221.7	23500	NA	NA	2.4
		prod140	0.8	1.6	137.0	12700	0.3	8.4	87.8
203	a	feed	34.4	46.8	87.0	10800	1.0	7.8	1.9
		fr.brine	2.2	4.8	847.8	52400	NA	NA	176.6
		comb.back	28.8	102.0	217.4	25300	NA	NA	2.1
		rega14	39.0	160.0	413.0	39300	NA	NA	2.6
		regb15	26.4	64.0	717.4	50200	NA	NA	11.2
		rina5	16.0	33.0	147.8	53200	NA	NA	4.5
		rinb4	0.9	0.6	145.7	14000	NA	NA	260.1
		ser3	0.8	1.4	143.5	12400	0.3	NA	105.5
		ser10	0.8	1.3	143.5	12200	NA	NA	108.7
		comb.reg	26.0	54.8	673.9	47700	NA	NA	12.3
		comb.rinse	1.6	2.8	187.0	16300	NA	NA	66.8
		prod120	0.7	1.5	137.0	12300	0.5	8.5	92.5
204	a	feed	28.0	47.2	93.5	10200	0.8	8.0	2.0
		fr.brine	1.8	5.2	869.6	54700	NA	NA	167.2
		recyc.reg	26.8	82.4	630.4	50000	NA	NA	7.7
		rega14	30.4	175.0	369.6	37900	NA	NA	2.1
		regb15	26.4	106.0	630.4	48100	NA	NA	5.9
		rina5	29.2	53.0	739.1	53400	NA	NA	13.9
		rinb4	26.8	57.6	739.1	51100	NA	NA	12.8
		rinb10	2.4	8.4	239.1	20400	1.1	9.0	28.5
		ser0	1.5	3.9	154.3	14100	0.7	9.0	39.8
		ser10	1.4	2.5	134.8	12800	0.3	8.9	53.5
		comb.reg	26.8	108.0	587.0	46000	NA	8.3	5.4
		comb.rinse	4.7	8.4	230.4	20000	NA	8.9	27.4
		comb.back	28.0	110.0	230.4	25000	NA	8.2	2.1
		prod120	4.0	15.6	121.7	12300	0.4	8.2	7.8

SERIES 200 BENCH UNIT TESTS CHEMICAL ANALYSES
Analyses for tests 201 through 210 - Continued

SERIES	RUN	Event	Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Na:TH
			(meq/l)			(uS/cm)	(N.T.U.)		
205	a	feed	26.8	47.2	82.6	10000	0.7	NA	1.8
		fr.brine	1.4	4.8	956.5	52900	NA	NA	199.3
		recyc.br.	30.0	94.0	782.6	47900	NA	NA	8.3
		comb.back	36.0	123.0	210.9	25500	NA	NA	1.7
		comb.reg	26.4	107.0	695.7	44300	NA	NA	6.5
		comb.rinse	7.6	11.6	243.5	21500	NA	NA	21.0
		rega14	77.6	162.0	43.5	36600	NA	NA	0.3
		regb12	28.0	102.0	760.9	47500	NA	NA	7.5
		regb17	26.8	95.0	826.1	49300	NA	NA	8.7
		rina3	20.0	60.0	913.0	52500	NA	NA	15.2
		ser0	1.3	2.3	143.5	13900	NA	NA	62.9
		ser10	2.2	2.1	134.8	12500	NA	NA	64.8
		prod120	2.2	12.0	115.2	11700	0.3	NA	9.6
206	a	feed	27.6	50.0	87.0	10800	0.6	NA	1.7
		fr.brine	2.8	6.4	869.6	55100	NA	NA	135.9
		recyc.br.	30.0	104.8	565.2	47800	NA	NA	5.4
		comb.back	36.8	122.0	232.6	26300	NA	NA	1.9
		comb.reg	28.4	113.0	543.5	44600	NA	NA	4.8
		comb.rinse	6.0	13.6	243.5	21500	NA	NA	17.9
		rega14	37.2	170.0	347.8	36800	NA	NA	2.0
		regb15	26.0	120.0	630.4	48800	NA	NA	5.3
		rinb4	27.2	74.0	717.4	52700	NA	NA	9.7
		rinb15	1.9	5.2	143.5	15600	NA	NA	27.6
		prod120	1.3	3.4	134.8	13600	0.3	NA	39.6
207	a	feed	27.2	50.4	82.6	11200	0.6	7.9	1.6
		fr.brine	2.8	6.0	739.1	54400	NA	NA	123.2
		recyc.br.	30.8	110.8	543.5	46600	NA	NA	4.9
		comb.back	33.2	124.0	234.8	27400	NA	NA	1.9
		comb.reg	27.6	116.0	434.8	41400	NA	NA	3.7
		comb.rinse	10.0	20.0	282.6	25800	NA	NA	14.1
		rega14	34.4	180.0	391.3	39000	NA	NA	2.2
		regb15	27.6	123.0	630.4	48300	NA	NA	5.1
		rina5	28.4	50.0	93.5	12500	NA	NA	1.9
		rinb4	22.0	57.0	717.4	52000	NA	NA	12.6
		rinb15	2.8	6.4	150.0	13900	NA	NA	23.4
		prod130	1.6	4.4	132.6	13800	0.5	8.4	30.4
208	a	feed	28.4	49.6	87.0	10600	1.5	8.1	1.8
		fr.brine	2.8	6.0	760.9	52700	NA	NA	126.8
		recyc.br.	33.6	130.0	500.0	41300	NA	NA	3.8
		comb.back	36.4	125.0	217.4	27600	NA	NA	1.7
		comb.reg	30.0	120.0	565.2	42200	NA	NA	4.7
		comb.rinse	6.4	126.0	273.9	24100	NA	NA	2.2
		rega14	29.2	131.0	391.3	38600	NA	NA	3.0
		regb15	33.2	117.0	456.5	42100	NA	NA	3.9
		rina5	21.2	53.6	760.9	50200	NA	NA	14.2
		rinb15	2.7	4.4	143.5	13700	NA	NA	32.9
		prod120	2.1	7.8	137.0	12800	0.5	8.4	17.6

SERIES 200 BENCH UNIT TESTS CHEMICAL ANALYSES
Analyses for tests 201 through 210 - Continued

SERIES	RUN	Event	Calcium	THardness	Sodium	Elec.Cond.	Turbidity	pH	Na:TH
			(meq/l)			(uS/cm)	(N.T.U.)		
209	a	feed	29.2	49.0	95.7	12200	1.6	8.0	2.0
		fr.brine	2.4	6.0	847.8	56200	NA	NA	141.3
		recyc.br.	28.0	123.0	543.5	47100	NA	NA	4.4
		comb.back	37.6	130.0	204.3	26800	NA	NA	1.6
		comb.reg	40.0	136.0	321.7	42900	NA	NA	2.4
		comb.rinse	10.0	24.0	213.0	25400	NA	NA	8.9
		rega14	36.4	198.0	256.5	38700	NA	NA	1.3
		regb12	35.6	152.0	617.4	51000	NA	NA	4.1
		regb17	24.4	76.0	391.3	53800	NA	NA	5.1
		rina3	1.1	6.0	121.7	14700	NA	NA	20.3
		ser0	0.9	2.6	147.8	13000	NA	NA	57.7
		ser10	0.8	2.4	113.0	12900	NA	NA	47.1
		prod120	1.0	3.4	113.0	12700	0.5	8.4	33.2
210	a	feed	27.2	51.6	99.6	11400	0.4	7.5	1.9
		fr.brine	2.2	6.4	837.0	55900	NA	NA	130.8
		recyc.br.	30.0	126.0	510.9	47200	NA	NA	4.1
		comb.reg	26.0	130.0	563.0	45000	NA	NA	4.3
		rega14	36.5	192.0	320.0	38000	NA	NA	1.7
		regb15	32.5	450.0	584.8	49000	NA	NA	1.3
		rinb4	13.4	32.0	773.9	56400	NA	NA	24.2
		rinb15	0.6	1.2	202.0	18200	NA	NA	168.3
		ser0	0.5	1.0	154.8	14400	NA	NA	148.8
		ser10	0.5	1.0	158.9	13800	NA	NA	158.9
		ser120	0.4	1.2	153.8	13300	NA	NA	124.1
		prod120	0.5	1.0	158.9	13300	1.5	8.7	152.8

APPENDIX C

SERIES 300 ION-EXCHANGE BENCH UNIT TESTS

Resin Capacity
Operation Parameters and Results

Bench Unit Series 300

RESIN CAPACITY TEST - SUMMARY

Test No.	Resin Capacity Test No.	Process Water Influent Calcium (meq/l)	Process Water Influent Total (meq/l)	Process Water Influent Sodium (meq/l)	Average Effluent Calcium (meq/l)	Average Effluent Total (meq/l)	Resin Capacity Calcium (meq/l of resin)	Resin Capacity Total (meq/l of resin)	Regen. Sodium Thruput	RATIO Influent TH:Ca	RATIO Influent Na:TH	RATIO Effluent TH:Ca	RATIO Resin Cap. TH:Ca
301	1	35.00	91.60	196.51	1.15	10.01	0.447	1.089	15.88	2.6	2.1	8.7	2.4
302	2	31.00	94.66	196.51	3.88	13.95	0.374	1.112	11.40	3.1	2.1	3.6	3.0
303	3	35.40	89.00	209.61	0.96	7.61	0.494	1.168	10.53	2.5	2.4	7.9	2.4
304	4	26.40	50.80	122.27	0.44	7.24	0.898	1.507	10.56	1.9	2.4	16.5	1.7
305	5	26.26	52.14	117.90	0.19	5.16	1.057	1.906	16.36	2.0	2.3	27.2	1.8
306	6	28.92	52.80	109.17	0.45	3.79	0.884	1.522	11.01	1.8	2.1	8.4	1.7
307	7	31.80	54.20	78.60	0.62	5.15	1.077	1.694	9.34	1.7	1.5	8.3	1.6
308	8	28.00	53.00	480.35?	0.75	5.75	0.844	1.463	10.34	1.9	0.0	7.7	1.7
309	9	22.00	40.90	78.60	0.05	0.12	0.742	1.378	NA	1.9	1.9	2.4	1.9
310	10	21.50	39.90	74.24	0.26	9.23	1.198	1.730	NA	1.9	1.9	35.5	1.4
311	11	25.20	41.44	96.07	0.71	2.36	1.052	1.680	NA	1.6	2.3	3.3	1.6
312	12	23.06	42.26	104.80	1.32	3.86	0.847	1.495	9.89	1.8	2.5	2.9	1.8
313	13	27.40	41.74	74.24	1.89	6.84	1.041	1.423	13.61	1.5	1.8	3.6	1.4

? Sodium analysis noted questionable by lab.

Test: Series 300 Resin capacity test 1

Date: Sept. 12, 1985

Purpose: Determine resin capacity

Influent process water: Marshpond

Regenerant brine:
- Type: Rotating Evaporator Disk
- Temperature (C): NA
- Concentration (%) NA

Hardness Leakage: Service product water (analysed during event)

Time	Thruput (bv)	Calcium (meq/l)	Total (meq/l)
5	1.76	1.76	NA
10	2.52	1.36	NA
22	4.36	1.20	NA
35	6.36	1.24	2.92
50	8.66	1.24	2.92
80	13.26	1.56	NA
110	17.86	2.28	44.80

Resin data:
- Type: Duolite C 20; resin taken from colunm A of main unit 1
- Depth (cm)(during service) 152
- Volume (liters) : 7.0 (= 1 bed volume)

Operating Conditions:

Event	Input	Output	Duration (min)	Thruput (liters)	Volume (bv)	Average Flow Rate (l/min)	Average Flow Rate (bv/min)	Bed Expansion (%)
Regeneration A	Fr. Regenerant	Waste	10	9.5	1.37	1.0	0.137	
Regeneration B	Fr. Regenerant	Sp. Regenerant	30	28.7	4.13	1.0	0.138	see notes
Regeneration C	Fr. Regenerant	Sp. Regenerant	10	6.5	0.94	0.7	0.094	37
Drain		Waste						
Rinse A	Feed	Waste	5	3.3	0.48	0.7	0.095	
Rinse B	Feed	Waste	5	5.6	0.81	1.1	0.161	
Service	Feed	Product	115	122.9	17.64	1.1	0.153	

Service Performance Summary:

	Influent (meq/l)	Average Effluent (meq/l)	Difference (meq/l)	Removal (%)	Resin Capacity (eq/l of resin)
Calcium	35.0	1.5	33.5	96	0.447
Total Hardness	91.6	10.0	81.6	89	1.089
Sodium	196.5	326.0	-129.5		

Regeneration Performance Summary:

	Brine Influent (meq/l)	Total Thruput (eq/l of resin)	Average Effluent (meq/l)	Difference (inf-eff) (meq/l)	Resin Absorbance (eq/l of resin)
Calcium	36.6	--	40.2	-3.6	-0.020
Total Hardness	90.6	--	115.9	-25.3	-0.140
Sodium	2882.1	15.9	1742.8	1139.3	6.275

Test: Resin capacity test 1

CHEMICAL ANALYSES:	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
PW Influent	35.0	91.6	196.5	21000	3.6	7.6	91.7	145.7	1.4
Fr. Brine	36.6	90.6	2882.1	108000	NA	NA	859.8	624.6	2.0
Used Brine	34.0	106.4	1615.7	106000	NA	NA	916.0	1145.1	0.9
Product 1at Ser 85	1.4	7.2	327.5	23000	2.2	8.3	98.7	187.4	1.2
Product 2at Ser 115	1.6	13.2	401.7	23000	2.2	8.1	91.7	145.7	1.8

INSTANTANEOUS EFFLUENT SAMPLES:

Regen.	Thruput (bv)	Regen. time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.45	10	46.0	144.0	1310.0	95000	831.9	676.7	1.0
	1.41	17	50.4	145.4	1528.4	100000	831.9	676.7	1.1
	2.37	24	37.6	108.0	1615.7	105000	958.8	728.7	1.0
	3.33	31	38.0	106.6	1746.7	106000	NA	NA	NA
	4.30	38	34.4	101.4	2052.4	108000	NA	NA	NA
	5.04	45	36.4	101.2	1790.4	108000	NA	NA	NA
	5.51	50	36.0	96.6	2096.1	109000	930.6	1041.0	1.1

Service	Thruput (bv)	Service time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.66	0	8.4	18.9	759.8	51000	NA	NA	310.2	333.1	1.2
	1.27	4	1.3	3.7	366.8	24000	NA	NA	84.6	208.2	1.3
	1.73	7	1.2	3.0	292.6	24000	NA	NA	98.7	229.0	0.9
	2.19	10	1.2	2.9	279.5	23000	NA	NA	84.6	187.4	1.0
	2.65	13	1.2	2.9	279.5	24000	NA	NA	NA	NA	NA
	4.49	25	1.2	2.9	358.1	23000	NA	NA	NA	NA	NA
	8.33	50	1.2	3.0	336.2	23000	NA	NA	NA	NA	NA
	12.93	80	1.7	27.0	266.4	23000	NA	NA	NA	NA	NA
	18.30	115	3.2	64.0	279.5	21000	1.9	NA	98.7	166.6	1.3

Notes:

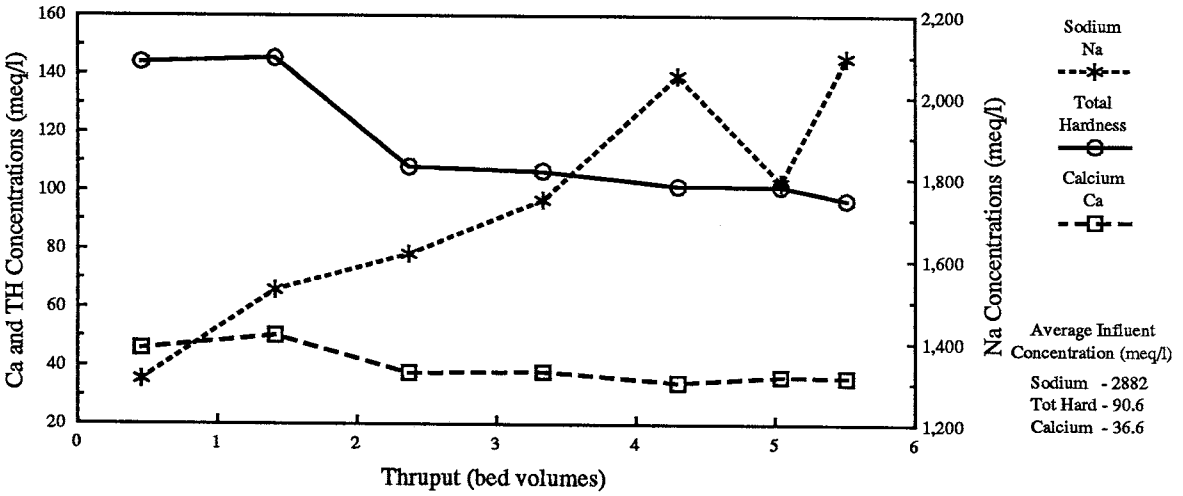
1. Column lost resin during event
2. All flow rates comparible to those of the main units
3. Fresh brine was used during entire regeneration cycle
4. Cycle ends when calcium leakage = 2.0 meq/l. Average effluent values reflect this.

Major Cation Concentrations

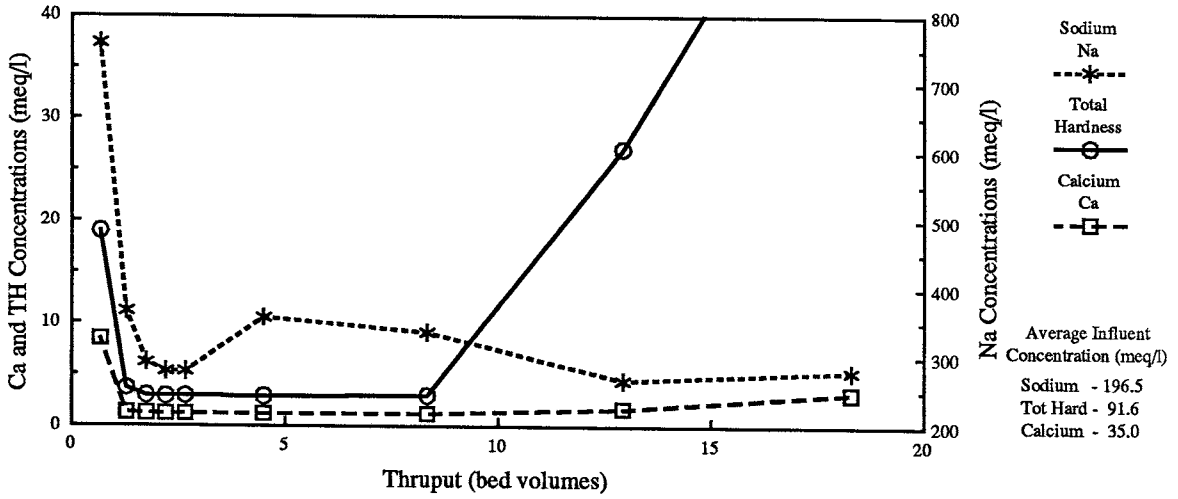
IX Bench Unit

Resin Capacity Test 1

IX Regeneration Effluent



IX Service Effluent



Test: Series 300 Resin capacity test 2

Date: Sept. 13, 1985

Purpose: Determine resin capacity

Influent process water: Marshpond

Regenerant brine:
- Type: Rotating eveporator disk
- Temperature (C): 18
- Concentration (%) NA

Resin data:
- Type: Resin taken from column A of main unit 2
- Depth (cm)(during service) 142.2
- Volume (liters) : 6.5 (= 1 bed volume)

Hardness Leakage Service product water (analysed during test)

Time	Thruput (bv)	Calcium (meq/l)	Total (meq/l)
5.0	1.6	1.9	4.0
10.0	2.4	1.7	3.6
20.0	4.1	1.6	3.5
30.0	5.7	1.6	3.5
40.0	7.3	1.7	3.7
50.0	9.0	1.6	3.8
60.0	10.6	1.8	4.8
80.0	13.9	2.7	35.2
90.0	15.6	3.1	NA

Operating Conditions:

Event	Input	Output	Duration (min.)	Thruput (liters)	Volume (bv)	Average Flow Rate (l/min.)	Average Flow Rate (bv/min.)	Bed Expansion (%)
Regeneration A	Fr. Regenerant	Waste	14	13.5	2.1	1.0	0.1	
Regeneration B	Fr. Regenerant	Sp. Regenerant	26	24.7	3.8	1.0	0.1	
Regeneration C	Fr. Regenerant	Sp. Regenerant	10	7.1	1.1	0.7	0.1	53.6
Drain		Waste						
Rinse A	Feed	Waste	5	5.7	0.9	1.1	0.2	
Rinse B	Feed	Waste	4	3.9	0.6	1.0	0.2	
Service	Feed	Product	100	107.0	16.4	1.1	0.2	

Service Performance Summary:

	Influent (meq/l)	Average Effluent (meq/l)	Difference (meq/l)	Removal (%)	Resin Capacity (eq/l of resin)
Calcium	31.0	3.9	27.1	87.5	0.4
Total Hardness	94.7	14.0	80.7	85.3	1.1
Sodium	196.5	318.2	-121.7		

Regeneration Performance Summary:

	Brine Influent (meq/l)	Total Thruput (eq/l of resin)	Average Effluent (meq/l)	Difference (inf-eff) (meq/l)	Resin Absorbance (eq/l of resin)
Calcium	28.0	--	36.5	-8.5	-0.1
Total Hardness	81.4	--	176.8	-95.4	-0.6
Sodium	1921.4	11.4	1731.0	190.4	1.1

Test: Resin capacity test 2

CHEMICAL ANALYSES:	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
PW Influent	31.0	94.7	196.5	22700	2.3	7.5	98.7	187.4	1.1
Product 1at Ser60	2.9	7.6	314.4	25600	1.5	7.9	126.9	249.8	0.9
Product 2at Ser100	3.1	22.2	314.4	23200	1.3	7.8	98.7	208.2	1.1
Fr. Brine	28.0	81.4	1921.4	112800	NA	NA	930.6	936.9	1.1
Used Brine	31.0	131.0	1572.1	104700	NA	NA	916.5	832.8	1.0

INSTANTANEOUS EFFLUENT SAMPLES:

Regen.	Thruput (bv)	Regen. time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.45	10	35.6	296.6	1572.1	92800	803.4	832.8	1.2
	1.48	17	34.0	214.3	1528.4	102300	902.1	832.8	1.0
	2.80	26	41.4	182.7	1659.4	107000	916.5	936.9	1.0
	3.53	31	40.6	154.0	1877.7	107800	NA	NA	NA
	4.55	38	34.6	128.0	1790.4	120600	NA	NA	NA
	5.39	45	34.6	126.6	1965.1	120600	NA	NA	NA
	5.93	50	37.0	114.3	1877.7	110300	1071.3	884.9	1.0

Service	Thruput (bv)	Service time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.77	0	40.7	107.4	1877.7	110100	NA	NA	986.7	832.8	1.1
	1.43	4	30.9	8.0	362.4	30900	NA	NA	126.9	208.2	1.2
	1.92	7	3.1	3.8	296.9	24200	NA	NA	91.7	208.2	1.0
	2.41	10	1.8	3.7	283.8	23100	NA	NA	98.7	187.4	1.0
	2.91	13	1.6	3.8	292.6	22300	NA	NA	NA	NA	NA
	4.88	25	1.6	3.7	275.1	22400	NA	NA	NA	NA	NA
	8.99	50	1.6	4.0	292.6	22400	NA	NA	NA	NA	NA
	13.92	80	1.8	35.5	244.5	22200	NA	NA	NA	NA	NA
	17.21	100	2.8	73.9	205.2	20900	1.2	7.7	91.7	187.4	1.0

Notes:

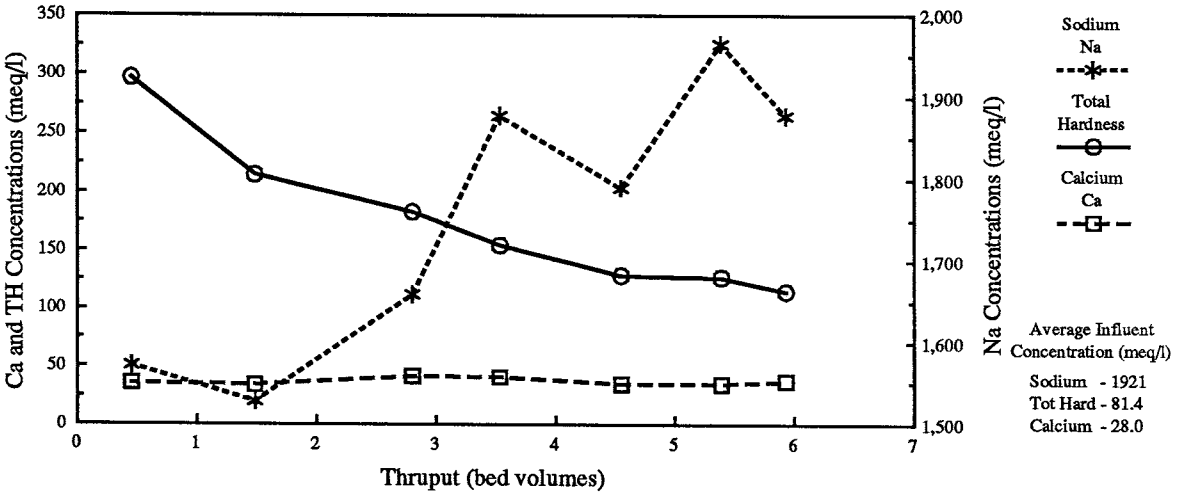
1. Resin level at 147cm. at beginning of test.
2. Lost resin during regenerations A and B. Resin level at end of service at142cm..
3. Stored resin in 12% NaCl brine.

Major Cation Concentrations

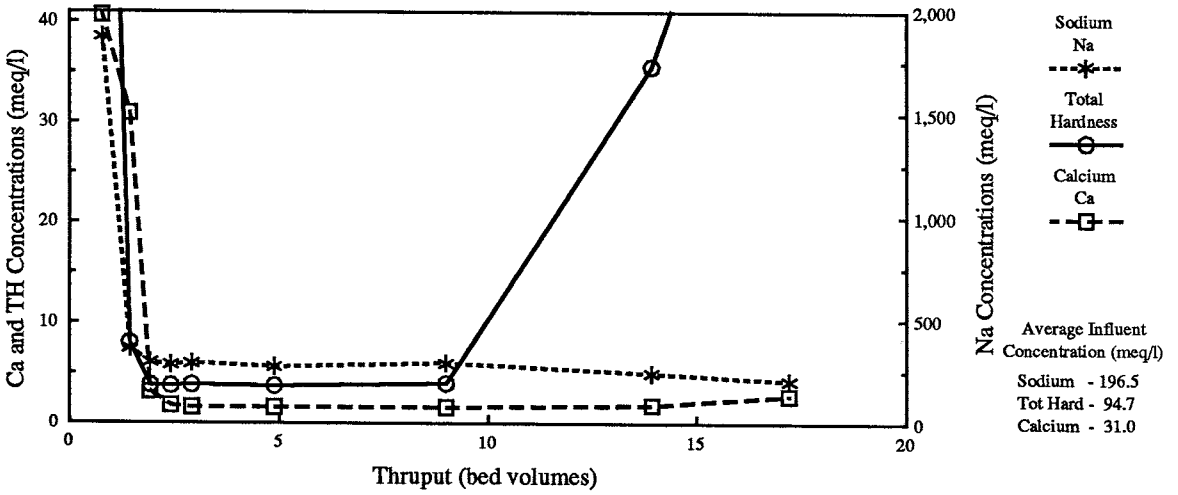
IX Bench Unit

Resin Capacity Test 2

IX Regeneration Effluent



IX Service Effluent



Test: Series 300 Resin capacity test 3

Date: Sept. 18, 1985

Purpose: Determine resin capacity

Hardness Leakage: Service product water

Time	Thruput (bv)	Calcium (meq/l)	Total (meq/l)
5.0	1.7	0.7	NA
35.0	6.7	0.7	1.1
50.0	9.2	0.8	1.2
60.0	10.9	0.9	2.1
80.0	14.3	1.3	29.0
100.0	17.6	2.8	>60

Influent process water: Marshpond

Regenerant brine:
- Type: Sodium Chloride
- Temperature (C): 17
- Concentration (%) NA

Resin data:
- Type: Resin taken from column A of main unit 1
- Depth (cm)(during service) 142.2
- Volume (liters) : 6.5 (= 1 bed volume)

Operating Conditions:

Event	Input	Output	Duration (min.)	Thruput (liters)	Volume (bv)	Average Flow Rate (l/min.)	Average Flow Rate (bv/min.)	Bed Expansion (%)
Regeneration A	Fr. Regenerant	Waste	50	34.7	5.3	0.7	0.1	33.9
Regeneration B	none							
Regeneration C	none							
Drain		Waste						
Rinse A	Feed	Waste	5	5.1	0.8	1.0	0.2	
Rinse B	Feed	Waste	5	5.1	0.8	1.0	0.2	
Service	Feed	Product	100	109.2	16.8	1.1	0.2	

Service Performance Summary:

	Influent (meq/l)	Average Effluent (meq/l)	Difference (meq/l)	Removal (%)	Resin Capacity (eq/l of resin)
Calcium	35.4	1.0	34.4	97.3	0.5
Total Hardness	89.0	7.6	81.4	91.5	1.2
Sodium	209.6	232.5	-22.9		

Regeneration Performance Summary:

	Brine Influent (meq/l)	Total Thruput (eq/l of resin)	Average Effluent (meq/l)	Difference (inf-eff) (meq/l)	Resin Absorbance (eq/l of resin)
Calcium	4.0	--	44.3	-40.3	-0.2
Total Hardness	6.0	--	83.0	-77.0	-0.3
Sodium	2445.4	10.5	2146.2	299.2	1.3

Test: Resin capacity test 3

CHEMICAL ANALYSES:

	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
PW Influent	35.4	89.0	209.6	22100	1.4	7.7	84.6	156.2	1.4
Product 1	18.8	24.5	235.8	24600	0.9	8.1	105.8	177.0	1.0
Product 2	2.4	18.2	227.1	23700	1.0	8.1	105.8	166.6	0.9
Fr. Brine	4.0	6.0	2445.4	151200	NA	NA	2537.2	3.1	1.0
Used Brine	44.2	81.6	2096.1	137400	NA	NA	1973.5	31.2	1.1

INSTANTANEOUS EFFLUENT SAMPLES:

Regen.	Thruput (bv)	Regen. time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.03	10	28.0	72.0	759.8	66200	676.8	14.6	1.2
	0.78	17	64.6	129.0	2139.7	148800	2114.5	9.4	1.1
	1.53	24	58.0	106.8	2227.1	150200	2283.6	7.3	1.0
	2.28	31	48.6	82.0	2314.4	151500	NA	NA	NA
	3.03	38	32.0	64.0	2401.7	152200	NA	NA	NA
	3.77	45	32.0	50.6	2314.4	152200	NA	NA	NA
	4.31	50	27.4	42.4	2358.1	150200	2537.2	5.7	1.0

Service	Thruput (bv)	Service time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.85	0	1.3	2.1	296.9	29200	NA	NA	162.2	182.2	0.9
	1.52	4	0.7	1.3	240.2	24000	NA	NA	70.5	177.0	1.0
	2.03	7	0.7	1.2	238.0	NA	NA	NA	NA	NA	NA
	2.53	10	0.7	1.1	235.8	23200	NA	NA	84.6	187.4	0.9
	3.03	13	0.7	1.1	253.3	23100	NA	NA	NA	NA	NA
	5.05	25	0.7	1.1	244.5	23000	NA	NA	NA	NA	NA
	9.25	50	0.8	1.3	227.1	23000	NA	NA	NA	NA	NA
	14.28	80	1.5	26.0	214.0	22300	NA	NA	NA	NA	NA
	20.16	115	4.8	70.0	174.7	21500	0.9	NA	91.7	177.0	0.9

Notes:

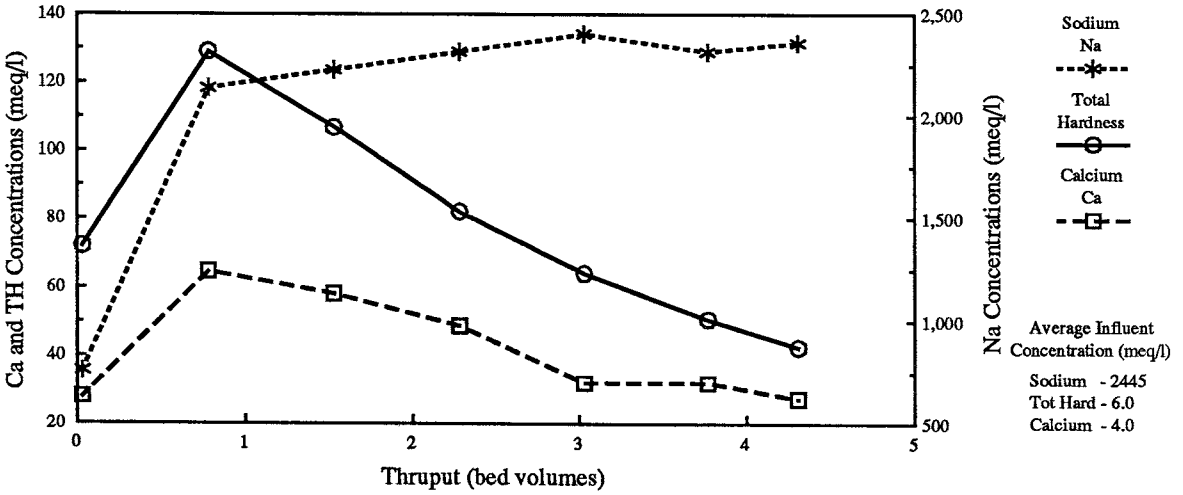
1. Resin stored in 12% NaCl brine.

Major Cation Concentrations

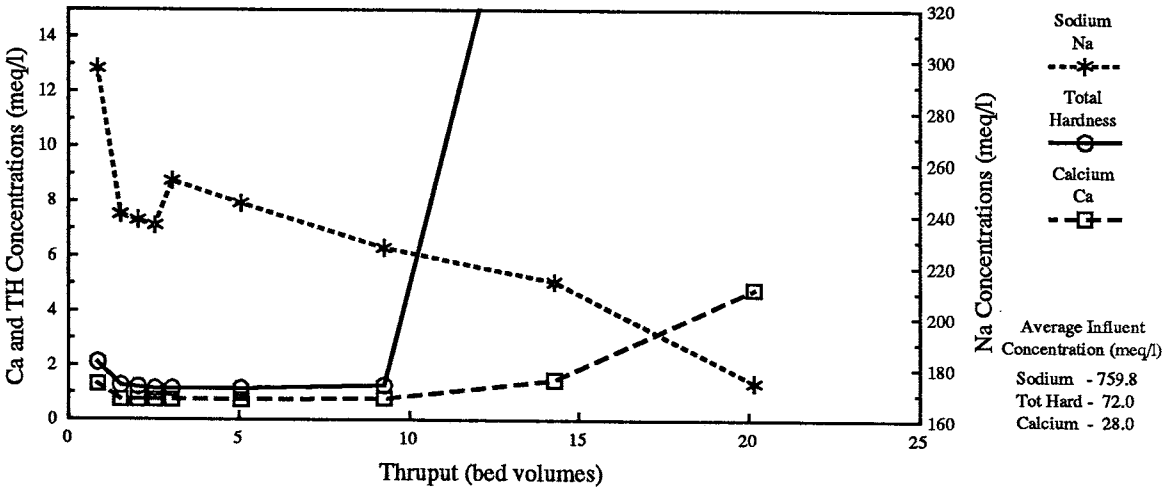
IX Bench Unit

Resin Capacity Test 3

IX Regeneration Effluent



IX Service Effluent



Test: Series 300 Resin capacity test 4

Date: Sept. 19, 1985

Purpose: Determine resin capacity

Influent process water: Filtered clarifier

Regenerant brine:
- Type: Sodium chloride
- Temperature (C): 17
- Concentration (%) 12.0

Resin data:
- Type: Resin taken from column A of main unit 1
- Depth (cm)(during service) 134.6
- Volume (liters) : 6.2 (= 1 bed volume)

Hardness Leakage: Service product water (analysed during event)

Time	Thruput (bv)	Calcium (meq/l)	Total (meq/l)
5.0	1.2	0.3	0.5
10.0	2.0	0.2	0.4
20.0	2.9	0.2	0.4
50.0	4.6	0.3	0.6
70.0	9.8	0.4	0.7
90.0	13.2	0.4	0.6
110.0	16.7	0.4	0.6
130.0	20.1	0.4	0.7
140.0	23.6	0.4	0.6
160.0	25.3	0.4	0.7
170.0	28.7	0.5	1.4
190.0	30.4	0.9	32.4
205.0	33.9	1.5	46.4

Operating Conditions:

Event	Input	Output	Duration (min.)	Thruput (liters)	Volume (bv)	Average Flow Rate (l/min.)	Average Flow Rate (bv/min.)	Bed Expansion (%)
Regeneration A	Fr. Regenerant	Waste	50	36.1	5.9	0.7	0.1	45.3
Regeneration B	none							
Regeneration C	none							
Drain		Waste						
Rinse A	Feed	Waste	5	2.6	0.4	0.5	0.1	
Rinse B	Feed	Waste	4	4.2	0.7	1.1	0.2	
Service	Feed	Product	205	217.2	35.3	1.1	0.2	

Service Performance Summary:

	Influent (meq/l)	Average Effluent (meq/l)	Difference (meq/l)	Removal (%)	Resin Capacity (eq/l of resin)
Calcium	26.4	0.4	26.0	98.3	0.9
Total Hardness	50.8	7.2	43.6	85.7	1.5
Sodium	122.3	189.9	-67.7		

Regeneration Performance Summary:

	Brine Influent (meq/l)	Total Thruput (eq/l of resin)	Average Effluent (meq/l)	Difference (inf-eff) (meq/l)	Resin Absorbance (eq/l of resin)
Calcium	3.2	--	55.5	-52.3	-0.2
Total Hardness	5.7	--	97.1	-91.4	-0.4
Sodium	2227.1	10.6	2993.7	-766.6	-3.6

Test: Resin capacity test 4

CHEMICAL ANALYSES:

	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
PW Influent	26.4	50.8	122.3	13300	0.1	7.3	47.9	88.5	1.5
Product 1at Ser145	0.4	0.7	187.8	13300	0.4	7.5	56.4	104.1	1.2
Product 2at Ser205	0.6	7.8	183.4	13200	0.1	7.4	50.8	104.1	1.2
Fr. Brine	3.2	5.7	2227.1	150600	1.0	0.0	2396.2	2.1	0.9
Used Brine	70.4	127.7	3100.4	171700	0.0	0.0	2819.2	10.4	1.2

INSTANTANEOUS EFFLUENT SAMPLES:

Regen.	Thruput (bv)	Regen. time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.86	17	90.4	175.5	2620.1	171600	2819.2	4.2	1.0
	1.69	24	79.5	143.7	3362.4	175400	2960.2	5.2	1.2
	2.51	31	58.5	99.5	3100.4	177500	NA	NA	NA
	3.33	38	44.4	68.7	3231.4	178100	NA	NA	NA
	4.15	45	36.5	56.3	3144.1	177200	NA	NA	NA
	4.74	50	32.8	46.8	2838.4	177200	2678.2	5.2	1.1

Service	Thruput (bv)	Service time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.32	0	30.0	45.2	3013.1	178800	NA	NA	2819.2	2.1	1.1
	1.01	4	0.5	0.8	266.4	20800	NA	NA	126.9	135.3	1.0
	1.69	8	0.2	0.3	200.9	15200	NA	NA	63.5	108.3	1.2
	2.04	10	0.2	0.3	196.5	14800	NA	NA	62.0	108.3	1.2
	2.55	13	0.2	0.3	187.8	14600	NA	NA	NA	NA	NA
	4.62	25	0.2	0.3	205.2	14500	NA	NA	NA	NA	NA
	8.92	50	0.3	0.5	179.0	13600	NA	NA	NA	NA	NA
	14.09	80	0.3	0.6	200.9	13100	NA	NA	NA	NA	NA
	20.11	115	0.4	0.6	192.1	13000	NA	NA	45.1	108.3	1.3
	23.55	135	0.4	0.6	205.2	12400	0.2	NA	45.1	108.3	1.3
	29.58	170	6.1	18.8	192.1	13300	NA	NA	NA	NA	NA
	33.02	190	0.8	30.2	148.5	12200	NA	NA	33.8	104.1	1.3
	35.60	205	1.4	44.2	144.1	11600	NA	NA	47.9	104.1	1.2

Notes:

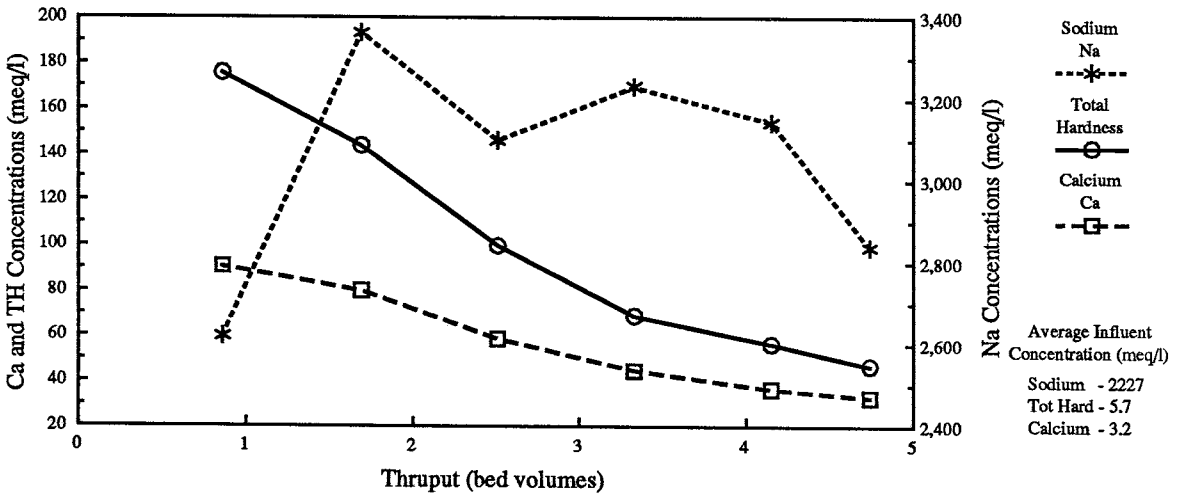
1. Drained pw tank to 20gal. from 40gallons at SER145. Product205 taken from pw tank at 37gallons..
2. Resin stored in 12% NaCl brine.

Major Cation Concentrations

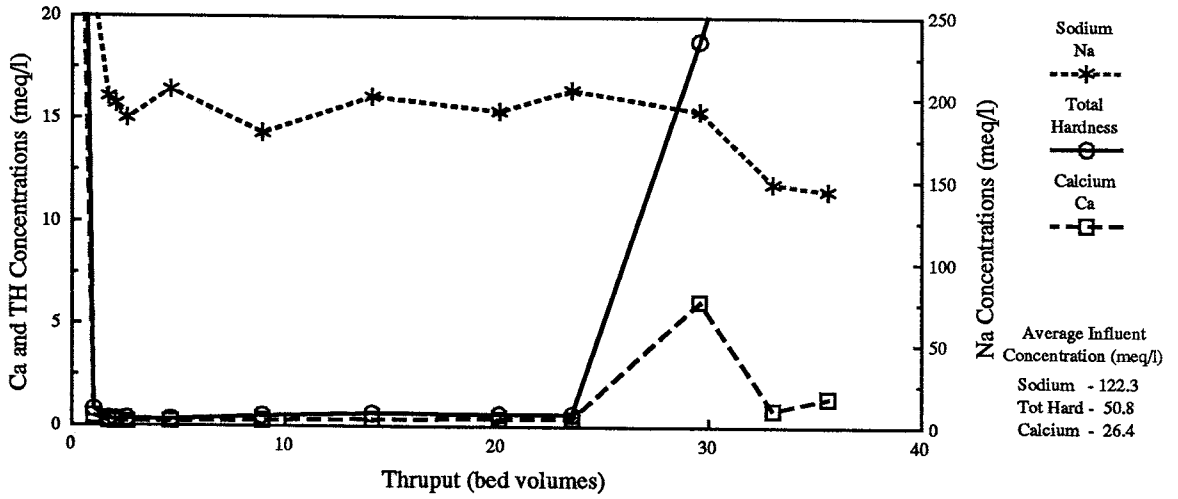
IX Bench Unit

Resin Capacity Test 4

IX Regeneration Effluent



IX Service Effluent



Test: Series 300 Resin capacity test 5

Date: Sept. 20, 1985

Purpose: Determine resin capacity

Influent process water: Filtered clarifier

Regenerant brine:
- Type: Sodium chloride
- Temperature (C): 19
- Concentration (%) 12.0

Resin data:
- Type: Resin taken from column A of main unit 2
- Depth (cm)(during service) 134.6
- Volume (liters) : 6.2 (= 1 bed volume)

Hardness Leakage: Service product water (analysed during test)

Time	Thruput (bv)	Calcium (meq/l)	Total (meq/l)
5.0	1.2	0.1	0.2
14.0	2.8	0.1	0.2
25.0	4.7	0.1	0.2
50.0	9.2	0.1	0.2
80.0	14.6	0.1	0.2
110.0	20.0	0.1	0.2
140.0	25.4	0.1	0.2
180.0	32.6	0.3	3.0
190.0	34.4	0.3	10.8
200.0	36.2	0.6	26.2
210.0	38.0	0.9	37.2
220.0	39.8	1.4	44.8
230.0	41.6	2.2	45.6

Operating Conditions:

Event	Input	Output	Duration (min.)	Thruput (liters)	Volume (bv)	Average Flow Rate (l/min.)	Average Flow Rate (bv/min.)	Bed Expansion (%)
Regeneration A	Fr. Regenerant	Waste	50	34.5	5.6	0.7	0.1	41.5
Regeneration B	none							
Regeneration C	none							
Drain		Waste						
Rinse A	Feed	Waste	5	2.6	0.4	0.5	0.1	
Rinse B	Feed	Waste	4	3.8	0.6	1.0	0.2	
Service	Feed	Product	230	254.4	41.3	1.1	0.2	

Service Performance Summary:

	Influent (meq/l)	Average Effluent (meq/l)	Difference (meq/l)	Removal (%)	Resin Capacity (eq/l of resin)
Calcium	26.3	0.2	26.1	99.3	1.1
Total Hardness	52.1	5.2	47.0	90.1	1.9
Sodium	117.9	116.0	1.9		

Regeneration Performance Summary:

	Brine Influent (meq/l)	Total Thruput (eq/l of resin)	Average Effluent (meq/l)	Difference (inf-eff) (meq/l)	Resin Absorbance (eq/l of resin)
Calcium	3.4	--	26.8	-23.5	-0.1
Total Hardness	6.2	--	33.5	-27.3	-0.2
Sodium	2925.8	16.4	2649.4	276.4	1.5

Test: Resin capacity test 5

CHEMICAL ANALYSES:	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
PW Influent	26.3	52.1	117.9	15300	<.1	7.6	56.4	124.9	1.1
Product 1 at Ser160	0.1	0.2	113.5	12800	<.1	7.8	45.1	66.6	1.0
Product 2 at Ser230	0.5	13.0	96.1	12500	<.1	7.6	47.9	83.3	0.8
Fr.Brine	3.4	6.2	2925.8	152300	NA	NA	2537.2	1.9	1.2
Used Brine	31.3	39.2	1965.1	151700	NA	NA	2537.2	20.8	0.8

INSTANTANEOUS EFFLUENT SAMPLES:

Regen.	Thruput (bv)	Regen. time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	1.11	10	36.7	48.4	2751.1	151200	NA	NA	2396.2	26.0	1.2
	2.12	19	34.4	43.8	2663.8	153100	NA	NA	2396.2	19.3	1.1
	2.68	24	31.5	38.8	2489.1	153900	NA	NA	2396.2	18.2	1.1
	3.46	31	27.1	32.0	2532.8	154600	NA	NA	NA	NA	NA
	4.25	38	23.0	27.5	2489.1	154000	NA	NA	NA	NA	NA
	5.03	45	20.7	24.5	2794.8	154100	NA	NA	NA	NA	NA
	5.59	50	28.0	32.2	2489.1	154600	NA	NA	2537.2	19.3	1.0

Service	Thruput (bv)	Service time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.26	0	0.5	0.8	292.6	31300	NA	NA	126.9	104.1	1.3
	0.98	4	0.2	0.3	170.3	14500	NA	NA	56.4	62.5	1.4
	1.51	7	0.1	0.2	144.1	13100	NA	NA	50.8	87.4	1.0
	2.05	10	0.1	0.2	139.7	12900	NA	NA	47.9	87.4	1.0
	2.59	13	0.1	0.2	148.5	12900	NA	NA	NA	NA	NA
	4.75	25	0.1	0.1	148.5	12800	NA	NA	NA	NA	NA
	9.24	50	0.1	0.2	126.6	12700	NA	NA	NA	NA	NA
	14.63	80	0.0	0.3	122.3	12700	NA	NA	NA	NA	NA
	20.92	115	0.1	0.1	113.5	12800	NA	NA	NA	NA	NA
	26.31	145	0.1	0.1	113.5	12800	NA	NA	NA	NA	NA
	32.60	180	0.1	4.7	109.2	12200	NA	NA	NA	NA	NA
	36.19	200	0.4	27.2	83.0	12000	NA	NA	45.1	72.9	0.9
	39.79	220	1.6	46.1	78.6	11600	NA	NA	47.9	79.1	1.0
	41.59	230	2.3	48.4	95.2	11600	NA	NA	45.1	66.6	1.3

Notes:

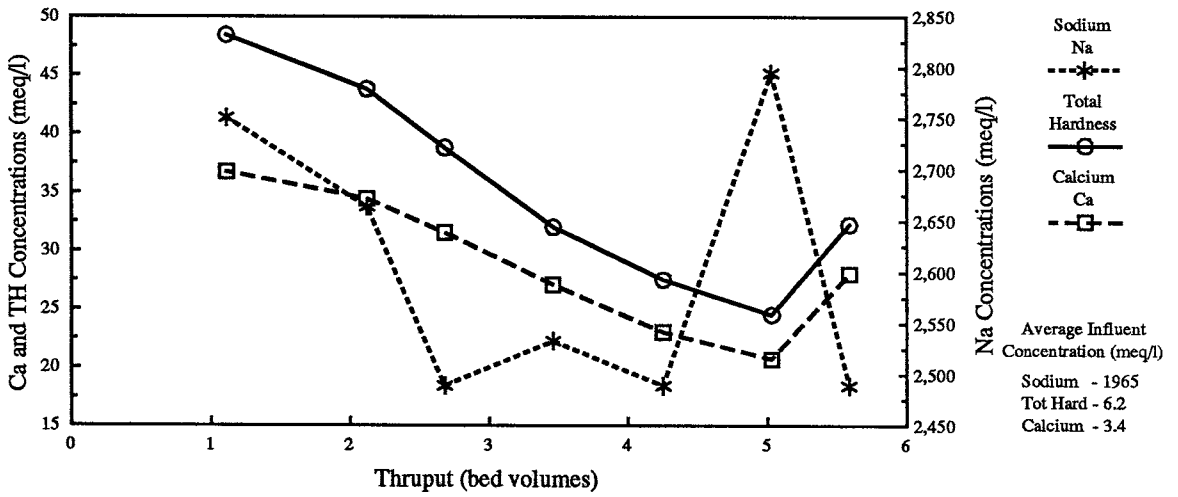
1. Drained PW tank from 45 gallons to 10 gallons at Ser160
2. PW tank at 28.75 gallons at Ser230
3. Resin level at 140cm. at beginning of test
4. Resin level at 142cm. at end of service.
5. Resin stored in 12% NaCl brine.

Major Cation Concentrations

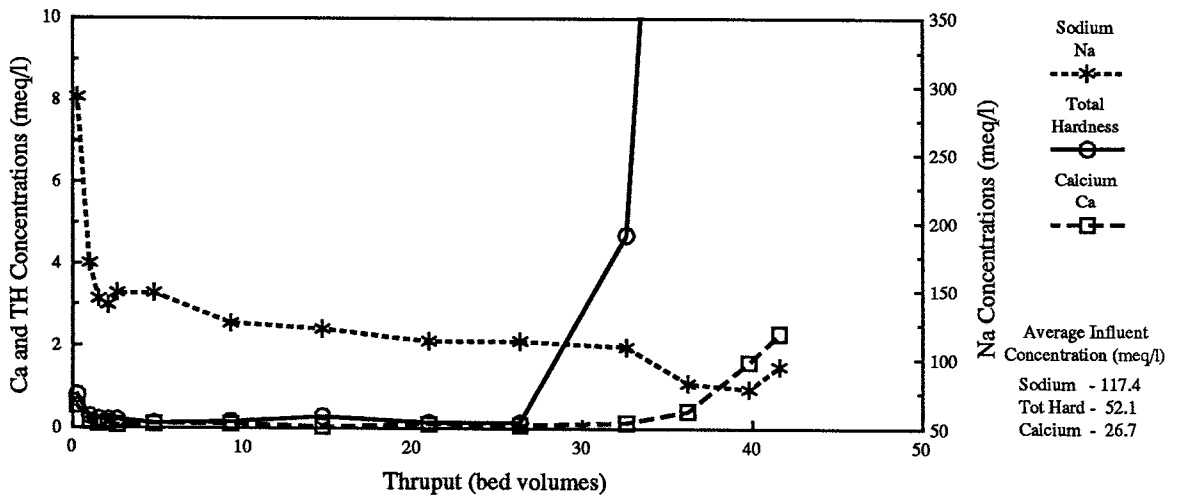
IX Bench Unit

Resin Capacity Test 5

IX Regeneration Effluent



IX Service Effluent



Test: Series 300 Resin capacity test 6

Date: Sept. 24, 1985

Purpose: Determine resin capacity

Influent process water: San Luis drain

Regenerant brine:
- Type: Sodium chloride
- Temperature (C): 23
- Concentration (%) 12.0

Resin data:
- Type: Resin taken from column A of main unit 2
- Depth (cm)(during service) 141.0
- Volume (liters) : 6.4 (= 1 bed volume)

Hardness Leakage: Service product water (analysed during event)

Time	Thruput (bv)	Calcium (meq/l)	Total (meq/l)
5.0	1.3	0.3	0.5
10.0	2.1	0.3	0.4
25.0	4.6	0.3	0.4
50.0	8.8	0.3	0.4
90.0	15.5	0.3	0.4
120.0	20.6	0.2	0.4
140.0	23.9	0.3	0.5
170.0	29.0	0.5	6.8
180.0	30.7	1.2	22.4
190.0	32.3	1.9	35.6

Operating Conditions:

Event	Input	Output	Duration (min.)	Thruput (liters)	Volume (bv)	Average Flow Rate (l/min.)	Average Flow Rate (bv/min.)	Bed Expansion (%)
Regeneration A	Fr. Regenerant	Waste	50	35.3	5.5	0.7	0.1	35.1
Regeneration B	none							
Regeneration C	none							
Drain		Waste						
Rinse A	Feed	Waste	5	2.8	0.4	0.6	0.1	
Rinse B	Feed	Waste	4	4.5	0.7	1.1	0.2	
Service	Feed	Product	190	205.8	31.9	1.1	0.2	

Service Performance Summary:

	Influent (meq/l)	Average Effluent (meq/l)	Difference (meq/l)	Removal (%)	Resin Capacity (eq/l of resin)
Calcium	28.9	0.5	28.5	98.4	0.9
Total Hardness	52.8	3.8	49.0	92.8	1.5
Sodium	109.2	161.6	-52.5		

Regeneration Performance Summary:

	Brine Influent (meq/l)	Total Thruput (eq/l of resin)	Average Effluent (meq/l)	Difference (inf-eff) (meq/l)	Resin Absorbance (eq/l of resin)
Calcium	3.7	--	144.8	-141.1	-0.6
Total Hardness	7.0	--	229.6	-222.6	-1.0
Sodium	2489.1	11.0	2399.5	89.6	0.4

Test: Resin capacity test 6

CHEMICAL ANALYSES:	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
PW Influent	28.9	52.8	109.2	14000	0.1	8.5	987.0	83.3	0.2
Product at Ser140	0.3	0.7	148.5	13200	0.3	8.7	46.5	83.3	1.2
Product at Ser190	0.8	7.3	152.8	13100	0.1	8.5	45.1	93.7	1.2
Fr.Brine	3.7	7.0	2489.1	150000	NA	NA	2537.2	1.5	1.0
Used brine	163.4	306.0	2227.1	148600	NA	NA	2537.2	7.3	1.1

INSTANTANEOUS EFFLUENT SAMPLES:

Regen.	Thruput (bv)	Regen. time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.05	10	316.6	610.6	1659.4	136800	NA	NA	2255.4	3.5	1.1
	0.81	17	214.7	338.0	2314.4	150000	NA	NA	2396.4	5.2	1.2
	1.58	24	173.3	264.6	2401.7	152400	NA	NA	2537.2	4.6	1.1
	2.34	31	119.3	182.6	2532.8	153500	NA	NA	NA	NA	NA
	3.11	38	86.7	116.6	2620.1	153800	NA	NA	NA	NA	NA
	3.88	45	63.7	87.9	2445.4	154100	NA	NA	NA	NA	NA
	4.43	50	54.5	69.2	2620.1	154800	NA	NA	2396.2	1.9	1.1

Service	Thruput (bv)	Service time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.41	0	4.8	9.6	786.0	50000	0.1	8.5	704.7	78.1	1.0
	1.08	4	0.4	0.8	192.1	16000	NA	NA	64.9	78.1	1.4
	1.59	7	0.4	0.6	157.2	13700	NA	NA	50.7	83.3	1.2
	2.09	10	0.3	0.5	144.1	13200	NA	NA	45.1	77.0	1.2
	2.60	13	0.3	0.8	139.7	13100	NA	NA	NA	NA	NA
	4.61	25	0.3	0.7	135.4	13100	NA	NA	NA	NA	NA
	8.81	50	0.3	0.7	165.9	13100	NA	NA	NA	NA	NA
	15.53	90	0.3	0.5	165.9	13200	NA	NA	NA	NA	NA
	23.94	140	0.3	0.6	157.2	13300	NA	NA	45.1	83.3	1.2
	28.98	170	0.7	9.0	139.7	13700	0.2	NA	45.1	83.3	1.2
	32.34	190	2.5	37.9	126.6	13200	0.2	NA	45.1	77.0	1.4

Notes:

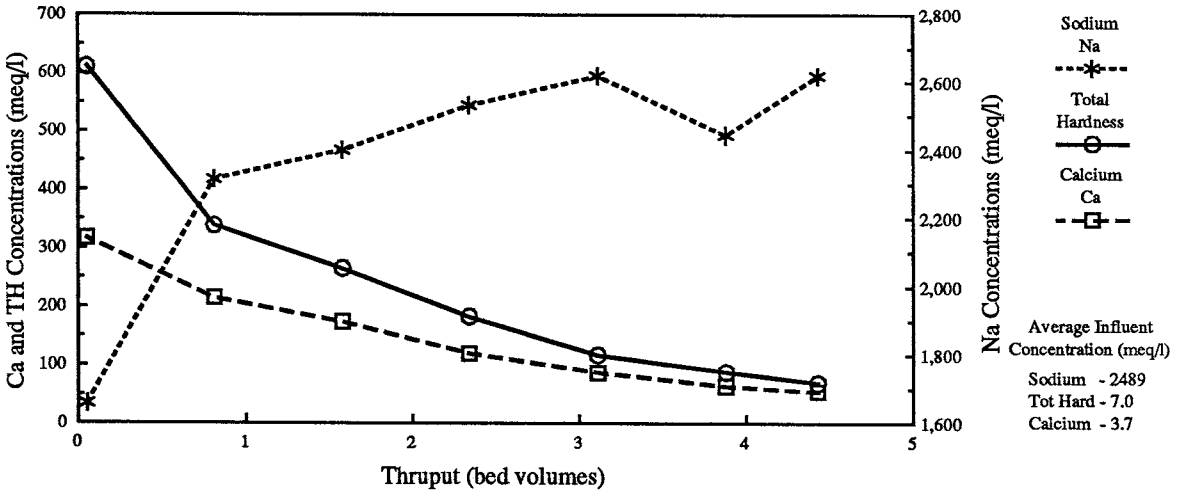
1. PW tank drained from 41 gallons to 10 gallons at Ser145
2. PW tank at about 26.75 gallons ar Ser190
3. Resin level at 137cm. at beginning of test.
4. Resin level at 141cm. at end of service.
5. Resin stored in 12% NaCl brine.

Major Cation Concentrations

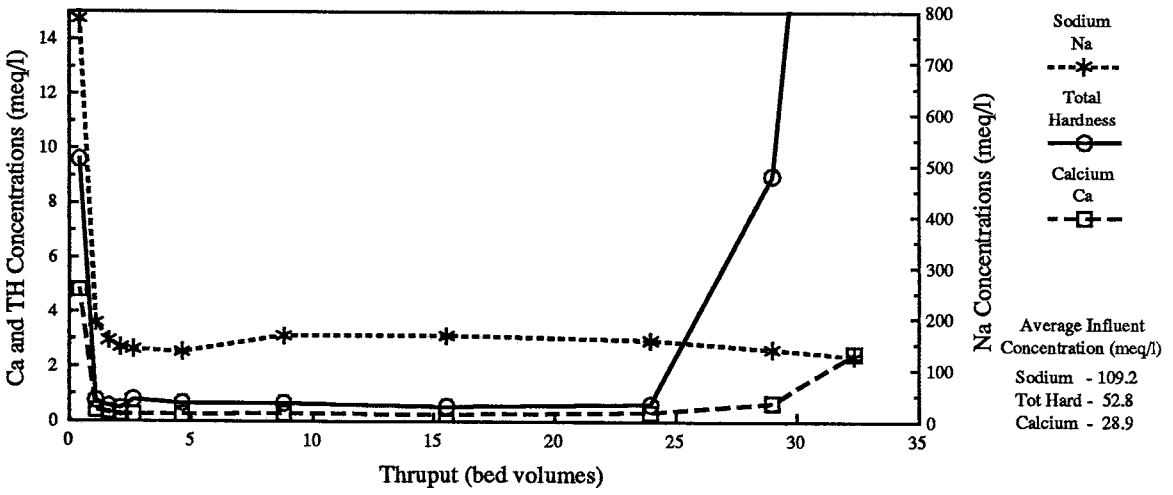
IX Bench Unit

Resin Capacity Test 6

IX Regeneration Effluent



IX Service Effluent



Test: Series 300 Resin capacity test 7

Date: Sept. 25, 1985

Purpose: Determine resin capacity

Influent process water: San Luis drain

Regenerant brine:
- Type: Sodium chloride
- Temperature (C): 21
- Concentration (%) 12.5

Resin data:
- Type: Resin taken from column A of main unit 1
- Depth (cm)(during service) 136.5
- Volume (liters) : 6.2 (= 1 bed volume)

Hardness Leakage: Service product water (analysed during test)

Time	Thruput (bv)	Calcium (meq/l)	Total (meq/l)
5.0	1.3	0.3	0.4
10.0	2.2	0.3	0.4
25.0	4.8	0.3	0.4
50.0	9.3	0.3	0.4
90.0	16.3	0.3	0.4
120.0	21.7	0.3	0.4
150.0	27.0	0.3	0.6
160.0	28.8	0.4	1.9
170.0	30.5	0.6	8.4
180.0	32.3	1.1	29.8
190.0	34.1	1.7	44.2
200.0	35.8	2.3	48.4

Operating Conditions:

Event	Input	Output	Duration (min.)	Thruput (liters)	Volume (bv)	Average Flow Rate (l/min.)	Average Flow Rate (bv/min.)	Bed Expansion (%)
Regeneration A	Fr. Regenerant	Waste	50	34.7	5.6	0.7	0.1	39.5
Regeneration B	none							
Regeneration C	none							
Drain		Waste						
Rinse A	Feed	Waste	5	2.8	0.4	0.6	0.1	
Rinse B	Feed	Waste	4	4.5	0.7	1.1	0.2	
Service	Feed	Product	200	221.2	35.4	1.1	0.2	

Service Performance Summary:

	Influent (meq/l)	Average Effluent (meq/l)	Difference (meq/l)	Removal (%)	Resin Capacity (eq/l of resin)
Calcium	31.8	0.6	31.2	98.0	1.1
Total Hardness	54.2	5.2	49.0	90.5	1.7
Sodium	78.6	135.9	-57.3		

Regeneration Performance Summary:

	Brine Influent (meq/l)	Total Thruput (eq/l of resin)	Average Effluent (meq/l)	Difference (inf-eff) (meq/l)	Resin Absorbance (eq/l of resin)
Calcium	3.5	--	89.0	-85.4	-0.4
Total Hardness	9.5	--	134.1	-124.6	-0.6
Sodium	2139.7	9.5	1992.4	147.3	0.7

Test: Resin capacity test 7

CHEMICAL ANALYSES:	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
PW Influent	31.8	54.2	78.6	12300	0.8	8.6	49.4	88.5	1.2
Product at Ser160	0.3	0.4	135.4	13100	0.4	8.8	46.5	85.4	1.0
Product at Ser184	0.5	5.8	126.6	12500	0.4	8.8	46.5	67.7	1.2
Fr.Brine	3.5	9.5	2139.7	155550	NA	NA	2396.4	1.5	0.9
UsedBrine	104.7	166.0	1921.4	151900	NA	NA	2396.4	2.1	0.9

INSTANTANEOUS EFFLUENT SAMPLES:

Regen.	Thruput (bv)	Regen. time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.01	10	170.0	247.3	1921.4	154400	NA	NA	2466.7	10.4	0.9
	0.79	17	121.3	214.0	2008.7	150900	NA	NA	2537.2	2.1	0.9
	1.56	24	96.0	143.3	2052.4	152200	NA	NA	2396.4	2.1	1.0
	2.34	31	86.0	122.7	1965.1	153200	NA	NA	NA	NA	NA
	3.12	38	64.0	88.7	2008.7	153400	NA	NA	NA	NA	NA
	3.90	45	48.5	63.9	2096.1	153700	NA	NA	NA	NA	NA
	4.46	50	40.5	53.6	1659.4	154000	NA	NA	2396.4	2.1	0.7

Service	Thruput (bv)	Service time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.40	0	10.5	14.5	873.4	78100	NA	NA	987.0	88.5	0.8
	1.11	4	0.4	0.4	135.4	13300	NA	NA	47.9	83.3	1.0
	1.64	7	0.3	0.4	131.0	12800	NA	NA	45.1	72.9	1.1
	2.17	10	0.3	0.3	131.0	13100	NA	NA	45.1	72.9	1.1
	2.71	13	0.3	0.3	139.7	13200	NA	NA	NA	NA	NA
	4.83	25	0.3	0.4	139.7	13200	NA	NA	NA	NA	NA
	9.26	50	0.3	0.4	131.0	13200	NA	NA	NA	NA	NA
	21.67	120	0.3	0.4	131.0	13200	NA	NA	NA	NA	NA
	28.75	160	0.4	1.5	131.0	13200	NA	NA	46.5	83.3	1.0
	32.30	180	2.2	28.9	104.8	12400	0.3	NA	39.5	85.4	1.1
	34.07	190	1.6	43.8	87.3	11600	0.3	8.7	42.3	67.7	1.2
	35.84	200	2.4	48.5	83.0	11500	0.3	8.6	46.5	88.5	1.0

Notes:

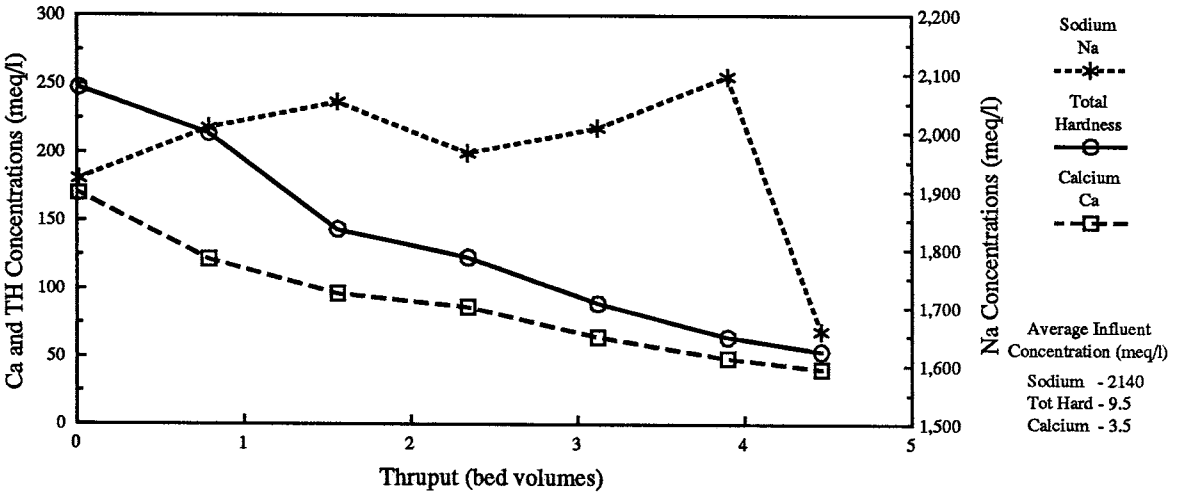
1. PW tank drained from 45 gallons to 10 gallons at Ser160.
2. Level in PW tank at Ser200, 21 gallons.
3. Resin level at beginning of test at 132cm. (12% NaCl brine).
4. Resin level at end of service at 137cm..

Major Cation Concentrations

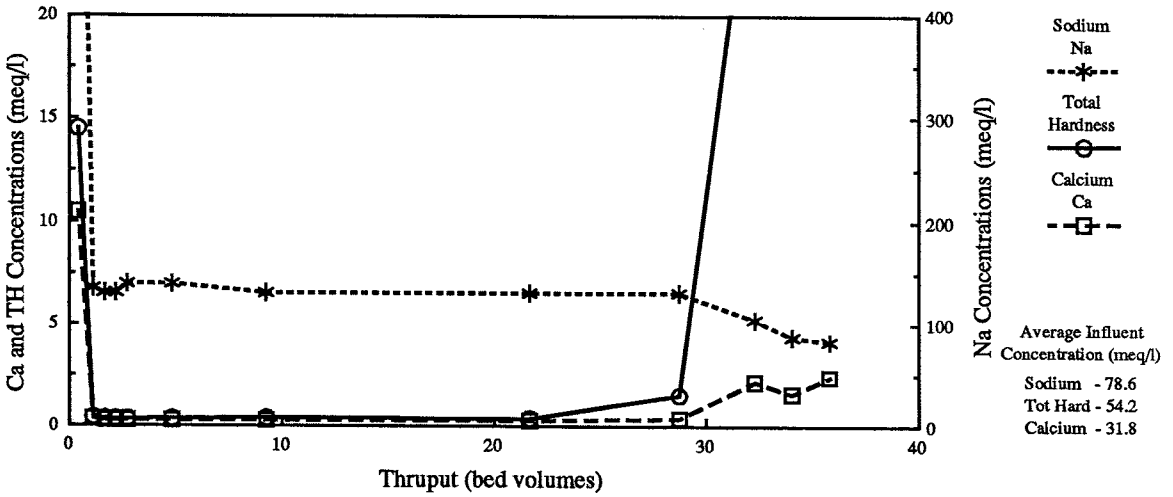
IX Bench Unit

Resin Capacity Test 7

IX Regeneration Effluent



IX Service Effluent



Test: Series 300 Resin capacity test 8

Date: Sept. 26, 1985

Purpose: Determine resin capacity

Influent process water: San Luis drain

Regenerant brine:
- Type: Rotating evaporator disk
- Temperature (C): 22
- Concentration (%) 12.0

Resin data:
- Type: Resin taken from column A of main unit 2
- Depth (cm)(during service) 147.3
- Volume (liters) : 6.7 (= 1 bed volume)

Hardness Leakage: Service product water (analysed during test)

Time	Thruput (bv)	Calcium (meq/l)	Total (meq/l)
5.0	1.1	0.4	1.0
10.0	1.9	0.3	0.8
25.0	4.3	0.3	0.7
50.0	8.3	0.3	0.7
80.0	13.2	0.3	0.7
110.0	18.0	0.3	0.8
130.0	21.2	0.3	0.7
160.0	26.0	0.4	2.2
170.0	27.6	0.6	8.0
180.0	29.2	0.9	18.0
190.0	30.8	1.5	34.0
200.0	32.4	2.4	43.2

Operating Conditions:

Event	Input	Output	Duration (min.)	Thruput (liters)	Volume (bv)	Average Flow Rate (l/min.)	Average Flow Rate (bv/min.)	Bed Expansion (%)
Regeneration A	Fr. Regenerant	Waste	14	13.3	2.0	1.0	0.1	
Regeneration B	Fr. Regenerant	Sp. Regenerant	26	25.0	3.7	1.0	0.1	50.0
Regeneration C	Fr. Regenerant	Sp. Regenerant	10	7.2	1.1	0.7	0.1	36.2
Drain		Waste						
Rinse A	Feed	Waste	5	2.6	0.4	0.5	0.1	
Rinse B	Feed	Waste	4	4.0	0.6	1.0	0.1	
Service	Feed	Product	200	216.2	32.1	1.1	0.2	

Service Performance Summary:

	Influent (meq/l)	Average Effluent (meq/l)	Difference (meq/l)	Removal (%)	Resin Capacity (eq/l of resin)
Calcium	28.0	0.7	27.3	97.3	0.8
Total Hardness	53.0	5.8	47.2	89.1	1.5
Sodium	480.4	288.3	192.0		

Regeneration Performance Summary:

	Brine Influent (meq/l)	Total Thruput (eq/l of resin)	Average Effluent (meq/l)	Difference (inf-eff) (meq/l)	Resin Absorbance (eq/l of resin)
Calcium	23.6	--	40.3	-16.7	-0.1
Total Hardness	64.6	--	158.6	-94.1	-0.5
Sodium	1790.4	10.3	1761.3	29.1	0.2

Test: Resin capacity test 8

CHEMICAL ANALYSES:	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
PW Influent	28.0	53.0	480.35?	13500	0.7	8.6	42.3	72.9	0.7
Product at Ser160	0.4	0.9	187.8	13500	0.4	8.8	45.1	87.4	1.4
Product at Ser200	0.8	18.3	148.5	13200	0.4	8.8	45.1	72.9	1.4
Fr.Brine	23.6	64.6	1790.4	100100	NA	NA	507.5	499.7	1.9
UsedBrine	42.0	154.7	2008.7	100600	NA	NA	591.9	499.7	2.0

? sodium analysis noted questionable by lab

INSTANTANEOUS EFFLUENT SAMPLES:

Regen.	Thruput (bv)	Regen. time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.44	10	38.7	205.4	1659.4	110700	NA	NA	761.1	374.8	1.7
	1.43	17	45.3	236.0	1615.7	105000	NA	NA	591.9	416.4	1.9
	2.43	24	41.3	160.0	1790.4	101700	NA	NA	549.6	499.7	1.9
	3.43	31	42.7	152.0	1790.4	100300	NA	NA	NA	NA	NA
	4.42	38	38.7	125.3	1790.4	100600	NA	NA	NA	NA	NA
	5.24	45	38.1	101.8	1834.1	100900	NA	NA	NA	NA	NA
	5.78	50	38.1	99.0	2052.4	101300	NA	NA	451.1	458.0	2.4

Service	Thruput (bv)	Service time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.32	0	34.4	75.0	2052.4	94300	NA	NA	751.8	416.4	1.9
	0.96	4	0.5	1.1	183.4	15400	NA	NA	47.9	87.4	1.4
	1.44	7	0.4	0.9	170.3	14200	NA	NA	42.3	72.9	1.5
	1.92	10	0.3	0.8	157.2	13600	NA	NA	42.3	83.3	1.3
	2.40	13	0.3	0.7	157.2	13500	NA	NA	NA	NA	NA
	4.33	25	0.3	0.7	152.8	13200	NA	NA	NA	NA	NA
	8.34	50	0.3	0.7	152.8	13300	NA	NA	NA	NA	NA
	17.97	110	0.3	0.7	165.9	13200	NA	NA	NA	NA	NA
	25.99	160	0.4	2.2	157.2	13200	NA	NA	43.7	79.1	1.3
	27.60	170	0.4	7.6	148.5	13200	0.4	NA	42.3	72.9	1.4
	29.20	180	0.9	38.7	135.4	12700	0.4	NA	43.7	83.3	1.4
	32.41	200	2.6	42.3	113.5	12000	0.4	NA	43.7	83.3	1.2

Notes:

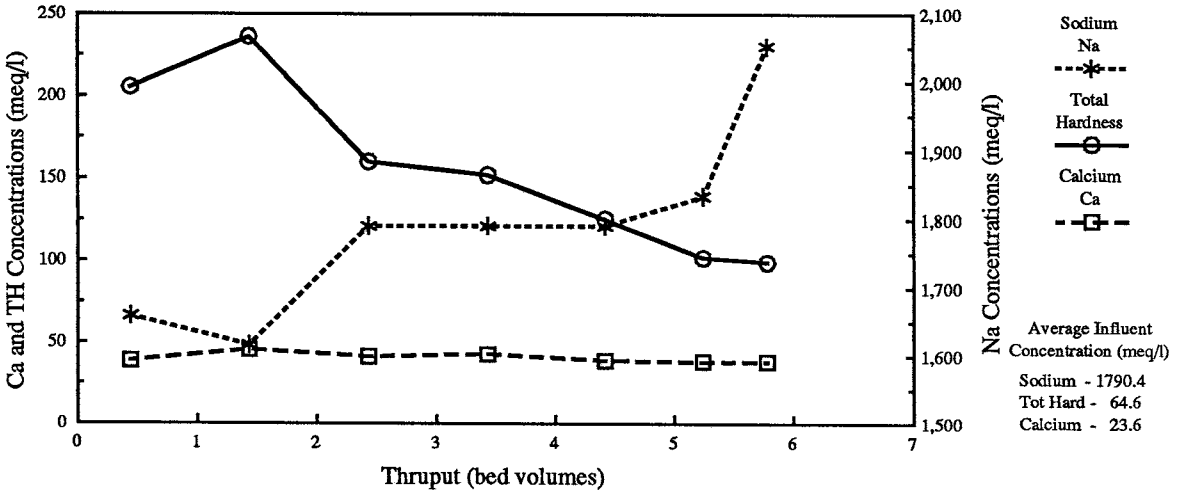
1. PW tank drained from 45 gallons to about 8 gallons at Ser160.
2. Pw tank at about 18.25 gallons at Ser200.
3. Resin level at beginning of test at 137cm.(in 12% NaCl brine).
4. Resin level at end of service at 147cm..

Major Cation Concentrations

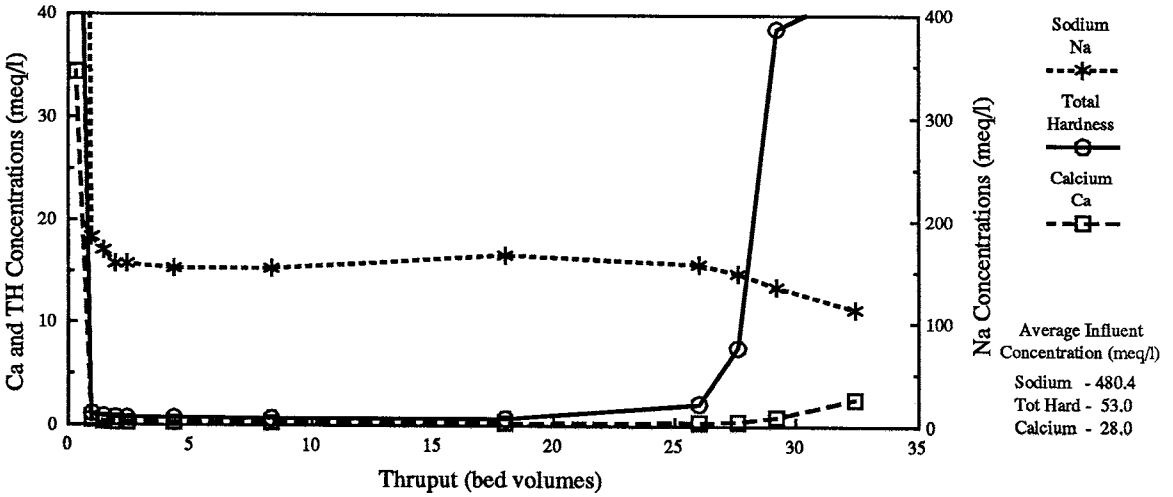
IX Bench Unit

Resin Capacity Test 8

IX Regeneration Effluent



IX Service Effluent



Test: Series 300 Resin capacity test 9

Date: October 30, 1985

Purpose: 1. Determine resin capacity
2. Condition resin for testing

Influent process water: filtered clarifier

Regenerant brine:
Type: none, see notes
Temperature (C): 17 (process water)
Concentration (%)see notes

Resin data:
Type: Dowex HCR-S
Depth (cm)(during service) 147.3
Volume (liters) : 6.7 (= 1 bed volume)

Hardness Leakage: Service product water (analysed during test)

Time	Thruput (bv)	Calcium (meq/l)	Total (meq/l)
5.0	1.4	<0.20	<0.20
10.0	2.2	<0.20	<0.20
15.0	3.0	<0.20	<0.20
25.0	4.6	<0.20	<0.20
80.0	13.4	<0.20	<0.20
80.0	13.4	<0.20	<0.20
120.0	19.9	<0.20	<0.20
180.0	29.5	<0.20	<0.20
240.0	39.2	<0.20	<0.20
285.0	46.4	<0.20	<0.20
315.0	51.2	0.7	NA
375.0	60.9	1.8	NA
435.0	70.5	4.7	NA

Operating Conditions:

Event	Input	Output	Duration (min.)	Thruput (liters)	Volume (bv)	Average Flow Rate (l/min.)	(bv/min.)	Bed Expansion (%)
Regeneration A	Fr. Regenerant	Waste	see note	see note	--	--	--	--
Regeneration B	Fr. Regenerant	Sp. Regenerant	" "	" "	--	--	--	--
Regeneration C	Fr. Regenerant	Sp. Regenerant	" "	" "	--	--	--	--
Drain		Waste						
Rinse A	Feed	Waste	5	4.7	0.7	0.9	0.1	
Rinse B	Feed	Waste	4	3.5	0.5	0.9	0.1	
Service	Feed	Product	210	227.6	33.8	1.1	0.2	

Service Performance Su see notes

	Influent (meq/l)	Average Effluent (meq/l)	Difference (meq/l)	Removal (%)	Resin Capacity (eq/l of resin)
Calcium	22.0	0.0	22.0	99.8	0.7
Total Hardness	40.9	0.1	40.8	99.7	1.4
Sodium	78.6	98.2	-19.6		

Test: Resin capacity test 9

CHEMICAL ANALYSES:	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
PW Influent	22.0	40.9	78.6	8100	0.2	7.4	42.3	62.5	1.4
Product1 at Ser162	0.1	0.1	104.8	9200	0.3	NA	33.8	60.4	1.1
Fr.Brine	see notes	NA	NA	NA	NA	NA	NA	NA	ERR
Recycle Brine	NA	NA	NA	NA	NA	NA	NA	NA	NA
Used Brine	NA	NA	NA	NA	NA	NA	NA	NA	NA

INSTANTANEOUS EFFLUENT SAMPLES:

Service	Thruput (bv)	Service time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.55	0	0.1	0.2	122.3	10600	NA	NA	47.9	66.6	1.1
	1.19	4	0.1	0.2	96.1	9200	NA	NA	33.8	62.5	1.0
	1.68	7	0.1	0.1	100.4	9200	NA	NA	33.8	64.5	1.0
	2.16	10	0.1	0.2	104.8	9500	NA	NA	NA	NA	NA
	2.64	13	0.0	0.1	100.4	9100	NA	NA	NA	NA	NA
	4.57	25	0.0	0.1	104.8	9000	NA	NA	NA	NA	NA
	15.03	90	0.0	0.1	100.4	8700	NA	NA	NA	NA	NA
	26.29	160	0.1	0.1	87.3	9400	NA	NA	NA	NA	NA
	34.33	210	0.0	0.1	104.8	9400	NA	NA	31.0	66.6	1.1

Notes:

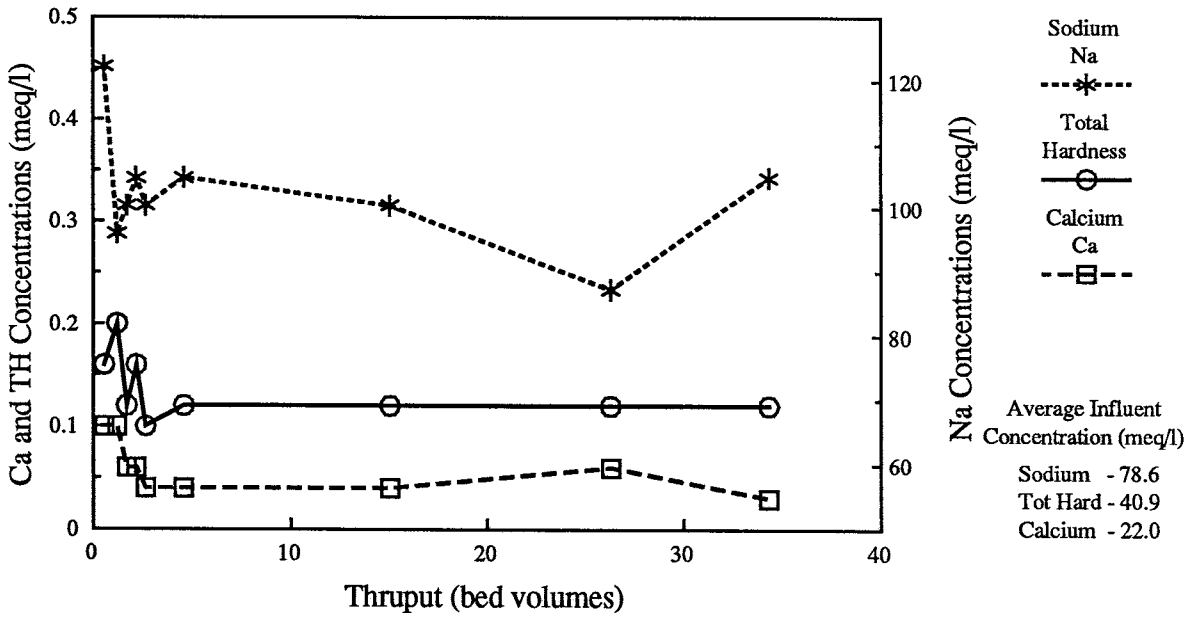
1. New resin. No regeneration. Resin stored in 6% NaCl brine previous to first run.
2. Resin stored in process water after test.
3. PW tank drained from 41 gal. to 10 gal. at Ser162
4. Product1 taken at Ser162.
5. Resin capacities as shown on page 1 in The Service Performance Summary are to service at 210 minutes.

Major Cation Concentrations

IX Bench Unit

Resin Capacity Test 9

IX Service Effluent



Test: Series 300 Resin capacity test 10

Date: October 31, 1985

Purpose: 1. Determine resin capacity
2. Condition resin for testing

Influent process water: filtered clarifier

Regenerant brine:
Type: none, see notes
Temperature (C): 16 (process water)
Concentration (%) --

Resin data:
Type: Amberlite IR-120
Depth (cm)(during service) 145.5
Volume (liters) : 6.7 (= 1 bed volume)

Hardness Leakage: Service product water (analysed during test)

Time	Thruput (bv)	Calcium (meq/l)	Total (meq/l)
5.0	0.4	<0.20	<0.20
10.0	1.2	<0.20	<0.20
15.0	2.0	<0.20	<0.20
25.0	3.5	<0.20	<0.20
80.0	12.1	<0.20	<0.20
80.0	12.1	<0.20	<0.20
120.0	18.4	<0.20	<0.20
180.0	27.8	<0.20	<0.20
245.0	38.0	<0.20	<0.20
300.0	46.6	18.0	18.6
310.0	48.2	30.0	NA

Operating Conditions:

Event	Input	Output	Duration (min.)	Thruput (liters)	Volume (bv)	Average Flow Rate (l/min.)	(bv/min.)	Bed Expansion (%)
Regeneration A	Fr. Regenerant	Waste	see note	see note	--	--	--	--
Regeneration B	Fr. Regenerant	Sp. Regenerant	" "	" "	--	--	--	--
Regeneration C	Fr. Regenerant	Sp. Regenerant	" "	" "	--	--	--	--
Drain		Waste						
Rinse A	Feed	Waste	5	3.0	0.4	0.6	0.1	
Rinse B	Feed	Waste	4	4.2	0.6	1.0	0.2	
Service	Feed	Product	300	325.1	48.9	1.1	0.2	

Service Performance Summary:

	Influent (meq/l)	Average Effluent (meq/l)	Difference (meq/l)	Removal (%)	Resin Capacity (eq/l of resin)
Calcium	21.5	0.3	21.2	98.8	1.2
Total Hardness	39.9	9.2	30.7	76.9	1.7
Sodium	74.2	114.4	-40.1		

Test: Resin capacity test 10

CHEMICAL ANALYSES:	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
PW Influent	21.5	39.9	74.2	47100	0.1	7.4	33.8	58.3	1.5
Product1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Product2	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fr.Brine	NA	NA	NA	NA	NA	NA	NA	NA	NA
Recycle Brine	NA	NA	NA	NA	NA	NA	NA	NA	NA
Used Brine	NA	NA	NA	NA	NA	NA	NA	NA	NA

INSTANTANEOUS EFFLUENT SAMPLES:

Service	Thruput (bv)	Service time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.39	0	0.9	2.1	655.0	9800	NA	NA	521.7	60.4	1.1
	1.04	4	0.1	0.1	126.6	45800	NA	NA	49.4	60.4	1.2
	1.53	7	0.1	0.1	117.9	12100	NA	NA	36.7	58.3	1.2
	2.02	10	0.1	0.1	117.9	10400	NA	NA	33.8	79.1	1.0
	4.46	25	0.1	0.1	113.5	9600	NA	NA	NA	NA	NA
	15.05	90	0.1	0.2	113.5	9500	NA	NA	NA	NA	NA
	29.70	180	0.1	0.1	113.5	9500	NA	NA	NA	NA	NA
	39.47	240	0.0	0.1	117.9	9600	NA	NA	31.0	64.5	1.2
	49.24	300	0.5	20.1	100.4	9100	0.1	NA	33.8	68.7	1.2
	50.87	310	0.5	25.9	96.1	8900	0.1	NA	31.0	70.8	1.2
	52.50	320	1.2	30.7	91.7	8600	0.1	NA	31.0	70.8	1.2
	54.13	330	1.5	33.4	96.1	8700	0.1	7.6	33.8	79.1	1.2
		Ave.leak	0.3	9.2	114.4						

Notes:

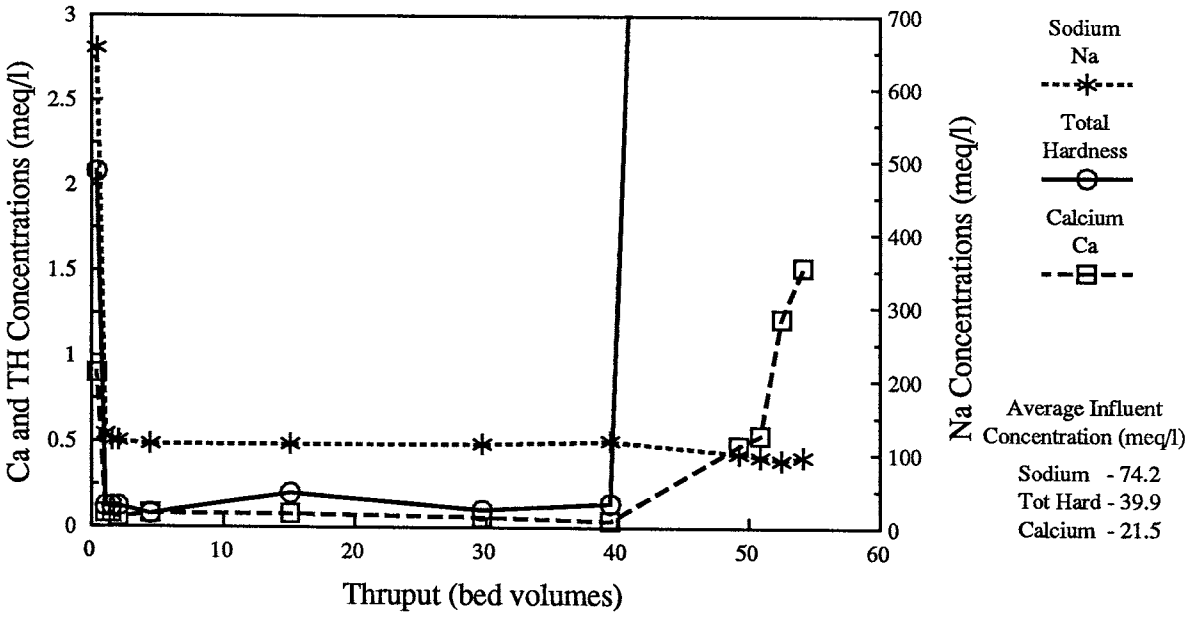
1. New resin. No regeneration. Resin stored in 6% NaCl brine previous to first run.
2. Resin stored in process water after test.

Major Cation Concentrations

IX Bench Unit

Resin Capacity Test 10

IX Service Effluent



Test: Series 300 Resin capacity test 11

Date: Oct. 4, 1985

Purpose: Determine resin capacity

Influent process water: filtered clarifier

Regenerant brine:
- Type: Rotating Evaporator Disk
- Temperature (C): 18
- Concentration (%) 12.0

Resin data:
- Type: Resin taken from column A of main unit 2
- Depth (cm)(during service) 148.6
- Volume (liters) : 6.8 (= 1 bed volume)

Hardness Leakage: Service product water (analysed during test)

Time	Thruput (bv)	Calcium (meq/l)	Total (meq/l)
5.0	0.2	0.7	0.9
15.0	1.8	0.6	0.8
25.0	3.4	0.6	0.9
65.0	9.9	0.5	0.8
120.0	18.7	0.5	0.9
180.0	28.4	0.6	0.9
210.0	33.3	0.6	1.0
220.0	34.9	0.6	1.2
230.0	36.5	0.7	1.9
240.0	38.1	1.0	4.4
250.0	39.7	1.2	9.8
260.0	41.4	1.8	17.2
270.0	43.0	2.6	25.2

Operating Conditions:

Event	Input	Output	Duration (min.)	Thruput (liters)	Volume (bv)	Average Flow Rate (l/min.)	Average Flow Rate (bv/min.)	Bed Expansion (%)
Regeneration A	Fr. Regenerant	Waste	see notes					
Regeneration B	Fr. Regenerant	Sp. Regenerant	" "					
Regeneration C	Fr. Regenerant	Sp. Regenerant	" "					
Rinse A	Feed	Waste	" "					
Rinse B	Feed	Waste	" "					
Service	Feed	Product	270	296.5	43.6	1.1	0.2	

Service Performance Summary:

	Influent (meq/l)	Average Effluent (meq/l)	Difference (meq/l)	Removal (%)	Resin Capacity (eq/l of resin)
Calcium	25.2	0.7	24.5	97.2	1.1
Total Hardness	41.4	2.4	39.1	94.3	1.7
Sodium	96.1	125.4	-29.4		

Test: Resin capacity test 11

CHEMICAL ANALYSES:	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
PW Influent	25.2	41.4	96.1	9100	0.1	7.7	36.7	108.3	1.1
Product1	0.6	4.4	139.7	10300	0.1	7.8	39.5	99.9	1.0
Product2	0.9	3.5	144.1	10200	0.1	7.8	33.8	108.3	1.0
Fr.Brine	see notes								
Recycle Brine	" "								
Used Brine	" "								

INSTANTANEOUS EFFLUENT SAMPLES:

Service	Thruput (bv)	Service time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	3.39	25	0.8	0.9	131.0	10200	NA	NA	36.7	99.9	1.0
	12.27	80	0.7	0.9	131.0	10200	NA	NA	36.7	93.7	1.0
	18.74	120	0.5	1.0	139.7	10300	NA	NA	36.7	89.5	1.1
	28.44	180	0.6	0.8	144.1	10300	NA	NA	33.8	93.7	1.1
	33.28	210	0.5	0.9	139.7	10300	NA	NA	NA	NA	NA
	34.90	220	0.6	1.1	139.7	10300	NA	NA	NA	NA	NA
	36.52	230	0.7	2.0	131.0	10300	NA	NA	NA	NA	NA
	38.13	240	1.6	4.0	135.4	10200	NA	NA	NA	NA	NA
	39.75	250	1.4	8.7	135.4	10100	NA	NA	33.8	104.1	1.1
	41.36	260	1.9	18.0	126.6	9700	NA	NA	36.7	89.5	1.2
	42.98	270	2.3	23.2	117.9	9600	NA	NA	33.8	91.6	1.1

Notes:

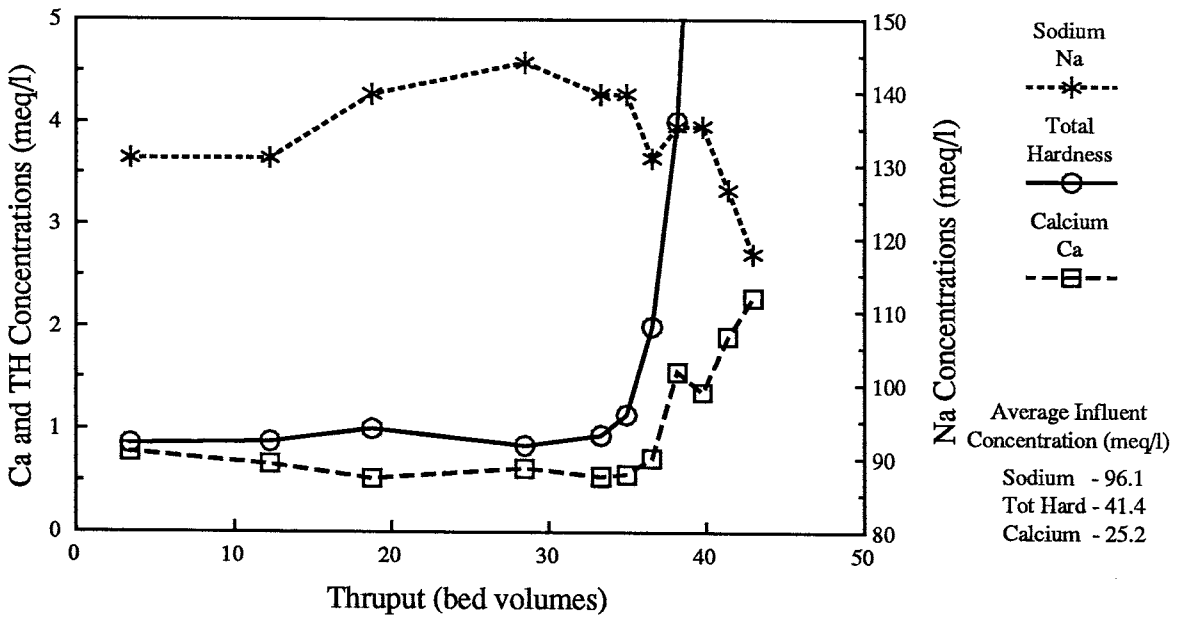
1. Air pocket formed in column during regeneration causing resin to be pushed up and out of the column. While performing a series of up/downflow operations to work out the air pocket, a white precipitate (presumedly CaSO4) formed in the column. Cleaned bed with about 9.5 gallons of 13.5% NaCl brine at a flow rate of approximately 1.4 l/minute. The white preciptate appeared to have dissolved with the cleaning. The resin soaked in the NaCl brine for about two hours before continuing the test. The test was restarted at service.
2. Product 1 sample at Ser 180 and then drained PW tank from 45 to 10 gallons.
3. Product 2 at Ser 270 with 33.5 gallons in PW tank.

Major Cation Concentrations

IX Bench Unit

Resin Capacity Test 11

IX Service Effluent



Test: Series 300 Resin capacity test 12

Date: Nov. 7, 1985

Purpose: Determine resin capacity

Influent process water: filtered clarifier

Regenerant brine:
- Type: Rotating evaporator disk
- Temperature (C): 16
- Concentration (%) 12.0

Resin data:
- Type: Amberlite IR 120
- Depth (cm)(during service) 149.9
- Volume (liters) : 6.9 (= 1 bed volume)

Hardness Leakage: Service product water (analysed during test)

Time	Thruput (bv)	Calcium (meq/l)	Total (meq/l)
5.0	1.1	2.4	4.4
7.0	1.5	2.2	3.2
10.0	1.9	1.5	3.0
13.0	2.4	1.1	2.0
25.0	4.4	0.7	1.3
70.0	11.6	0.5	1.0
110.0	18.0	0.5	1.0
170.0	27.6	0.5	1.0
180.0	29.2	0.5	1.2
190.0	30.8	0.7	1.9
200.0	32.4	0.8	5.0
210.0	34.0	1.2	9.4
220.0	35.6	1.6	17.6
225.0	36.4	2.0	23.6

Operating Conditions:

Event	Input	Output	Duration (min.)	Thruput (liters)	Volume (bv)	Average Flow Rate (l/min.)	Average Flow Rate (bv/min.)	Bed Expansion (%)
Regeneration A	Fr. Regenerant	Waste	14	13.7	2.0	1.0	0.1	see notes
Regeneration B	Fr. Regenerant	Sp. Regenerant	26	24.7	3.6	0.9	0.1	" "
Regeneration C	Fr. Regenerant	Sp. Regenerant	10	6.9	1.0	0.7	0.1	39.0
Drain		Waste			0.3			
Rinse A	Feed	Waste	5	2.8	0.4	0.6	0.1	
Rinse B	Feed	Waste	4	3.9	0.6	1.0	0.1	
Service	Feed	Product	225	247.2	36.1	1.1	0.2	

Service Performance Summary:

	Influent (meq/l)	Average Effluent (meq/l)	Difference (meq/l)	Removal (%)	Resin Capacity (eq/l of resin)
Calcium	23.1	1.3	21.7	94.3	0.8
Total Hardness	42.3	3.9	38.4	90.9	1.5
Sodium	104.8	170.5	-65.7		

Regeneration Performance Summary:

	Brine Influent (meq/l)	Total Thruput (eq/l of resin)	Average Effluent (meq/l)	Difference (inf-eff) (meq/l)	Resin Absorbance (eq/l of resin)
Calcium	21.6	--	30.4	-8.8	-0.0
Total Hardness	59.0	--	163.4	-104.4	-0.6
Sodium	1746.7	9.9	1591.9	154.9	0.9

Test: Resin capacity test 12

CHEMICAL ANALYSES:	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
PW Influent	23.1	42.3	104.8	10800	0.5	7.5	36.7	108.3	1.2
Product1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Product2	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fr.Brine	21.6	59.0	1746.7	98300	3.3	8.6	668.4	395.6	1.7
Recycle Brine	none								
Used Brine	NA	NA	NA	NA	NA	NA	NA	NA	NA

INSTANTANEOUS EFFLUENT SAMPLES:

Regen.	Thruput (bv)	Regen. time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.48	10	33.2	344.0	960.7	72100	NA	NA	NA	NA	NA
	1.47	17	NA	NA	NA	NA	NA	NA	NA	NA	NA
	2.43	24	30.1	149.4	1659.4	97400	NA	NA	NA	416.4	NA
	3.04	33	28.9	113.6	1790.4	95400	NA	NA	NA	NA	NA
	3.73	38	28.8	101.0	1790.4	98600	NA	NA	NA	NA	NA
	5.16	45	31.2	99.6	1834.1	97300	NA	NA	745.6	NA	NA
	5.66	50	33.9	96.8	1877.7	97800	NA	NA	775.5	905.7	1.2

Service	Thruput (bv)	Service time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.34	0	38.0	81.9	1746.7	88300	NA	NA	662.7	999.4	1.1
	0.98	4	3.4	5.1	266.4	20200	NA	NA	49.4	270.7	0.9
	1.47	7	2.1	3.0	200.9	14600	NA	NA	36.7	143.7	1.1
	1.95	10	NA	NA	179.0	12800	NA	NA	36.7	131.2	NA
	2.43	13	NA	NA	165.9	11700	NA	NA	NA	NA	NA
	4.35	25	NA	NA	157.2	10900	NA	NA	NA	NA	NA
	11.57	70	NA	NA	157.2	10500	NA	NA	NA	NA	NA
	17.98	110	NA	NA	157.2	10400	NA	NA	NA	NA	NA
	24.40	150	NA	NA	152.8	10400	NA	NA	36.7	114.5	NA
	30.81	190	0.6	1.9	157.2	10300	NA	NA	36.7	104.1	1.1
	32.41	200	0.8	4.2	157.2	10200	NA	NA	33.8	95.8	1.3
	34.02	210	1.1	8.9	152.8	10200	0.1	7.9	33.8	89.5	1.3
	37.06	225	1.9	23.0	139.7	9900	0.1	7.8	33.8	83.3	1.4

Notes:

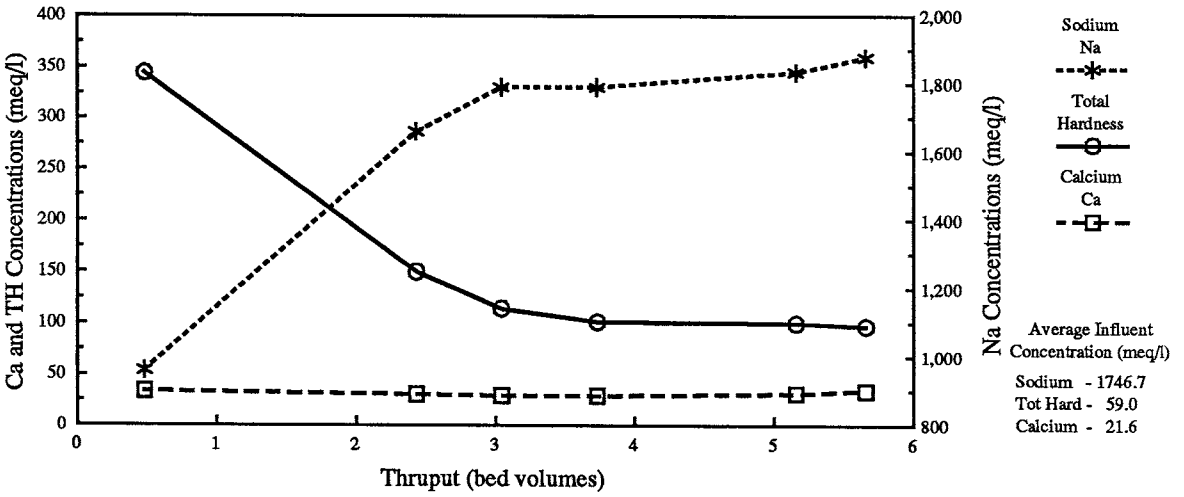
1. Lost resin in regeneration at 12 minutes.
2. White precipitate formed in resin bed during entire regeneration cycle in resin bed.
3. Two inches of white precipitate on top of resin bed during service.
4. PW tank drained from 45 gallons to 10 gallons at Ser 175.
5. PW tank at 24 gallons at Ser225.

Major Cation Concentrations

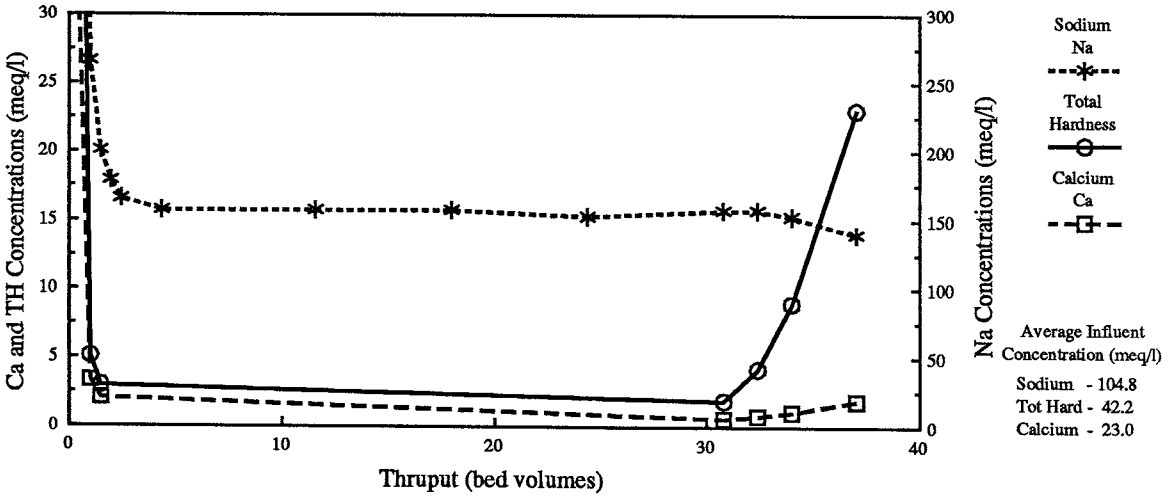
IX Bench Unit

Resin Capacity Test 12

IX Regeneration Effluent



IX Service Effluent



Test: Series 300 Resin capacity test 13

Date: November 14, 1985

Purpose: Determine the ability of the main units' resin to remove using solar pond brine. The solar pond brine will be used during start-up of the main units.

Influent process water: filtered clarifier

Regenerant brine:
- Type: solar pond
- Temperature (C): 9
- Concentration (%) 15.0

Resin data:
- Type: Resin taken from column B of main unit 2
- Depth (cm)(during service) 132.1
- Volume (liters) : 6.0 (= 1 bed volume)

Hardness Leakage: Service product water (analysed during test)

Time	Thruput (bv)	Calcium (meq/l)	Total (meq/l)
0.0	0.7	1.4	4.1
5.0	1.7	0.3	1.1
10.0	2.7	0.3	1.0
25.0	5.6	0.3	0.9
50.0	10.4	0.3	0.9
90.0	18.2	0.3	0.9
120.0	24.0	0.3	0.9
140.0	27.9	0.3	0.9
160.0	31.8	0.3	1.0
180.0	35.6	0.4	2.0
190.0	37.6	0.5	7.0
205.0	40.5	1.0	22.4
215.0	42.4	1.4	31.6

Operating Conditions:

Event	Input	Output	Duration (min.)	Thruput (liters)	Volume (bv)	Average Flow Rate (l/min.)	Average Flow Rate (bv/min.)	Bed Expansion (%)
Regeneration A	Fr. Regenerant	Waste	0					
Regeneration B	Fr. Regenerant	Used Regenerant	43	39.2	6.5	0.9	0.2	
Regeneration C	Fr. Regenerant	Used Regenerant	7	4.7	0.8	0.7	0.1	59.6
Drain		Waste		2.9	0.5			
Rinse A	Feed	Waste	5	4.1	0.7	0.8	0.1	
Rinse B	Feed	Waste	6	5.4	0.9	0.9	0.1	
Service	Feed	Product	207	242.3	40.1	1.2	0.2	

Service Performance Summary:

	Influent (meq/l)	Average Effluent (meq/l)	Difference (meq/l)	Removal (%)	Resin Capacity (eq/l of resin)
Calcium	27.4	1.9	25.5	93.1	1.0
Total Hardness	41.7	6.8	34.9	83.6	1.4
Sodium	74.2	113.8	-39.5		

Regeneration Performance Summary:

	Brine Influent (meq/l)	Total Thruput (eq/l of resin)	Average Effluent (meq/l)	Difference (inf-eff) (meq/l)	Resin Absorbance (eq/l of resin)
Calcium	79.3	--	78.6	0.7	0.0
Total Hardness	275.3	--	263.3	12.0	0.1
Sodium	2227.1	13.6	1991.0	236.1	1.4

Test: Resin capacity test 13

CHEMICAL ANALYSES:	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
PW Influent	27.4	41.7	74.2	9600	0.1	7.5	338.4	145.7	0.3
Product1	0.3	1.0	122.3	10000	NA	NA	338.4	95.8	0.3
Product2	1.3	12.2	109.2	9800	NA	NA	338.4	124.9	0.3
Fr.Brine	79.3	275.3	2227.1	142200	NA	NA	225.6	603.8	3.1
Recycle Brine	NA	NA	NA	NA	NA	NA	NA	NA	NA
Used Brine	92.0	248.7	1965.1	143800	NA	NA	169.2	562.1	3.2

INSTANTANEOUS EFFLUENT SAMPLES:

Regen.	Thruput (bv)	Regen. time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.34	10	41.3	110.0	873.4	68100	NA	NA	NA	NA	NA
	1.40	17	64.7	272.7	2052.4	136200	NA	NA	NA	NA	NA
	2.46	24	82.0	278.0	2139.7	138100	NA	NA	NA	NA	NA
	2.60	31	87.3	294.7	2270.7	142600	NA	NA	NA	NA	NA
	3.66	38	90.7	284.7	2052.4	143100	NA	NA	NA	NA	NA
	5.89	45	88.7	288.0	2227.1	144300	NA	NA	NA	NA	NA
	6.11	50	89.3	284.7	2270.7	144300	NA	NA	NA	NA	NA

Service	Thruput (bv)	Service time	Ca (meq/l)	TH (meq/l)	Na (meq/l)	Ec (uS/cm)	Turb. (NTU)	pH	Chloride (meq/l)	Sulfate (meq/l)	Ratio Cat/Anion
	0.74	0	3.4	15.3	262.0	24100	NA	NA	NA	NA	NA
	1.52	4	1.1	4.1	122.3	11100	NA	NA	NA	NA	NA
	2.10	7	0.8	5.1	113.5	10300	NA	NA	NA	NA	NA
	2.68	10	0.8	1.9	113.5	10100	NA	NA	NA	NA	NA
	3.26	13	1.1	1.9	113.5	10100	NA	NA	NA	NA	NA
	5.59	25	0.9	2.1	113.5	9800	NA	NA	NA	NA	NA
	10.43	50	0.7	4.5	117.9	9700	NA	NA	NA	NA	NA
	18.19	90	0.9	1.6	113.5	9800	NA	NA	NA	NA	NA
	27.88	140	0.9	2.0	113.5	9800	0.1	NA	NA	NA	NA
	35.63	180	8.0	9.3	113.5	9800	NA	NA	NA	NA	NA
	38.54	195	0.9	14.8	109.2	9600	NA	NA	NA	NA	NA
	40.48	205	1.6	26.5	100.4	9400	NA	NA	NA	NA	NA

Notes:

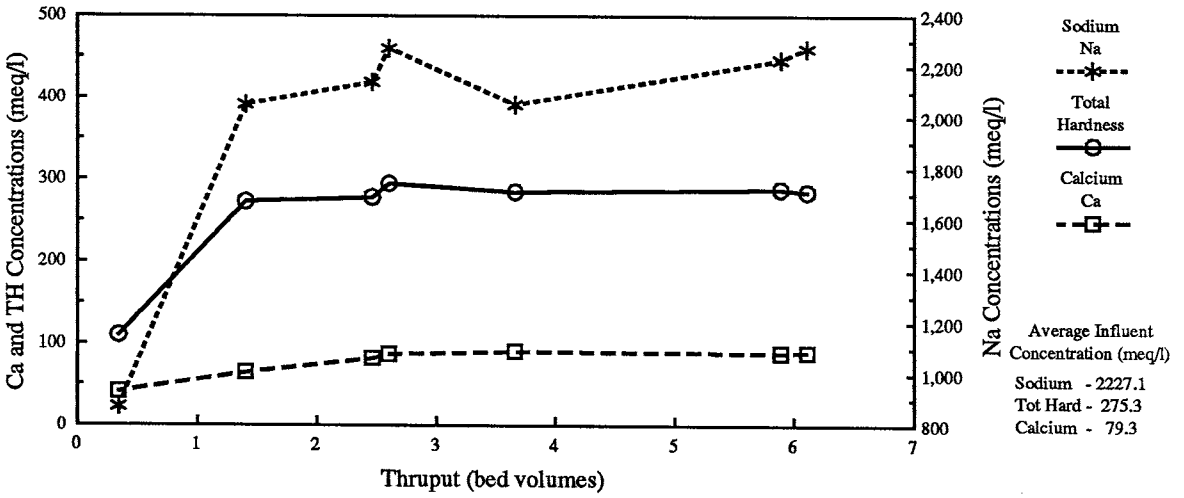
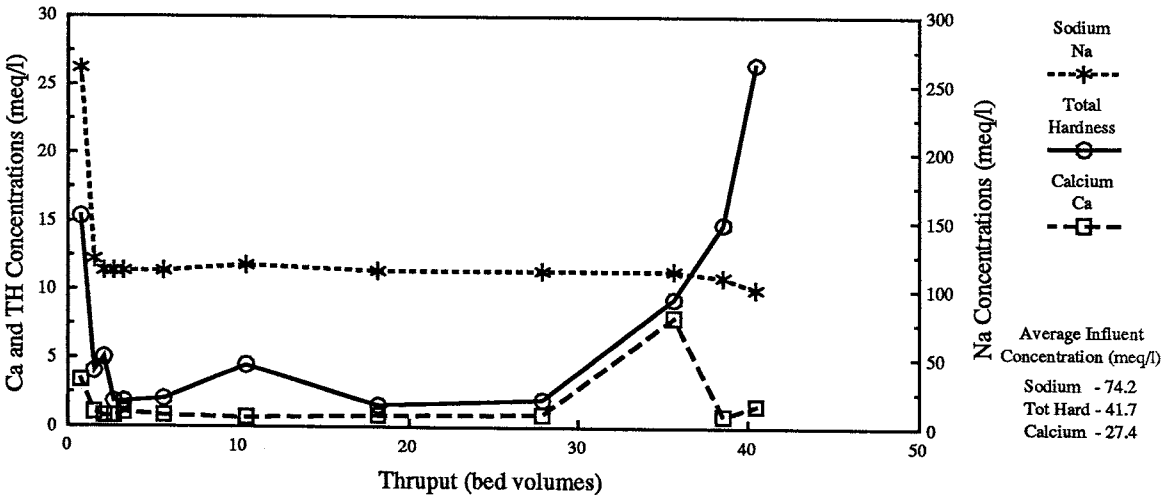
1. Resin stored in process water prior to test.
2. Resin level at 48.5 inches at beginning of test.
3. Lost resin 12 minutes into regeneration.
4. Stopped losing resin 28 minutes into regeneration.
5. PW tank drained to 10 gal. from 50 gal. 170 minutes into Service.
6. PW tank level at 23.5 gallons when shut-down at Ser220.

Major Cation Concentrations

IX Bench Unit

Resin Capacity Test 13

IX Regeneration Effluent



IX Service Effluent